MATHEMATICAL

Collections *and* Tranſlations:

In two

TOMES.

MATHEMATICAL COLLECTIONS AND TRANSLATIONS.

THE FIRST TOME.

THE FIRST PART;

Containing,

I. GALILEUS GALILEUS, *His SYSTEME of the World.*

II. GALILEUS, *his EPISTLE to the GRAND DUTCHESSE Mother concerning the Authority of Sacred SCRIPTURE in Philosophical Controversies.*

III. JOHANNES KEPLERUS, *his Reconcilings of SCRIPTURE Texts, &c.*

IV. DIDACUS a STUNICA, *his Reconcilings of SCRIPTURE Texts, &c.*

V. P. A. FOSCARINUS, *his Epistle to Father FANTONUS, reconciling the Authority of Sacred SCRIPTURE, and Judgments of Divines alledged against, &c.*

By *THOMAS SALUSBURY, Esq.*

LONDON,
Printed by WILLIAM LEYBOURNE, MDCLXI.

To the Noble and moſt perfectly Accompliſhed

Sr. JOHN DENHAM

Knight of the Noble Order of the

BATH,

And Surveyor General of his Maties Works, &c.

SIR,

I Humbly begge your Pardon for bringing this Book under your Protection. Were it a VVork of my own, or I any thing but the Tranſlatour, I ſhould maſter my Thoughts to a meaner Dedication; But being a Collection of ſome of the greateſt Maſters in the VVorld, and never made English till now, I conceived I might ſooner procure their VVelcome to a perſon ſo eminent for Noble Candor, as well as for all thoſe Intellectual Excellencies wherewith Your Rich Soul is known to be furnished. I reſolv'd to be as kind to this Book as I could, and

and ſeriouſly conſidering which way to effect it, I at laſt concluded to prefix Your Name, whom His Majeſty and all his Subjects, (who have a higher Senſe and Judgement of Excellent Parts) know beſt able to defend my Imperfections. And yet I confeſs there's one thing makes againſt me, which is your eminent Integrity and great Affection to Truth, whereby my Lapſes in a VVork of this Nature might juſtly deſpair of Shelter, but that the Excellency of Your Native Candor ſtrives for Predominancy over all Your great Abilities. For 'tis all-moſt impoſſible to think what Your Matchleſs VVit is not able to Conquer, would Your known Modeſty but give leave: therefore *Galileus*, *Kepler*, and thoſe other Worthies in Learning are now brought before You in English Habit; having chang'd their Latine, Italian and French; whereby they were almoſt Strangers to our Nation, unleſs to ſuch as You, who ſo perfectly maſter the Originals. I know you have ſo much and great imployment for His Majeſty, and his good Subjects that I ſhall not robb you of another Minutes loſs; beſides the liberty of ſubſcribing my Self;

SIR,

Your Honours

Moſt Humble and
Moſt obedient Servant

THOMAS SALUSBURY.

READER,

MAthematical Learning (to speak nothing touching the necessity & delight thereof) hath bin so sparingly imparted to our Countrymen in their native English, especially the nobler and sublimer part, that in Compliance with the Solicitations of several of my noble and learned Friends, and the Inclinations of such as are Mathematically disposed, more especially those; who either want Time or Patience to look into the vulgar and unstudied Languages, I did adventure upon this Work of Collecting & Translating from amongst the excellent Pieces that are so abounding in the Italian and French Tongues, some of those that my own observation and the intimation of Friends were most usefull and desired, and with all most wanting in their Own.

I was, indeed, at first seriously Conscious, and am now, by experience, fully convinced how disproportionate the weight of the Enterprize is to the weakness of the Undertaker, but yet the Passion I ever had to be subservient to my Friends and Compatriots in their Inquisition after these Sublime Studies, and a Patience which I owe to the Flegme that is predominant in my Constitution, joyned with a nine-years converse in these Languages, as also an unhappy and long Vacation that the persecutions of the late Tyrants gave me from more advantagious employments so prevailed with me, that I resolved to improve even my very Confinement to serve those Friends, whom, as the Times then stood, I could not see.

The Book being for Subject and Design intended chiefly for Gentlemen, I have bin as careless of using a studied Pedantry in my Style; as careful in contriving a pleasant and beautiful Impression. And when I had considered the hazard, and computed the charge of the undertaking, I found it to exceed the ability of a private Purse, especially of mine, that had bin so lately emptied by the hand of violent enemies, and perfidious friends; not to make mention here of the Sums that a Loyal Reflexion upon my Princes Affairs had at the same time drawn from me; and judg'd that the most safe, easy, and reasonable way was to invite those Persons who had appeared desirous of the Book, to be contributary to their own Contentment, by subscribing towards the charge of this Publication.

And for the better management of the Work, I joyned to my self a Printer, whose Genius having rendered him Mathematical, and my overtures of profit having interessed his diligence, I was induced to promise my self a more than common Assistance from him: and at his door I with reason lay all miscarriages that concerns his Profession in the Business.

In this Work I found [illegible]inary Encouragement from that publick spirited Person the Reverend and Learned Dr. Thomas Barlow, Provost of Queens Colledge Oxford, and Margaret Professor in that University, as also from those two able Mathematicians and my Reall Friends Major Miles Symner, and Mr. Robert Wood of Trinity Colledge Dublin, and some few others whose Modesty hath expresly enjoin'd me a concealment of their Names.

Well, at length I have got to the end of my first Stage; and if I have not rid Post, let my excuse be that my long stay for my Warrant caused me to set out late; and being ill mounted, and in a road full of rubbs, I could not with any safety go faster; but hope to get it up in the next Stage, for in that I intend to shift my Horses.

The names of those Authors and Treatices which I judged would most grace our Language, and gratify Students, are particularly exprest in the General Title of the two Tomes. Distinct Tomes they are as consisting of several Pieces: Collections I call them, because they have bin so published, disperst, and worn out of Print, that they very rarely meet in one hand: and Translations I own them to be, as not pretending to any thing more than the disposure and conversion of them: those Tracts only excepted which compose the second Part of the second Tome.

The first Book which offers it self to your view in this Tome is that singular and unimitable Piece of Reason and Demonstration the Systeme of Galileo. The subject of it is a new and Noble port of Astronomy, to wit the Doctrine and Hypothesis of the Mobility of the Earth and the Stability of the Sun; the History whereof I shall hereafter give you at large in the Life of that famous Man. Only this by the by; that the Reader may not wonder why these Dialogues found so various entertainment in Italy (for he cannot but have heard that though they have been with all veneration valued, read & applauded by the Judicious, yet they were with much detestation persecuted, suppressed & exploded by the Superstitious) I am to tell him that our Author having assigned his intimate Friends Salviati and Sagredo the more successfull Parts of the Challenger, and Moderater, he made the famous Commentator Simplicius to personate the Peripatetick. The Book coming out, and Pope Urban the VIII. taking his Honour to be concern'd as having in his private Capacity bin very positive in declaiming against the Samian Philosophy, and now (as he supposed) being ill delt with by Galileo who had summed up all his Arguments, and put them into the mouth of Simplicius; his Holiness thereupon conceived an implacable Displeasure against our Author, and thinking no other revenge sufficient, he employed his Apostolical Authority, and deals with the Consistory to condemn him and proscribe his Book as Heretical; prostituting the Censure of the Church to his private revenge. This was Galileo's fortune in Italy: but had I not reason to hope that the English will be more hospitable, on the account of that Principle which induceth them to be civil to (I say not to dote on) Strangers, I should fear to be charged with imprudence for appearing an Interpreter to that great Philosopher. And in this confidence I shall forbear to make any large Exordium concerning him or his Book: & the rather in regard that such kind of Gauderies become not the Gravity of the Subject; as also knowing how much (coming from me) they must fall short of the Merits of it, or him: but principally because I court only persons of Judgement & Candor, that can distinguish between a Native Beauty, and spurious Vernish. This only let me premise, though more to excuse my weakness in the menaging, than to insinuate my ability in accomplishing this so arduous a Task, that these profound Dialogues have bin found so uneasy to Translate, that neither affectation of Novelty could induce the French, nor the Translating humour perswade the Germans to undertake them. This difficulty, as I conceived, was charged either upon the Intricacy of this manner of Writing, or upon the singular Elegance in the stile of Galileo, or else upon the

miſcarriage of the unfortunate Mathias Berneggerus *who firſt attempted to turn them into Latine for the benefit of the Learned World.*

I ſhall not preſume to Cenſure the Cenſure which the Church of Rome paſt upon this Doctrine and its Aſſertors. But, on the contrary, my Author having bin indefinite in his diſcourſe, I ſhall forbear to exaſperate, and attempt to reconcile ſuch perſons to this Hypotheſis as devout eſteem for Holy Scripture, and dutifull Reſpect to Canonical Injunctions hath made to ſtand off from this Opinion: and therefore for their ſakes I have at the end of the Dialogues by way of ſupplement added an Epiſtle of Galileo *to Her Moſt Serene Highneſs* Chriſtina Lotharinga *the Grand Dutcheſſe Mother of* Tuſcany; *as alſo certain Abſtracts of* John Kepler, *Mathematician to two Emperours, and* Didacus à Stunica *a famous Divine of Salamanca, with an Epiſtle of* Paulo Antonio Foſcarini *a learned Carmelite of Naples, that ſhew the Authority of Sacred Scripture in determining of Philoſophical and Natural Controverſies: hoping that the ingenious & impartial Reader will meet with full ſatisfaction in the ſame. And leaſt what I have ſpoken of the prohibiting of theſe Pieces by the Inquiſition may deterre any ſcrupulous perſon from reading of them, I have purpoſely inſerted the Imprimatur by which that Office licenced them. And for a larger account of the Book or Author, I refer you to the Relation of his Life, which ſhall bring up the Reare in the Second Tome.*

What remains of this, is that Excellent Diſcourſe of D. Benedetto Caſtelli Abbate di San Benedetto Aloyſio, *concerning the Menſuration of Running Waters, with other Treatiſes of that Learned Prelate, & of the Superintendent* Corſini. *Some may alledge, and I doe confeſs that I promiſed to publiſh the Life of* Galileo *in this place: But the great miſcarriages of Letters from ſome Friends in Italy and elſe where, to whom I am a Debtor for ſeveral Remarques, & from whom I daily expect yet greater Helps concerning the Hiſtory of that famous Perſonage: theſe diſappointments, I ſay, joyned with the undeniable Requeſt of ſome Friends, who were impatient to ſee* Caſtelli *in Engliſh, together with a conſideration of the diſproportionate Bulk that would otherwiſe have bin betwixt the two Volumes, perſwaded me to this exchange. This deviation from my Promiſe I hope is Venial, and for the expiating of it I plead Supererrogation: having in each Tome made ſo large Aditions (though to my great expenſe) that they make neer a third part more than I ſtood by promiſe bound to Publiſh. That this is ſo will appear by comparing the Contents I here prefix with the Advertiſment I formerly Printed. For not to mention thoſe Epitomes of* Kepler *and* à Stunica, *the whole ſecond and following Books of* Caſtelli, *were not come to my hands at the time of my penning that Paper; yet knowing how imperfect the Volume would be without them, they being partly a ſupplement to the Theoremes and Problemes which the Abbot had formerly Printed, and partly experiments that had procured him and his Doctrine a very great Reputation, knowing this I ſaw I apprehended a neceſſity of publiſhing them with the reſt: and hope that if you think [illegible] done therein worth your acknowledgement, you will yet at leaſt account the increaſe of my expence a ſufficient extenuation of the Treſpaſs that thoſe Additions have forced me to commit upon your Patience in point of Time.*

As for the ſecond Tome, I have only this to aſſure the Generous Readers; 1 that I am very confident I ſhall be much more punctual in publiſhing that, than (for the reaſons above related.) I was able to be in ſetting forth this: 2 that they ſhall not be abuſed in advancing of their moneys, (as hath bin uſed in the like caſe) by ſelling the remaining Copyes at an under rate; and 3 that I have a very great care that no diſeſteem may by my means ariſe unto this way of publiſhing Books, for that it is of excellent uſe in uſhering Great and Coſtly Volumes into the World.

To ſay nothing of the diſadvantages of Tranſlations in general, this of mine doubtleſs is not without it's Errours, and overſights: but thoſe of the Printer diſcounted, I hope the reſt may be allowed me upon the ſcore of Human Imbecilitie. *The truth is, I have aſſumed the Liberty to note the Miſtakes in the Florid Verſion of* Berneggerus *in the Margent, not ſo much to reproach him, as to convince thoſe who told me that they accounted my pains needleſs, having his Latine Tranſlation by them. The like they ſaid of the whole two Tomes: but they thereby cauſed me to queſtion their Underſtanding or Veracity. For ſome of the Books were yet never extant: As for inſtance; the Mechanicks of Monſieur* Des Cartes, *a Manuſcript which I found amongſt the many other Rarities that enrich the well-choſen Library of my Learned and Worthy Friend Dr.* Charles Scarburgh; *the Experiments of Gravity, and the Life of* Galileo, *both my own: Others were included in Volumes of great price, or ſo diſperſed that they were not to be purchaſed for any money; as thoſe of* Kepler, à Stunica, Archimedes, Tartaglia, *and the Mechanicks of* Galileo: *And the remainder, though eaſyer to procure, were harder to be underſtood; as* Tartaglia *his notes on* Archimedes, Torricellio *his Doctrine of Projects,* Galileo *his Epiſtle to the Dutcheſſe of* Tuſcany, *and above all his Dialogues* de Motu; *(never till now done into any Language) which were ſo intermixt of Latine and Italian, that the difficulty of the Stile, joyned with the intricatneſſe of the Subject rendered them Unpleaſant, if not wholly Unintelligible, to ſuch as were not abſolute Maſters of both the Tongues.*

To conclude; according to the entertainment that you pleaſe to afford theſe Collections, I ſhall be encouraged to proceed with the Publication of a large Body of Hydrography; declaring the Hiſtory, Art, Lawes, and Apendages of that Princely Study of Navigation, wherein I have omitted nothing of note that can be found either in Dudley, Fournier, Aurigarius, Nonius, Snellius, Marſennus, Bayſius, Moriſetus, Blondus, Wagoner, *abroad, or learnt amongſt our Mariners at home, touching the Office of an Admiral, Commander, Pilot, Modelliſt, Shipwright, Gunner, &c.*

But order requiring that I ſhould diſcharge my firſt Obligation before I contract a ſecond; I ſhall detein you no longer in the Portall, but put you into poſſeſſion of the Premiſes,

Novemb. 20. 1661.

T. S.

THE

THE SYSTEME OF THE WORLD: IN FOUR DIALOGUES.

Wherein the Two

GRAND SYSTEMES

Of *PTOLOMY* and *COPERNICUS* are largely discourſed of:

And the *REASONS*, both *Philoſophical* and *Phyſical*, as well on the one ſide as the other, *impartially* and *indefinitely* propounded:

By *GALILEUS GALILEUS LINCEUS*, A *Gentleman* of *FLORENCE*: Extraordinary *Profeſſor* of the *Mathematicks* in the UNIVERSITY of *PISA*; and Chief *Mathematician* to the GRAND DUKE of *TUSCANY*.

Ingliſhed from the Original *Italian* Copy, *by* THOMAS SALUSBURY.

ALCINOUS,

Δεῖ δ' ἐλευθέριον εἶναι τῇ γνωμῇ τὸν μέλλοντα φιλοσοφεῖν.

SENECA,

Inter nullos magis quam inter PHILOSOPHOS eſſe debet æqua LIBERTAS.

LONDON,

Printed by WILLIAM LEYBOURNE. MDCLXI.

* *

To the moſt Serene Grand DUKE

OF

TUSCANY.

THough the difference between Men and other living Creatures be very great, yet happly he that ſhould ſay that he could ſhew little leſs between Man and Man would not ſpeak more than he might prove. What proportion doth one bear to a thouſand? and yet it is a common Proverb, *One Man is worth a thouſand, when as a thouſand are not worth one.* This difference hath dependence upon the different abilities of their Intellectuals; which I reduce to the being, or not being a Philoſopher; in regard that Philoſophy as being the proper food of ſuch as live by it, diſtinguiſheth a Man from the common Eſſence of the Vulgar in a more or leſs honourable degree according to the variety of that diet. In this ſence he that hath the higheſt looks, is of higheſt quality; and the turning over of the great Volume of Nature, which is the proper Object of Philoſophy is the way to make one look high: in which Book, although whatſoever we read, as being the Work of Almighty God, is therefore moſt proportionate; yet notwithſtanding that is more abſolute and noble wherein we more plainly deſerne his art and skill. The *Conſtitution* of the *Vnivers*, among all Phyſical points that fall within Humane Comprehenſion, may, in my opinion, be preferred to the Precedency: for if that in regard of univerſal extent it excell all others, it ought as the Rule and Standard of the reſt to goe before them in Nobility. Now if ever any perſons might challenge to be ſignally diſtinguiſhed for Intellectuals from other men,

Ptolomey and *Copernicus* were they that have had the honour to ſee fartheſt into, and diſcourſe moſt profoundly of the *Worlds Syſteme*. About the Works of which famous Men theſe Dialous being chiefly converſant, I conceived it my duty to Dedicate them only to *Your Highneſs*. For laying all the weight upon theſe two, whom I hold to be the Ableſt Wits that have left us their Works upon theſe Subjects; to avoid a Soleciſme in Manners, I was obliged to addreſs them to Him, who with me, is the Greateſt of all Men, from whom they can receive either Glory or Patrociny. And if theſe two perſons have ſo farre illuminated my Underſtanding as that this my Book may in a great part be confeſſed to belong to them, well may it alſo be acknowledged to belong to *Your Highneſs*, unto whoſe Bounteous Magnificence I owe the time and leaſure I had to write it, as alſo unto Your Powerful Aſſiſtance, (never weary of honouring me) the means that at length I have had to publiſh it. May *Your Highneſs* therefore be pleaſed to accept of it according to Your accuſtomed Goodneſs; and if any thing ſhall be found therein, that may be ſubſervient towards the information or ſatisfaction of thoſe that are Lovers of Truth; let them acknowledge it to be due to *Your Self*, who are ſo expert in doing good, that Your Happy Dominion can not ſhew the man that is concerned in any of thoſe general Calamities that diſturb the World; ſo that Praying for Your Proſperity, and continuance in this Your Pious and Laudable Cuſtome, I humbly kiſs Your Hands;

Your Moſt Serene Highneſſes

Moſt Humble and moſt devoted

Servant and Subject

GALILEO GALILEI.

THE AUTHOR'S
INTRODUCTION.

Judicious Reader,

There was published some years since in Rome *a salutiferous Edict*; *that, for the obviating of the dangerous Scandals of the present Age, imposed a seasonable Silence upon the Pythagorean Opinion of the Mobility of the Earth. There want not such as unadvisedly affirm, that that Decree was not the production of a sober Scrutiny, but of an ill informed Passion; & one may hear some mutter that Consultors altogether ignorant of Astronomical Observations ought not so clipp the Wings of Speculative Wits with rash Prohibitions. My zeale cannot keep silence when I hear these inconsiderate complaints. I thought fit, as being thoroughly acquainted with that prudent Determination, to appear openly upon the Theatre of the World as a Witness of the naked Truth. I was at that time in* Rome; *and had not only the audiences, but applauds of the most Eminent Prelates of that Court; nor was that Decree Published without Previous Notice given me thereof. Therefore it is my resolution in the present case to give Foraign Nations to see, that this point is as well understood in* Italy, *and particularly in* Rome, *as Transalpine Diligence can imagine it to be: and collecting together all the proper Speculations that concern the* Copernican Systeme, *to let them know, that the notice of all preceded the Censure of the* Roman Court; *and that there proceed from this Climate not only Doctrines for the health of the Soul, but also ingenious Discoveries for the recreating of the Mind.*

To this end I have personated the Copernican *in this Discourse; proceeding upon an Hypothesis purely Mathematical; striving by all artificial wayes to represent it Superiour, not to that of the Immobility of the Earth absolutely, but according as it is mentioned by some, that retein no more, but the name of* Peripateticks, *and are content, without going farther, to adore Shadows, not philosophizing with requisit caution, but with the sole remembrance of four* Principles, *but badly understood.*

We shall treat of three principall heads. First I will endeavour to shew that all Experiments that can be made upon the Earth are insufficient means to conclude it's Mobility, but are indifferently applicable to the Earth moveable or immoveable: and I hope that on this occasion we shall discover many observable passages unknown to the Ancients. Secondly we will examine the Cœlestiall Phœnomena *that make for the* Copernican Hypothesis, *as if it were to prove absolutely victorious; adding by the way certain new Observations, which yet serve only for the Astronomical Facility, not for Natural Necessity. In the third place I will propose an ingenuous Fancy. I remember that I have said many years since, that the unknown Probleme of the Tide might receive some light, admitting the Earths Motion. This Position of mine passing from one to another had found charitable Fathers that adopted it for the Issue of their own Wit. Now, because no stranger may ever appear that defending himself with our armes, shall charge us with want of caution in so principal an Accident, I have thought good to lay down those probabilities that would render it credible, admitting that the Earth did move. I hope, that by these Considerations the World will come to know, that if other Nations have Navigated more than we, we have not studied less than they; & that our returning to assert the Earths Stability, and to take the contrary only for a Mathematical* Capriccio, *proceeds not from inadvertency of what others have thought thereof, but (had we no other inducements) from those Reasons that Piety, Religion, the Knowledge of the Divine Omnipotency, and a consciousness of the incapacity of mans Understanding dictate unto us.*

With all I conceived it very proper to expreſs theſe conceits by Way of Dialogue, which, as not being bound up to the riggid obſervance of Mathematical Laws, gives place alſo to Digreſsions that are ſometimes no leſs curious than the principal Argument.

I chanced to be ſeveral years ſince, at ſeveral times, in the Stupendious Citty of Venice, *where I converſed with* Signore Giovan Franceſco Sagredo *of a Noble Extraction, and piercing Wit. There came thither from* Florence *at the ſame time* Signore Filippo Salviati, *whoſe leaſt glory Was the Eminence of his Blood, and Magnificence of his Eſtate: a ſublime Wit that fed not more hungerly upon any pleaſure than on elevated Speculations. In the company of theſe two I often diſcourſed of theſe matters before a certain Peripatetick Philoſopher who ſeemed to have no geater obſtacle in underſtanding of the Truth, than the Fame he had acquired by Ariſtotelical Interpretations.*

Now, ſeeing that inexorable Death hath deprived Venice *and* Florence *of thoſe two great Lights in the very Meridian of their years, I did reſolve, as far as my poor ability would permit, to perpetuate their lives to their honour in theſe leaves, bringing them in as Interlocutors in the preſent Controverſy. Nor ſhall the Honeſt Peripatetick want his place, to whom for his exceſsive affection towards the Commentaries of* Simplicius, *I thought fit, without mentioning his own Name, to leave that of the Author he ſo much reſpected. Let thoſe two great Souls, ever venerable to my heart, pleaſe to accept this publick Monument of my never-dying Love; and let the remembrance of their Eloquence aſsiſt me in delivering to Poſterity the Conſiderations that I have promiſed.*

There caſually happened (as was uſuall) ſeveral diſcourſes at times between theſe Gentlemen, the Which had rather inflamed than ſatisfied in their Wits the thirſt they had to be learning; whereupon they took a diſcreet reſolution to meet together for certain dayes, in: Which all other buſineſs ſet aſide, they might betake themſelves more methodically to contemplate the Wonders of God in Heaven, and in the Earth: the place appointed for their meeting being in the Palace of the Noble Sagredo, *after the due, but very ſhort complements;* Signore Salviati *began in this manner.*

GALI-

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The

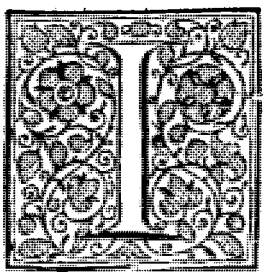
GALILÆUS
Galilæus Lyncæus,
HIS
SYSTEME
OF THE
WORLD.

The First Dialogue.

INTERLOCUTORS.

SALVIATUS, SAGREDUS, and SIMPLICIUS.

SALVIATUS.



IT was our yesterdayes resolution, and agreement, that we should to day discourse the most distinctly, and particularly we could possible, of the natural reasons, and their efficacy that have been hitherto alledged on the one or other part, by the maintainers of the Positions, *Aristotelian*, and *Ptolomaique*; and by the followers of the *Copernican Systeme*: And because *Copernicus* placing the Earth among the moveable Bodies of Heaven, comes to constitute a Globe for the same like to a Planet; it would be good that we began our disputation with the examination of what, and how great the energy of the *Peripatetick's* arguments is, when they demonstrate, that this *Hypothesis* is impos-

Copernicus reckoneth the Earth a Globe like to a Planet.

Cœleſtial ſubſtances that are inalterable, and Elementary that be alterable, are neceſſary in the opinion of Ariſtotle.

ſible : Since that it is neceſſary to introduce in Nature, ſubſtances different betwixt themſelves, that is, the Cœleſtial, and Elementary; that impaſſible and immortal, this alterable and corruptible. Which argument *Ariſtotle* handleth in his book *De Cœlo*, inſinuating it firſt, by ſome diſcourſes dependent on certain general aſſumptions, and afterwards confirming it with experiments and perticular demonſtrations: following the ſame method, I will propound, and freely ſpeak my judgement, ſubmitting my ſelf to your cenſure, and particularly to *Simplicius*, a Stout Champion and contender for the *Ariſtotelian* Doctrine.

Ariſtotle *maketh the World perfect, becauſe it hath the threefold demenſion.*

And the firſt Step of the *Peripatetick* arguments is that, where *Ariſtotle* proveth the integrity and perfection of the World, telling us, that it is not a ſimple line, nor a bare ſuperficies, but a body adorned with Longitude, Latitude, and Profundity; and becauſe there are no more dimenſions but theſe three; The World having them, hath all, and having all, is to be concluded perfect. And again, that by ſimple length, that magnitude is conſtituted, which is called a Line, to which adding breadth, there is framed the Superficies, and yet further adding the altitude or profoundity, there reſults the Body, and after theſe three dimenſions there is no paſſing farther, ſo that in theſe three the integrity, and to ſo ſpeak, totality is terminated, which I might but with juſtice have required *Ariſtotle* to have proved to me by neceſſary conſequences, the rather in regard he was able to do it very plainly, and ſpeedily.

SIMPL. What ſay you to the excellent demonſtrations in the 2. 3. and 4. Texts, after the definition of *Continual*? have you it not firſt there proved, that there is no more but three dimenſions, for that thoſe three are all things, and that they are every where? And is not this confirmed by the Doctrine and Authority of the *Pythagorians*, who ſay that all things are determined by three, beginning, middle, and end, which is the number of All? And where leave you that reaſon, namely, that as it were by the law of Nature, this number is uſed in the ſacrifices of the Gods? And why being ſo dictated by nature, do we atribute to thoſe things that are three, and not to leſſe, the title of all? why of two is it ſaid both, and not all, unleſs they be three? And all this Doctrine you have in the ſecond Text. Afterwards in the third, *Ad pleniorem ſcientiam*, we read that *All*, the *Whole*, and *Perfect*, are formally one and the ſame; and that therefore onely the *Body*, amongſt magnitudes is perfect: becauſe it is determined by three, which is All, and being diviſible three manner of waies, it is every way diviſible; but of the others, ſome are dividible in one manner, and ſome in two, becauſe according to the number affixed, they have their diviſion and continuity, and thus one magnitude is continuate one way, another two, a third, namely the Body, every way.

Ariſtotles *demonſtrations to prove the dimenſions to be three and no more.*

The number three celebrated amongſt the Pythagorians

Omne, Totum & Perfectum.

Or Solid.

More-

Moreover in the fourth Text; doth he not after ſome other Doctrines, prove it by another demonſtration? *Scilicet*, That no tranſition is made but according to ſome defect (and ſo there is a tranſition or paſſing from the line to the ſuperficies, becauſe the line is defective in breadth) and that it is impoſſible for the perfect to want any thing, it being every way ſo; therefore there is no tranſition from the Solid or Body to any other magnitude. Now think you not that by all theſe places he hath ſufficiently proved, how that there's no going beyond the three dimenſions, Length, Breadth, and Thickneſs, and that therefore the body or ſolid, which hath them all, is perfect?

SALV. To tell you true, I think not my ſelf bound by all theſe reaſons to grant any more but onely this, That that which hath beginning, middle, and end, may, and ought to be called perfect: But that then, becauſe beginning, middle, and end, are Three, the number Three is a perfect number, and hath a faculty of conferring *Perfection* on thoſe things that have the ſame, I find no inducement to grant; neither do I underſtand, nor believe that, for example, of feet, the number three is more perfect then four or two, nor do I conceive the number four to be any imperfection to the Elements: and that they would be more perfect if they were three. Better therefore it had been to have left theſe ſubtleties to the *Rhetoricians*, and to have proved his intent, by neceſſary demonſtration; for ſo it behoves to do in demonſtrative ſciences.

SIMPL. You ſeem to ſcorn theſe reaſons, and yet it is all the Doctrine of the *Pythagorians*, who attribute ſo much to numbers; and you that be a *Mathematician*, and believe many opinions in the *Pythagorick* Philoſophy, ſeem now to contemn their Myſteries.

SALV. That the *Pythagorians* had the ſcience of numbers in high eſteem, and that *Plato* himſelf admired humane underſtanding, and thought that it pertook of Divinity, for that it underſtood the nature of numbers, I know very well, nor ſhould I be far from being of the ſame opinion: But that the Myſteries for which *Pythagoras* and his ſect, had the Science of numbers in ſuch veneration, are the follies that abound in the mouths and writings of the vulgar, I no waies credit: but rather becauſe I know that they, to the end admirable things might not be expoſed to the contempt, and ſcorne of the vulgar, cenſured as ſacrilegious, the publiſhing of the abſtruce properties of Numbers, and incommenſurable and irrational quantities, by them inveſtigated; and divulged, that he who diſcovered them, was tormented in the other World: I believe that ſome one of them to deter the common ſort, and free himſelf from their inquiſitiveneſs, told them that the myſteries of numbers were thoſe trifles, which afterwards did ſo

Plato held that humane underſtanding partook of divinity, becauſe it underſtood numbers.

The Myſtery of Pythagorick *numbers fabulous.*

De Papyrio prætextato, *Gellius* 1. 2. 3.

ſpread amongſt the vulgar; and this with a diſcretion and ſubtlety reſembling that of the prudent young man, that to be freed from the importunity of his inquiſitive Mother or Wife, I know not whether, who preſſed him to impart the ſecrets of the Senate, contrived that ſtory, which afterwards brought her and many other women to be derided and laught at by the ſame Senate.

SIMPL. I will not be of the number of thoſe who are over curious about the *Pythagorick* myſteries; but adhering to the point in hand; I reply, that the reaſons produced by *Ariſtotle* to prove the dimenſions to be no more than three, ſeem to me concludent, and I believe, That had there been any more evident demonſtrations thereof, *Ariſtotle* would not have omitted them.

SAGR. Put in at leaſt, if he had known, or remembred any more. But you *Salviatus* would do me a great pleaſure to alledge unto me ſome arguments that may be evident, and clear enough for me to comprehend.

SALV. I will; and they ſhall be ſuch as are not onely to be apprehended by you, but even by *Simplicius* himſelf: nor onely to be comprehended, but are alſo already known, although haply unobſerved; and for the more eaſie underſtanding thereof, we will take this Pen and Ink, which I ſee already prepared for ſuch occaſions, and deſcribe a few figures. And firſt we will note [Fig. 1. *at the end of this Dialog.*] theſe two points AB, and draw from the one to the other the curved lines, ACB, and ADB, and the right line A B, I demand of you which of them, in your mind, is that which determines the diſtance between the terms AB, & why?

A Geometrical demonſtration of the triple dimenſion.

SAGR. I ſhould ſay the right line, and not the crooked, as well becauſe the right is ſhorter, as becauſe it is one, ſole, and determinate, whereas the others are infinit, unequal, and longer; and my determination is grounded upon that, That it is one, and certain.

SALV. We have then the right line to determine the length between the two terms; let us add another right line and parallel to AB, which let be CD, [*Fig.* 2.] ſo that there is put between them a ſuperficies, of which I deſire you to aſſign me the breadth, therefore departing from the point A, tell me how, and which way you will go, to end in the line C D, and ſo to point me out the breadth comprehended between thoſe lines; let me know whether you will terminate it according to the quantity of the curved line A E, or the right line A F, or any other.

SIMPL. According to the right A F, and not according to the crooked, that being already excluded from ſuch an uſe.

SAGR. But I would take neither of them, ſeeing the right line A F runs obliquely; But would draw a line, perpendicular to C D, for this ſhould ſeem to me the ſhorteſt, and the propereſt of infinite that are greater, and unequal to one another, which may be pro-

produced from the term A to any other part of the oppoſite line C D.

SALV. Your choice, and the reaſon you bring for it in my judgment is moſt excellent; ſo that by this time we have proved that the firſt dimenſion is determined by a right line, the ſecond namely the breadth with another line right alſo, and not onely right, but withall, at right-angles to the other that determineth the length, and thus we have the two dimenſions of length and breadth, definite and certain. But were you to bound or terminate a height, as for example, how high this Roof is from the pavement, that we tread on, being that from any point in the Roof, we may draw infinite lines, both curved, and right, and all of diverſe lengths to infinite points of the pavement, which of all theſe lines would you make uſe of?

SAGR. I would faſten a line to the Seeling, and with a plummet that ſhould hang at it, would let it freely diſtend it ſelf till it ſhould reach well near to the pavement, and the length of ſuch a thread being the ſtreighteſt and ſhorteſt of all the lines, that could poſsibly be drawn from the ſame point to the pavement, I would ſay was the true height of this Room.

SALV. Very well, And when from the point noted in the pavement by this pendent thread (taking the pavement to be levell and not declining) you ſhould produce two other right lines; one for the length, and the other for the breadth of the ſuperficies of theſaid pavement, what angles ſhould they make with the ſaid thread?

SAGR. They would doubtleſs meet at right angles, the ſaid lines falling perpendicular, and the pavement being very plain and levell.

SALV. Therefore if you aſſign any point, for the term from whence to begin your meaſure; and from thence do draw a right line, as the terminator of the firſt meaſure, namely of the length, it will follow of neceſſity, that that which is to deſign out the largeneſs or breadth, toucheth the firſt at right-angles, and that that which is to denote the altitude, which is the third dimenſion, going from the ſame point formeth alſo with the other two, not oblique but right angles, and thus by the three perpendiculars, as by three lines, one, certain, and as ſhort as is poſſible, you have the three dimenſions A B length; A C breadth, and A D height; and becauſe, clear it is, that there cannot concurre any more lines in the ſaid point, ſo as to make therewith right-angles, and the dimenſions ought to be determined by the ſole right lines, which make between themſelves right-angles; therefore the dimenſions are no more but three, and that which hath three hath all, and that which hath all, is diviſible on all ſides, and that which is ſo, is perfect, &c.

SIMP.

SIMPL. And who ſaith that I cannot draw other lines? why may not I protract another line underneath, unto the point A, that may be perpendicular to the reſt?

SALV. You can doubtleſs, at one and the ſame point, make no more than three right lines concurre, that conſtitute right angles between themſelves.

SAGR. I ſee what *Simplicius* means, namely, that ſhould the ſaid D A be prolonged downward, then by that means there might be drawn two others, but they would be the ſame with the firſt three, differing onely in this, that whereas now they onely touch, then they would interſect, but not produce new dimenſions.

In phyſical proofs geometrical exactneſs is not neceſſary.

SIMPL. I will not ſay that this your argument may not be concludent; but yet this I ſay with *Ariſtotle*, that in things natural it is not alwaies neceſſary, to bring *Mathematical* demonſtrations.

SAGR. Grant that it were ſo where ſuch proofs cannot be had, yet if this caſe admit of them, why do not you uſe them? But it would be good we ſpent no more words on this particular, for I think that *Salviatus* will yield, both to *Ariſtotle*, and you, without farther demonſtration, that the World is a body, and perfect, yea moſt perfect, as being the greateſt work of God.

Parts of the world are two, according to Ariſtotle, *Cœleſtial and Elementary contrary to one another.*

SALV. So really it is, therefore leaving the general contemplation of the whole, let us deſcend to the conſideration of its parts, which *Ariſtotle*, in his firſt diviſion, makes two, and they very different and almoſt contrary to one another; namely the Cœleſtial, and Elementary: that ingenerable, incorruptible, unalterable, unpaſſible, &c. and this expoſed to a continual alteration, mutation, &c. Which difference, as from its original principle, he derives from the diverſity of local motions, and in this method he proceeds.

Local motion of three kinds, right, circular, & mixt.

Circular, and ſtreight motions are ſimple, as proceeding by ſimple lines.

Leaving the ſenſible, if I may ſo ſpeak, and retiring into the Ideal world, he begins Architectonically to conſider that nature being the principle of motion, it followeth that natural bodies be indued with local motion. Next he declares local motion to be of three kinds, namely, circular, right, and mixt of right and circular: and the two firſt he calleth ſimple, for that of all lines the circular, and right are onely ſimple; and here ſomewhat reſtraining himſelf, he defineth anew, of ſimple motions, one to be circular, namely that which is made about the *medium*, and the other namely the right, upwards, and downwards; upwards, that which moveth from the *medium*; downwards, that which goeth towards the *medium*. And from hence he infers, as he may by and neceſſary conſequence, that all ſimple motions are confined to theſe three kinds, namely, to the *medium*, from the *medium*, and about the *medium*; the which correſponds ſaith he, with what hath been ſaid before of a body, that it alſo is perfected by three things, and ſo

Ad medium, à medio, & circa medium.

is

is its motion. Having confirmed these motions, he proceeds saying, that of natural bodies some being simple, and some composed of them (and he calleth simple bodies those, that have a principle of motion from nature, as the Fire and Earth) it follows that simple motions belong to simple bodies, and mixt to the compound; yet in such sort, that the compounded incline to the part predominant in the composition.

SAGR. Pray you hold a little *Salviatus*, for I find so many doubts to spring up on all sides in this discourse, that I shall be constrained, either to communicate them if I would attentively hearken to what you shall add, or to take off my attention from the things spoken, if I would remember objections.

SALV. I will very willingly stay, for that I also run the same hazard, and am ready at every step to lose my self whilst I sail between Rocks, and boisterous Waves, that make me, as they say, to lose my *Compass*; therefore before I make them more, propound your difficulties.

SAGR. You and *Aristotle* would at first take me a little out of the sensible World, to tell me of the *Architecture*, wherewith it ought to be fabricated; and very appositly begin to tell me, that a natural body is by nature moveable, nature being (as elsewhere it is defined) the principle of motion. But here I am somewhat doubtfull why *Aristotle* said not that of natural bodies, some are moveable by nature, and others immoveable, for that in the definition, nature is said to be the principle of Motion, and Rest; for if natural bodies have all a principle of motion, either he might have omitted the mention of Rest, in the definition of nature: or not have introduced such a definition in this place. Next, as to the declaration of what *Aristotle* intends by simple motions, and how by Spaces he determines them, calling those simple, that are made by simple lines, which are onely the right, and circular, I entertain it willingly; nor do I desire to tenter the instance of the Helix, about the Cylinder; which in that it is in every part like to it self, might seemingly be numbred among simple lines. But herein I cannot concurre, that he should so restrain simple motions (whilst he seems to go about to repeat the same definition in other words) as to call one of them the motion about the *medium*, the others *Sursum & Deorsum*, namely upwards and downward; which terms are not to be used, out of the World fabricated, but imply it not onely made, but already inhabited by us; for if the right motion be simple, by the simplicity of the right line, and if the simple motion be natural, it is made on every side, to wit, upwards, downwards, backwards, forwards, to the right, to the left, and if any other way can be imagined, provided it be straight, it shall agree to any simple natural body; or if

The definition of Nature, either imperfect, or unseasonable, produced by Aristotle.

The Helix about the Cylinder may be said to be a simple line.

Ariſtotle accommodates the rules of Architecture to the frame of the World, and not the frame to the rules.

if not ſo, then the ſuppoſion of *Ariſtotle* is defective. It appears moreover that *Ariſtotle* hinteth but one circular motion alone to be in the World, and conſequently but one onely Center, to which alone the motions of upwards and downwards, refer. All which are apparent proofs, that *Ariſtotles* aim is, to make white black, and to accommodate *Architecture* to the building, and not to modle the building according to the precepts of *Architecture*: for if I ſhould ſay that Nature in Univerſal may have a thouſand Circular Motions, and by conſequence a thouſand Centers, there would be alſo a thouſand motions upwards, and downwards. Again he makes as hath been ſaid, a ſimple motion, and a mixt motion, calling ſimple, the circular and right; and mixt, the compound of them two: of natural bodies he calls ſome ſimple (namely thoſe that have a natural principle to ſimple motion) and others compound: and ſimple motions he attributes to ſimple bodies, and the compounded to the compound; but by compound motion he doth no longer underſtand the mixt of right and circular, which may be in the World; but introduceth a mixt motion as impoſſible, as it is impoſſible to mixe oppoſite motions made in the ſame right line, ſo as to produce from them a motion partly upwards, partly downwards; and, to moderate ſuch an abſurdity, and impoſſibility, he aſſerts that ſuch mixt bodies move according to the ſimple part predominant: which neceſſitates others to ſay, that even the motion made by the ſame right line is ſometimes ſimple, and ſometimes alſo compound: ſo that the ſimplicity of the motion, is no longer dependent onely on the ſimplicity of the line.

Right motion, ſometimes ſimple, and ſometimes mixt according to Ariſt.

SIMPL. How? Is it not difference ſufficient, that the ſimple and abſolute are more ſwift than that which proceeds from predominion? and how much faſter doth a piece of pure Earth deſcend, than a piece of Wood?

SAGR. Well, *Simplicius*; But put caſe the ſimplicity for this cauſe was changed, beſides that there would be a hundred thouſand mixt motions, you would not be able to determine the ſimple; nay farther, if the greater or leſſe velocity be able to alter the ſimplicity of the motion, no ſimple body ſhould move with a ſimple motion; ſince that in all natural right motions, the velocity is ever encreaſing, and by conſequence ſtill changing the ſimplicity, which as it is ſimplicity, ought of conſequence to be immutable, and that which more importeth, you charge *Ariſtotle* with another thing, that in the definition of motions compounded, he hath not made mention of tardity nor velocity, which you now inſert for a neceſſary and eſſential point. Again you can draw no advantage from this rule, for that there will be amongſt the mixt bodies ſome, (and that not a few) that will move ſwiftly,

and

and others more ſlowly than the ſimple; as for example, Lead, and Wood, in compariſon of earth; and therefore amongſt theſe motions, which call you the ſimple, and which the mixt?

SIMPL. I would call that ſimple motion, which is made by a ſimple body, and mixt, that of a compound body.

SAGR. Very well, and yet *Simplicius* a little before you ſaid, that the ſimple, and compound motions, diſcovered which were mixt, and which were ſimple bodies; now you will have me by ſimple and mixt bodies, come to know which is the ſimple, and which is the compound motion: an excellent way to keep us ignorant, both of motions and bodies. Moreover, you have alſo a little above declared, how that a greater velocity did not ſuffice, but you ſeek a third condition for the definement of ſimple motion, for which *Ariſtotle* contented himſelf with one alone, namely, of the ſimplicity of the Space, or *Medium*: But now according to you, the ſimple motion, ſhall be that which is made upon a ſimple line, with a certain determinate velocity, by a body ſimply moveable. Now be it as you pleaſe, and let us return to *Ariſtotle*, who defineth the mixt motion to be that compounded of the right, and circular, but produceth not any body, which naturally moveth with ſuch a motion.

SALV. I come again to *Ariſtotle*, who having very well, and Methodically begun his diſcourſe; but having a greater aim to reſt at, and hit a marke, predeſigned in his minde; then that to which his method lead him, digreſſing from the purpoſe, he comes to aſſert, as a thing known and manifeſt, that as to the motions directly upwards or downwards, they naturally agree to Fire, and Earth; and that therefore it is neceſſary, that beſides theſe bodies, which are neer unto us, there muſt be in nature another, to which the circular motion may agree: which ſhall be ſo much the more excellent by how much the circular motion is more perfect, then the ſtreight, but how much more perfect that is than this, he determines from the greatneſs of the circular lines perfection above the right line; calling that perfect, and this imperfect; imperfect, becauſe if infinite it wanteth a termination, and end: and if it be finite, there is yet ſomething beyond which it may be prolonged. This is the baſis, ground work, and maſter-ſtone of all the Fabrick of the *Ariſtotelian* World, upon which they ſuperſtruct all their other properties, of neither heavy nor light; of ingenerable incorruptible, exemption from all motions, ſome onely the local, &c. And all theſe paſſions he affirmeth to be proper to a ſimple body that is moved circularly; and the contrary qualities of gravity, levity, corruptibility, &c. he aſſigns to bodies naturally moveable in a ſtreight line, for that if we have already diſcovered defects in the foundation, we may rationally queſtion what ſoever may far-

The circular line perfect, according to Ariſtotle, *and but the right imperfect, and why.*

ther built thereon. I deny not, that this which *Ariſtotle* hitherto hath introduced, with a general diſcourſe dependent upon univerſal primary principles, hathbeen ſince in proceſs of time, re-inforced with particular reaſons, and experiments; all which it would be neceſſary diſtinctly to conſider and weigh; but becauſe what hath been ſaid hitherto preſents to ſuch as conſider the ſame many and no ſmall difficulties, (and yet it would be neceſſary, that the primary principles and fundamentals, were certain, firm, and eſtabliſhed, that ſo they might with more confidence be built upon) it would not be amiſs, before we farther multiply doubts, to ſee if haply (as I conjecture) betaking our ſelves to other waies, we may not light upon a more direct and ſecure method; and with better conſidered principles of Architecture lay our primary fundamentals. Therefore ſuſpending for the preſent the method of *Ariſtotle*, (which we will re-aſſume again in its proper place, and particularly examine;) I ſay, that in the things hitherto affirmed by him, I agree with him, and admit that the World is a body enjoying all dimenſions, and therefore moſt perfect; and I add, that as ſuch, it is neceſſarily moſt ordinate, that is, having parts between themſelves, with exquiſite and moſt perfect order diſpoſed; which aſſumption I think is not to be denied, neither by you or any other.

The world is ſuppoſed by the Author to be perfectly ordinate.

SIMPL. Who can deny it? the firſt particular (of the worlds dimenſions) is taken from *Ariſtotle* himſelf, and its denomination of ordinate ſeems onely to be aſſumed from the order which it moſt exactly keeps.

SALV. This principle then eſtabliſhed, one may immediately conclude, that if the entire parts of the World ſhould be by their nature moveable, it is impoſſible that their motions ſhould be right, or other than circular; and the reaſon is ſufficiently eaſie, and manifeſt; for that whatſoever moveth with a right motion, changeth place; and continuing to move, doth by degrees more and more remove from the term from whence it departed, and from all the places thorow which it ſucceſſively paſſed; and if ſuch motion naturally ſuited with it, then it was not at the beginning in its proper place; and ſo the parts of the World were not diſpoſed with perfect order. But we ſuppoſe them to be perfectly ordinate, therefore as ſuch, it is impoſſible that they ſhould by nature change place, and conſequently move in a right motion. Again, the right motion being by nature infinite, for that the right line is infinite and indeterminate, it is impoſſible that any moveable can have a natural principle of moving in a right line; namely toward the place whither it is impoſſible to arrive, there being no præ-finite term; and nature, as *Ariſtotle* himſelf ſaith well, never attempts to do that which can never be done, nor

Streight motion impoſſible in the world exactly ordinate.

Right motion by nature infinite.

Motion by a right line naturally impoſſible.

Nature attempts not things impoſſible to be effected.

nor essaies to move whither it is impossible to arrive. And if any one should yet object, that albeit the right line, and consequently the motion by it is producible *in infinitum*, that is to say, is interminate; yet nevertheless Nature, as one may say, arbitrarily hath assigned them some terms, and given natural instincts to its natural bodies to move unto the same; I will reply, that this might perhaps be fabled to have come to pass in the first Chaos, where indistinct matters confusedly and inordinately wandered; to regulate which, Nature very appositely made use of right motions, by which, like as the well-constituted, moving, disorder themselves, so were they which were before depravedly disposed by this motion ranged in order: but after their exquisite distribution and collocation, it is impossible that there should remain natural inclinations in them of longer moving in a right motion, from which now would ensue their removal from their proper and natural place, that is to say, their disordination; we may therefore say that the right motion serves to conduct the matter to erect the work; but once erected, that it is to rest immoveable, or if moveable, to move circularly. Unless we will say with *Plato*, that these mundane bodies, after they had been made and finished, were for a certain time moved by their Maker, in a right motion, but that after their attainment to certain and determinate places, they were revolved one by one in Spheres, passing from the right to the circular motion, wherein they have been ever since kept and maintained. A sublime conceipt, and worthy indeed of *Plato*: upon which, I remember to have heard our common friend the **Lyncean Academick* discourse in this manner, if I have not forgot it. Every body for any reason constituted in a state of rest, but which is by nature moveable, being set at liberty doth move; provided withal, that it have an inclination to some particular place; for should it stand indifferently affected to all, it would remain in its rest, not having greater inducement to move one way than another. From the having of this inclination necessarily proceeds, that it in its moving shall continually increase its acceleration, and beginning with a most slow motion, it shall not acquire any degree of velocity, before it shall have passed thorow all the degrees of less velocity, or greater tardity: for passing from the state of quiet (which is the infinite degree of tardity of motion) there is no reason by which it should enter into such a determinate degree of velocity, before it shall have entred into a less, and into yet a less, before it entred into that: but rather it stands with reason, to pass first by those degrees neerest to that from which it departed, and from those to the more remote; but the degree from whence the moveable began to move, is that of extreme tardity, namely of rest.

Right motion might perhaps be in the first Chaos.

Right motion is commodious to range in order, things out of order.

Mundane bodies moved in the beginning in a right line, and afterwards circularly, according to Plato.

* Thus doth he covertly and modestly stile himself throughout this work.

A moveable being in a state of rest, shall not move unless it have an inclination to some particular place.

The moveable accelerates its motion, going towards the place whither it hath an inclination.

The moveable passing from rest, goeth thorow all the degrees of tardity.

Rest the infinite degree of tardity.

The moveable doth not accelerate ſave only as it approacheth nearer to its term.

Now this acceleration of motion is never made, but when the moveable in moving acquireth it; nor is its acquiſt other than an approaching to the place deſired, to wit, whither its natural inclination attracts it, and thither it tendeth by the ſhorteſt way; namely, by a right line. We may upon good grounds therefore ſay, That Nature, to confer upon a moveable firſt conſtituted in reſt a determinate velocity, uſeth to make it move according to a certain time and ſpace with a right motion. This preſuppoſed, let us imagine God to have created the Orb *v. g.* of *Jupiter*, on which he had determined to confer ſuch a certain velocity, which it ought afterwards to retain perpetually uniform; we may with *Plato* ſay, that he gave it at the beginning a right and accelerate motion, and that it afterwards being arrived to that intended degree of velocity, he converted its right, into a circular motion, the velocity of which came afterwards naturally to be uniform.

Nature, to introduce in the moveable a certain degree of velocity, made it move in a right line.

Uniform velocity convenient to the circular motion.

SAGR. I hearken to this Diſcourſe with great delight; and I believe the content I take therein will be greater, when you have ſatisfied me in a doubt: that is, (which I do not very well comprehend) how it of neceſſity enſues, that a moveable departing from its reſt, and entring into a motion to which it had a natural inclination, it paſſeth thorow all the precedent degrees of tardity, comprehended between any aſſigned degree of velocity, and the ſtate of reſt, which degrees are infinite? ſo that Nature was not able to confer them upon the body of *Jupiter*, his circular motion being inſtantly created with ſuch and ſuch velocity.

Betwixt reſt, and any aſſigned degree of velocity, infinite degrees of leſs velocity interpoſe.

SALV. I neither did, nor dare ſay, that it was impoſſible for God or Nature to confer that velocity which you ſpeak of, immediately; but this I ſay, that *de facto* ſhe did not do it; ſo that the doing it would be a work extra-natural, and by conſequence miraculous.

Nature doth not immediately confer a determinate degree of velocity, howbeit ſhe could.

SAGR. Then you believe, that a ſtone leaving its reſt, and entring into its natural motion towards the centre of the Earth, paſſeth thorow all the degrees of tardity inferiour to any degree of velocity?

SALV. I do believe it, nay am certain of it; and ſo certain, that I am able to make you alſo very well ſatisfied with the truth thereof.

SAGR. Though by all this daies diſcourſe I ſhould gain no more but ſuch a knowledge, I ſhould think my time very well beſtowed.

SALV. By what I collect from our diſcourſe, a great part of your ſcruple lieth in that it ſhould in a time, and that very ſhort, paſs thorow thoſe infinite degrees of tardity precedent to any velocity, acquired by the moveable in that time: and therefore before we go any farther, I will ſeek to remove this difficulty, which

ſhall

ſhall be an eaſie task; for I reply, that the moveable paſſeth by the aforeſaid degrees, but the paſſage is made without ſtaying in any of them; ſo that the paſſage requiring but one ſole inſtant of time, and every ſmall time containing infinite inſtants, we ſhall not want enough of them to aſſign its own to each of the infinite degrees of tardity; although the time were never ſo ſhort.

The moveable departing from reſt paſſeth thorow all degrees of velocity without ſtaying in any.

SAGR. Hitherto I apprehend you; nevertheleſs it is very much that that Ball ſhot from a Cannon (for ſuch I conceive the cadent moveable) which yet we ſee to fall with ſuch a precipice, that in leſs than ten pulſes it will paſs two hundred yards of altitude; ſhould in its motion be found conjoyned with ſo ſmall a degree of velocity, that, ſhould it have continued to have moved at that rate without farther acceleration, it would not have paſt the ſame in a day.

SALV. You may ſay, nor yet in a year, nor in ten, no nor in a thouſand; as I will endeavour to ſhew you, and alſo happily without your contradiction, to ſome ſufficiently ſimple queſtions that I will propound to you. Therefore tell me if you make any queſtion of granting that that ball in deſcending goeth increaſing its *impetus* and velocity.

SAGR. I am moſt certain it doth.

SALV. And if I ſhould ſay that the *impetus* acquired in any place of its motion, is ſo much, that it would ſuffice to re-carry it to that place from which it came, would you grant it?

SAGR. I ſhould conſent to it without contradiction, provided alwaies, that it might imploy without impediment its whole *impetus* in that ſole work of re-conducting it ſelf, or another equal toit, to that ſelf-ſame height as it would do, in caſe the Earth were bored thorow the centre, and the Bullet fell a thouſand yards from the ſaid centre, for I verily believe it would paſs beyond the centre, aſcending as much as it had deſcended; and this I ſee plainly in the experiment of a plummet hanging at a line, which removed from the perpendicular, which is its ſtate of reſt, and afterwards let go, falleth towards the ſaid perpendicular, and goes as far beyond it; or onely ſo much leſs, as the oppoſition of the air, and line, or other accidents have hindred it. The like I ſee in the water, which deſcending thorow a pipe, re-mounts as much as it had deſcended.

The ponderous mover deſcending acquireth impetus ſufficient to re-carry it to the like height.

SALV. You argue very well. And for that I know you will not ſcruple to grant that the acquiſt of the *impetus* is by means of the receding from the term whence the moveable departed, and its approach to the centre, whither its motion tendeth; will you ſtick to yeeld, that two equal moveables, though deſcending by divers lines, without any impediment, acquire equal *impetus*, provided that the approaches to the centre be equal?

SAGR.

SAGR. I do not very well underſtand the queſtion.

SALV. I will expreſs it better by drawing a Figure: therefore I will ſuppoſe the line A B [in *Fig.*3.] parallel to the Horizon, and upon the point B, I will erect a perpendicular B C; and after that I adde this ſlaunt line C A. Underſtanding now the line C A to be an inclining plain exquiſitely poliſhed, and hard, upon which deſcendeth a ball perfectly round and of very hard matter, and ſuch another I ſuppoſe freely to deſcend by the perpendicular C B: will you now confeſs that the *impetus* of that which deſcends by the plain C A, being arrived to the point A, may be equal to the *impetus* acquired by the other in the point B, after the deſcent by the perpendicular C B?

The impetuoſity of moveables equally approaching to the centre, are equal.

SAGR. I reſolutely believe ſo: for in effect they have both the ſame proximity to the centre, and by that, which I have already granted, their impetuoſities would be equally ſufficient to re-carry them to the ſame height.

SALV. Tell me now what you believe the ſame ball would do put upon the Horizontal plane A B?

Upon an horizontall plane the moveable lieth ſtill.

SAGR. It would lie ſtill, the ſaid plane having no declination.

SALV. But on the inclining plane C A it would deſcend, but with a gentler motion than by the perpendicular C B?

SAGR. I may confidently anſwer in the affirmative, it ſeeming to me neceſſary that the motion by the perpendicular C B ſhould be more ſwift, than by the inclining plane C A; yet nevertheleſs, if this be, how can the Cadent by the inclination arrived to the point A, have as much *impetus*, that is, the ſame degree of velocity, that the Cadent by the perpendicular ſhall have in the point B? theſe two Propoſitions ſeem contradictory.

The velocity by the inclining plane equal to the velocity by the perpendicular, and the motion by the perpendicular ſwifter than by the inclination.

SALV. Then you would think it much more falſe, ſhould I ſay, that the velocity of the Cadents by the perpendicular, and inclination, are abſolutely equal: and yet this is a Propoſition moſt true, as is alſo this that the Cadent moveth more ſwiftly by the perpendicular, than by the inclination.

SAGR. Theſe Propoſitions to my ears ſound very harſh: and I believe to yours *Simplicius*?

SIMPL. I have the ſame ſenſe of them.

SALV. I conceit you jeſt with me, pretending not to comprehend what you know better than my ſelf: therefore tell me *Simplicius*, when you imagine a moveable more ſwift than another, what conceit do you fancy in your mind?

SIMPL. I fancie one to paſs in the ſame time a greater ſpace than the other, or to move equal ſpaces, but in leſſer time.

SALV. Very well: and for moveables equally ſwift, what's your conceit of them?

SIMPL. I fancie that they paſs equal ſpaces in equal times.

SALV.

SALV. And have you no other conceit thereof than this?

SIMPL. This I think to be the proper definition of equal motions.

Velocities are ſaid to be equal, when the ſpaces paſſed are proportionate to their time.

SAGR. We will add moreover this other: and call that equal velocity, when the ſpaces paſſed have the ſame proportion, as the times wherein they are paſt, and it is a more univerſal definition.

SALV. It is ſo: for it comprehendeth the equal ſpaces paſt in equal times, and alſo the unequal paſt in times unequal, but proportionate to thoſe ſpaces. Take now the ſame Figure, and applying the conceipt that you had of the more haſtie motion, tell me why you think the velocity of the Cadent by C B, is greater than the velocity of the Deſcendent by C A?

SIMPL. I think ſo; becauſe in the ſame time that the Cadent ſhall paſs all C B, the Deſcendent ſhall paſs in C A, a part leſs than C B.

SALV. True; and thus it is proved, that the moveable moves more ſwiftly by the perpendicular, than by the inclination. Now conſider, if in this ſame Figure one may any way evince the other conceipt, and [illegible] that the moveables were equally ſwift by both the lines C A and C B.

SIMPL. I ſee no ſuch thing; nay rather it ſeems to contradict what was ſaid before.

SALV. And what ſay you, *Sagredus*? I would not teach you what you knew before, and that of which but juſt now you produced me the definition.

SAGR. The definition I gave you, was, that moveables may be called equally ſwift, when the ſpaces paſſed are proportional to the times in which they paſſed; therefore to apply the definition to the preſent caſe, it will be requiſite, that the time of deſcent by C A, to the time of falling by C B, ſhould have the ſame proportion that the line C A hath to the line C B; but I underſtand not how that can be, for that the motion by C B is ſwifter than by C A.

SALV. And yet you muſt of neceſſity know it. Tell me a little, do not theſe motions go continually accelerating?

SAGR. They do; but more in the perpendicular than in the inclination.

SALV. But this acceleration in the perpendicular, is it yet notwithſtanding ſuch in compariſon of that of the inclined, that two equal parts being taken in any place of the ſaid perpendicular and inclining lines, the motion in the parts of the perpendicular is alwaies more ſwift, than in the part of the inclination?

SAGR. I ſay not ſo: but I could take a ſpace in the inclination, in which the velocity ſhall be far greater than in the like ſpace taken in the perpendicular; and this ſhall be, if the ſpace in the perpen-

perpendicular ſhould be taken near to the end C, and in the inclination, far from it.

SALV. You ſee then, that the Propoſition which ſaith, that the motion by the perpendicular is more ſwift than by the inclination, holds not true univerſally, but onely of the motions, which begin from the extremity, namely from the point of reſt: without which reſtriction, the Propoſition would be ſo deficient, that its very direct contrary might be true; namely, that the motion in the inclining plane is ſwifter than in the perpendicular: for it is certain, that in the ſaid inclination, we may take a ſpace paſt by the moveable in leſs time, than the like ſpace paſt in the perpendicular. Now becauſe the motion in the inclination is in ſome places more, in ſome leſs, than in the perpendicular; therefore in ſome places of the inclination, the time of motion of the moveable, ſhall have a greater proportion to the time of the motion of the moveable, by ſome places of the perpendicular, than the ſpace paſſed, to the ſpace paſſed: and in other places, the proportion of the time to the time, ſhall be leſs than that of the ſpace to the ſpace. As for example: two moveables departing from their quieſcence, namely, from the point C, one by the perpendicular C B, [in *Fig.* 4.] and the other by the inclination C A, in the time that, in the perpendicular, the moveable ſhall have paſt all C B, the other ſhall have paſt C T leſſer. And therefore the time by C T, to the time by C B (which is equal) ſhall have a greater proportion than the line C T to C B, being that the *ſame* to the *leſs*, hath a greater proportion than to the *greater*. And on the contrary, if in C A, prolonged as much as is requiſite, one ſhould take a part equal to C B, but paſt in a ſhorter time; the time in the inclination ſhall have a leſs proportion to the time in the perpendicular, than the ſpace to the ſpace. If therefore in the inclination and perpendicular, we may ſuppoſe ſuch ſpaces and velocities, that the proportion between the ſaid ſpaces be greater and leſs than the proportion of the times; we may eaſily grant, that there are alſo ſpaces, by which the times of the motions retain the ſame proportion as the ſpaces.

SAGR. I am already freed from my greateſt doubt, and conceive that to be not onely poſſible, but neceſſary, which I but now thought a contradiction: but nevertheleſs I underſtand not as yet, that this whereof we now are ſpeaking, is one of theſe poſſible or neceſſary caſes; ſo as that it ſhould be true, that the time of deſcent by C A, to the time of the fall by C B, hath the ſame proportion that the line C A hath to C B; whence it may without contradiction be affirmed, that the velocity by the inclination C A, and by the perpendicular C B, are equal.

SALV. Content your ſelf for this time, that I have removed your

your incredulity; but for the knowledge of this, expect it at ſome other time, namely, when you ſhall ſee the matters concerning local motion demonſtrated by our *Academick*; at which time you ſhall find it proved, that in the time that the one moveable falls all the ſpace C B, the other deſcendeth by C A as far as the point T, in which falls the perpendicular drawn from the point B: and to find where the ſame Cadent by the perpendicular would be when the other arriveth at the point A, draw from A the perpendicular unto C A, continuing it, and C B unto the interſection, and that ſhall be the point ſought. Whereby you ſee how it is true, that the motion by C B is ſwifter than by the inclination C A (ſuppoſing the term C for the beginning of the motions compared) becauſe the line C B is greater than C T, and the other from C unto the interſection of the perpendicular drawn from A, unto the line C A, is greater than C A, and therefore the motion by it is ſwifter than by C A. But when we compare the motion made by all C A, not with all the motion made in the ſame time by the perpendicular continued, but with that made in part of the ſame; by the ſole part C B, it hinders not, that the motion by C A, continuing to deſcend beyond, may arrive to A in ſuch a time as is in proportion to the other time, as the line C A is to the line C B. Now returning to our firſt purpoſe; which was to ſhew, that the grave moveable leaving its quieſcence, paſſeth deſcending by all the degrees of tardity, precedent to any whatſoever degree of velocity that it acquireth, re-aſſuming the ſame Figure which we uſed before, let us remember that we did agree, that the Deſcendent by the inclination C A, and the Cadent by the perpendicular C B, were found to have acquired equal degrees of velocity in the terms B and A: now to proceed, I ſuppoſe you will not ſcruple to grant, that upon another plane leſs ſteep than A C; as for example, A D [in *Fig.* 5.] the motion of the deſcendent would be yet more ſlow than in the plane A C. So that it is not any whit dubitable, but that there may be planes ſo little elevated above the Horizon A B, that the moveable, namely the ſame ball, in any the longeſt time may reach the point A, which being to move by the plane A B, an infinite time would not ſuffice: and the motion is made always more ſlowly, by how much the declination is leſs. It muſt be therefore confeſt, that there may be a point taken upon the term B, ſo near to the ſaid B, that drawing from thence to the point A a plane, the ball would not paſs it in a whole year. It is requiſite next for you to know, that the *impetus*, namely the degree of velocity the ball is found to have acquired when it arriveth at the point A, is ſuch, that ſhould it continue to move with this ſelf-ſame degree uniformly, that is to ſay, without accelerating or retarding;

in as much more time as it was in coming by the inclining plane, it would paſs double the ſpace of the plane inclined: namely (for example) if the ball had paſt the plane D A in an hour, continuing to move uniformly with that degree of velocity which it is found to have in its arriving at the term A, it ſhall paſs in an hour a ſpace double the length D A; and becauſe (as we have ſaid) the degrees of velocity acquired in the points B and A, by the moveables that depart from any point taken in the perpendicular C B, and that deſcend, the one by the inclined plane, the other by the ſaid perpendicular, are always equal: therefore the cadent by the perpendicular may depart from a term ſo near to B, that the degree of velocity acquired in B, would not ſuffice (ſtill maintaining the ſame) to conduct the moveable by a ſpace double the length of the plane inclined in a year, nor in ten, no nor in a hundred. We may therefore conclude, that if it be true, that according to the ordinary courſe of nature a moveable, all external and accidental impediments removed, moves upon an inclining plane with greater and greater tardity, according as the inclination ſhall be leſs; ſo that in the end the tardity comes to be infinite, which is, when the inclination concludeth in, and joyneth to the horizontal plane; and if it be true likewiſe, that the degree of velocity acquired in ſome point of the inclined plane, is equal to that degree of velocity which is found to be in the moveable that deſcends by the perpendicular, in the point cut by a parallel to the Horizon, which paſſeth by that point of the inclining plane; it muſt of neceſſity be granted, that the cadent departing from reſt, paſſeth thorow all the infinite degrees of tardity, and that conſequently, to acquire a determinate degree of velocity, it is neceſſary that it move firſt by right lines, deſcending by a ſhort or long ſpace, according as the velocity to be acquired, ought to be either leſs or greater, and according as the plane on which it deſcendeth is more or leſs inclined; ſo that a plane may be given with ſo ſmall inclination, that to acquire in it the aſſigned degree of velocity, it muſt firſt move in a very great ſpace, and take a very long time; whereupon in the horizontal plane, any how little ſoever velocity, would never be naturally acquired, ſince that the moveable in this caſe will never move: but the motion by the horizontal line, which is neither declined or inclined, is a circular motion about the centre: therefore the circular motion is never acquired naturally, without the right motion precede it; but being once acquired, it will continue perpetually with uniform velocity. I could with other diſcourſes evince and demonſtrate the ſame truth, but I will not by ſo great a digreſſion interrupt our principal argument: but rather will return to it upon ſome other occaſion; eſpecially ſince we now aſſumed the ſame

The circular motion is never acquired naturally, without right motion precede it.

Circular motion perpetually uniform.

ſame, not to ſerve for a neceſſary demonſtration, but to adorn a *Platonick* Conceit; to which I will add another particular obſervation of our *Academick*, which hath in it ſomething of admirable. Let us ſuppoſe amongſt the decrees of the divine *Architect*, a purpoſe of creating in the World theſe Globes, which we behold continually moving round, and of aſſigning the centre of their converſions; and that in it he had placed the Sun immoveable, and had afterwards made all the ſaid Globes in the ſame place, and with the intended inclinations of moving towards the Centre; till they had acquired thoſe degrees of velocity, which at firſt ſeemed good to the ſame Divine Minde; the which being acquired, we laſtly ſuppoſe that they were turned round, each in his Sphere retaining the ſaid acquired velocity: it is now demanded, in what altitude and diſtance from the Sun the place was where the ſaid Orbs were primarily created; and whether it be poſſible that they might all be created in the ſame place? To make this inveſtigation, we muſt take from the moſt skilfull Aſtronomers the magnitude of the Spheres in which the Planets revolve, and likewiſe the time of their revolutions: from which two cognitions is gathered how much (for example) *Jupiter* is ſwifter than *Saturne*; and being found (as indeed it is) that *Jupiter* moves more ſwiftly, it is requiſite, that departing from the ſame altitude, *Jupiter* be deſcended more than *Saturne*, as we really know it is, its Orbe being inferiour to that of *Saturne*. But by proceeding forwards, from the proportions of the two velocities of *Jupiter* and *Saturne*, and from the diſtance between their Orbs, and from the proportion of acceleration of natural motion, one may finde in what altitude and diſtance from the centre of their revolutions, was the place from whence they firſt departed. This found out, and agreed upon, it is to be ſought, whether *Mars* deſcending from thence to his Orb, the magnitude of the Orb, and the velocity of the motion, agree with that which is found by calculation; and let the like be done of the *Earth*, of *Venus*, and of *Mercury*; the greatneſs of which Spheres, and the velocity of their motions, agree ſo nearly to what computation gives, that it is very admirable.

The magnitude of the Orbs, and the velocity of the motion of the Planets, anſwer proportionably, as if deſcended from the ſame place.

SAGR. I have hearkened to this conceit with extreme delight; and, but that I believe the making of theſe calculations truly would be a long and painfull task, and perhaps too hard for me to comprehend, I would make a trial of them.

SALV. The operation indeed is long and difficult; nor could I be certain to finde it ſo readily; therefore we ſhall refer it to another time, and for the preſent we will return to our firſt propoſal, going on there where we made digreſſion; which, if I well remember, was about the proving the motion by a right line of no

uſe, in the ordinate parts of the World; and we did proceed to ſay, that it was not ſo in circular motions, of which that which is made by the moveable in it ſelf, ſtill retains it in the ſame place, and that which carrieth the moveable by the circumference of a circle about its fixed centre, neither puts it ſelf, nor thoſe about it in diſorder; for that ſuch a motion primarily is finite and terminate (though not yet finiſhed and determined) but there is no point in the circumference, that is not the firſt and laſt term in the circulation; and continuing it in the circumference aſſigned it, it leaveth all the reſt, within and without that, free for the uſe of others, without ever impeding or diſordering them. This being a motion that makes the moveable continually leave, and continually arrive at the end; it alone therefore can primarily be uniform; for that acceleration of motion is made in the moveable, when it goeth towards the term, to which it hath inclination; and the retardation happens by the repugnance that it hath to leave and part from the ſame term; and becauſe in circular motion, the moveable continually leaves the natural term, and continually moveth towards the ſame, therefore, in it, the repugnance and inclination are always of equal force: from which equality reſults a velocity, neither retarded nor accelerated, *i. e.* an uniformity in motion. From this conformity, and from the being terminate, may follow the perpetual continuation by ſucceſſively reiterating the circulations; which in an undeterminated line, and in a motion continually retarded or accelerated, cannot naturally be. I ſay, naturally; becauſe the right motion which is retarded, is the violent, which cannot be perpetual; and the accelerate arriveth neceſſarily at the term, if one there be; and if there be none, it cannot be moved to it, becauſe nature moves not whether it is impoſſible to attain. I conclude therefore, that the circular motion can onely naturally conſiſt with natural bodies, parts of the univerſe, and conſtituted in an excellent diſpoſure; and that the right, at the moſt that can be ſaid for it, is aſſigned by nature to its bodies, and their parts, at ſuch time as they ſhall be out of their proper places, conſtituted in a depraved diſpoſition, and for that cauſe needing to be reduced by the ſhorteſt way to their natural ſtate. Hence, me thinks, it may rationally be concluded, that for maintenance of perfect order amongſt the parts of the World, it is neceſſary to ſay, that moveables are moveable onely circularly; and if there be any that move not circularly, theſe of neceſſity are immoveable: there being nothing but reſt and circular motion apt to the conſervation of order. And I do not a little wonder with my ſelf, that *Ariſtotle*, who held that the Terreſtrial globe was placed in the centre of the World, and there remained immoveable, ſhould not ſay, that

Finite and terminate circular motions diſorder not the parts of the World.

In the circular motion, every point in the circumference is the begining and end.

Circular motion onely is uniform.

Circular motion may be continued perpetually.

Right motion cannot naturally be perpetual.

Right motion aſſigned to natural bodies, to reduce them to perfect order, when removed from their places.

Reſt onely, and circular motion are apt to conſerve order.

of

of natural bodies ſome are moveable by nature; and others immoveable; eſpecially having before defined Nature, to be the principle of Motion and Reſt.

SIMPL. *Ariſtotle*, though of a very perſpicacious wit, would not ſtrain it further than needed: holding in all his argumentations, that ſenſible experiments were to be preferred before any reaſons founded upon ſtrength of wit, and ſaid thoſe which ſhould deny the teſtimony of ſenſe deſerved to be puniſhed with the loſs of that ſenſe; now who is ſo blind, that ſees not the parts of the Earth and Water to move, as being grave, naturally downwards, namely, towards the centre of the Univerſe, aſſigned by nature her ſelf for the end and term of right motion *deorſum*; and doth not likewiſe ſee the Fire and Air to move right upwards towards the Concave of the Lunar Orb, as to the natural end of motion *ſurſum*? And this being ſo manifeſtly ſeen, and we being certain, that *eadem eſt ratio totius & partium*, why may we not aſſert it for a true and manifeſt propoſition, that the natural motion of the Earth [illegible] *ad medium*, and that of the Fire [illegible] *a medio*?

Senſible experiments are to be preferred before humane argumentations.

He who denies ſenſe, deſerves to be deprived of it.

Senſe ſheweth that things grave move to the medium, *and the light to the concave.*

SALV. The moſt that you can pretend from this your Diſcourſe, were it granted to be true, is that, like as the parts of the Earth removed from the whole, namely, from the place where they naturally reſt, that is in ſhort reduced to a depraved and diſordered diſpoſure, return to their place ſpontaneouſly, and therefore naturally in a right motion, (it being granted, that *eadem ſit ratio totius & partium*) ſo it may be inferred, that the Terreſtrial Globe removed violently from the place aſſigned it by nature, it would return by a right line. This, as I have ſaid, is the moſt that can be granted you, and that onely for want of examination; but he that ſhall with exactneſs reviſe theſe things, will firſt deny, that the parts of the Earth, in returning to its whole, move in a right line, and not by a circular or mixt; and really you would have enough to do to demonſtrate the contrary, as you ſhall plainly ſee in the anſwers to the particular reaſons and experiments alledged by *Ptolomey* and *Ariſtotle*. Secondly, If another ſhould ſay that the *parts* of the Earth, go not in their motion towards the Centre of the World, but to unite with its *Whole*, and that for that reaſon they naturally incline towards the centre of the Terreſtrial Globe, by which inclination they conſpire to form and preſerve it, what other *All*, or what other Centre would you find for the World, to which the whole Terrene Globe, being thence removed, would ſeek to return, that ſo the reaſon of the *Whole* might be like to that of its *parts*? It may be added, That neither *Ariſtotle*, nor you can ever prove, that the Earth *de facto* is in the centre of the Univerſe; but if any Centre may

It is queſtionable whether deſcending weights move in a right line.

The Earth ſpherical by the conſpiration of its parts to its Centre.

The Sun more probably in the centre of the Univerſe, than the Earth.

may be aſſigned to the Univerſe, we ſhall rather find the Sun placed in it, as by the ſequel you ſhall underſtand.

Now, like as from the conſentaneous conſpiration of all the parts of the Earth to form its whole, doth follow, that they with equal inclination concurr thither from all parts; and to unite themſelves as much as is poſſible together, they there ſpherically adapt themſelves; why may we not believe that the Sun, Moon, and other mundane Bodies, be alſo of a round figure, not by other than a concordant inſtinct, and natural concourſe of all the parts compoſing them? Of which, if any, at any time, by any violence were ſeparated from the whole, is it not reaſonable to think, that they would ſpontaneouſly and by natural inſtinct return? and in this manner to infer, that the right motion agreeth with all mundane bodies alike.

Natural inclination of the parts of all the globes of the World to go to their centre.

SIMPL. Certainly, if you in this manner deny not onely the Principles of Sciences, but manifeſt Experience, and the Senſes themſelves, you can never be convinced or removed from any opinion which you once conceit, therefore I will chooſe rather to be ſilent (for, *contra negantes principia non eſt diſputandum*) than contend with you. And inſiſting on the things alledged by you even now (ſince you queſtion ſo much as whether grave moveables have a right motion or no) how can you ever rationally deny, that the parts of the Earth; or, if you will, that ponderous matters deſcend towards the Centre, with a right motion; whenas, if from a very high Tower, whoſe walls are very upright and perpendicular, you let them fall, they ſhall deſcend gliding and ſliding by the Tower to the Earth, exactly in that very place where a plummet would fall, being hanged by a line faſtned above, juſt there, whence the ſaid weights were let fall? is not this a more than evident argument of the motions being right, and towards the Centre? In the ſecond place you call in doubt, whether the parts of the Earth are moved, as *Ariſtotle* affirms, towards the Centre of the World; as if he had not rationally demonſtrated it by contrary motions, whilſt he thus argueth; The motion of heavie bodies is contrary to that of the light: but the motion of the light is manifeſt to be directly upwards, namely, towards the circumference of the World, therefore the motion of the heavie is directly towards the Centre of the World: and it happens *per accidens*, that it be towards the centre of the Earth, for that this ſtriveth to be united to that. The ſeeking in the next place, what a part of the Globe of the Sun or Moon would do, were it ſeparated from its whole, is vanity; becauſe that thereby that is ſought, which would be the conſequence of an impoſſibility; in regard that, as *Ariſtotle* alſo demonſtrates, the cœleſtial bodies are impaſſible, impenetrable, and infrangible; ſo that ſuch a caſe

The right motion of grave bodies manifeſt to ſenſe.

Arguments of Ariſtotle, to prove that grave bodies move with an inclination to arrive at the centre of the Univerſe.

Heavie bodies move towards the centre of the Earth per accidens.

To ſeek what would follow upon an impoſſibility, is folly.

a caſe can never happen: and though it ſhould, and that the ſeparated part ſhould return to its whole, it would not return as grave or light, for that the ſame *Ariſtotle* proveth, that the Cœleſtial Bodies are neither heavie nor light. *Cœleſtial bodies neither heavie nor light, according to* Ariſtotle.

SALV. With what reaſon I doubt, whether grave bodies move by a right and perpendicular line, you ſhall hear, as I ſaid before, when I ſhall examine this particular argument. Touching the ſecond point, I wonder that you ſhould need to diſcover the *Paralogiſm* of *Ariſtotle*, being of it ſelf ſo manifeſt; and that you perceive not, that *Ariſtotle* ſuppoſeth that which is in queſtion: therefore take notice.

SIMPL. Pray *Salviatus* ſpeak with more reſpect of *Ariſtotle*: for who can you ever perſwade, that he who was the firſt, only, and admirable explainer of the *Syllogiſtick* forms of demonſtration, of *Elenchs*, of the manner of diſcovering *Sophiſms*, *Paralogiſms*, and in ſhort, of all the parts of *Logick*, ſhould afterwards ſo notoriouſly equivocate in impoſing that for known, which is in queſtion? It would be better, my Maſters, firſt perfectly to underſtand him, and then to try, if you have a mind, to oppoſe him. Ariſtotle *cannot equivocate, being the inventer of* Logick.

SALV. *Simplicius*, we are here familiarly diſcourſing among our ſelves, to inveſtigate ſome truth; I ſhall not be diſpleaſed that you diſcover my errors; and if I do not follow the mind of *Ariſtotle*, freely reprehend me, and I ſhall take it in good part. Onely give me leave to expound my doubts, and to reply ſomething to your laſt words, telling you, that *Logick*, as it is well underſtood, is the Organe with which we philoſophate; but as it may be poſſible, that an Artiſt may be excellent in making Organs, but unlearned in playing on them, thus he might be a great Logician, but unexpert in making uſe of *Logick*; like as we have many that theorically underſtand the whole Art of Poetry, and yet are unfortunate in compoſing but meer four Verſes; others enjoy all the precepts of *Vinci**, and yet know not how to paint a Stoole. The playing on the Organs is not taught by them who know how to make Organs, but by him that knows how to play on them: Poetry is learnt by continual reading of Poets: Limning is learnt by continual painting and deſigning: Demonſtration from the reading of Books full of demonſtrations, which are the Mathematical onely, and not the Logical. Now returning to our purpoſe, I ſay, that that which *Ariſtotle* ſeeth of the motion of light bodies, is the departing of the Fire from any part of the Superficies of the Terreſtrial Globe, and directly retreating from it, mounting upwards; and this indeed is to move towards a circumference greater than that of the Earth; yea, the ſame *Ariſtotle* makes it to move to the concave of the Moon, but that this circumference is that of the World, or concentrick to it, ſo that

* A famous *Italian* Painter.

that to move towards this, is a moving towards that of the World, that he cannot affirm, unleſs he ſuppoſeth, That the Centre of the Earth, from which we ſee theſe light aſcendent bodies to depart, be the ſame with the Centre of the World; which is as much as to ſay, that the terreſtrial Globe is conſtituted in the midſt of the World: which is yet that of which we were in doubt, and which *Ariſtotle* intended to prove. And do you ſay that this is not a manifeſt *Paralogiſm*?

Paralogiſm of Ariſtotle, *in proving the Earth to be in the Centre of the World.*

The Paralogiſme of Ariſtotle *another way diſcovered.*

SAGR. This Argument of *Ariſtotle* appeared to me deficient alſo, and *non*-concludent for another reſpect; though it were granted, that that Circumference, to which the Fire directly moveth, be that which includeth the World: for that in a circle, not onely the centre, but any other point being taken, every moveable which departing thence, ſhall move in a right line, and towards any whatſoever part, ſhall without any doubt go towards the circumference, and continuing the motion, ſhall alſo arrive thither; ſo that we may truly ſay, that it moveth towards the circumference: but yet it doth not follow, that that which moveth by the ſame line with a contrary motion, would go towards the centre, unleſs when the point taken were the centre it ſelf, or that the motion were made by that onely line, which produced from the point aſſigned, paſſeth thorow the centre. So that to ſay, that Fire moving in a right line, goeth towards the circumference of the World, therefore the parts of the Earth which by the ſame lines move with a contrary motion, go towards the centre of the World, concludeth not, unleſs then when it is preſuppoſed, that the lines of the Fire prolonged paſs by the centre of the World; and becauſe we know certainly of them, that they paſs by the centre of the Terreſtrial Globe (being perpendicular to its ſuperficies, and not inclined) therefore to conclude, it muſt be ſuppoſed, that the centre of the Earth is the ſame with the centre of the World; or at leaſt, that the parts of the Fire and Earth deſcend not, ſave onely by one ſole line which paſſeth by the centre of the World. Which nevertheleſs is falſe, and repugnant to experience, which ſheweth us, that the parts of Fire, not by one line onely, but by infinite, produced from the centre of the Earth towards all the parts of the World, aſcend always by lines perpendicular to the Superficies of the Terreſtrial Globe.

SALV. You do very ingeniouſly lead *Ariſtotle* to the ſame inconvenience, *Sagredus*, ſhewing his manifeſt equivoke; but withal you add another inconſiſtency. We ſee the Earth to be ſpherical, and therefore are certain that it hath its centre, to which we ſee all its parts are moved; for ſo we muſt ſay, whilſt their motions are all perpendicular to the Superficies of the Earth; we mean,

mean, that as they move to the centre of the Earth, they move to their *Whole*, and to their Universal Mother: and we are still farther so free, that we will suffer our selves to be perswaded, that their natural instinct is, not to go towards the centre of the Earth, but towards that of the Universe; which we know not where to find, or whether it be or no; and were it granted to be, it is but an imaginary point, and a nothing without any quality. As to what *Simplicius* said last, that the contending whether the parts of the Sun, Moon, or other cœlestial Body, separated from their *Whole*, should naturally return to it, is a vanity, for that the case is impossible; it being clear by the Demonstrations of *Aristotle*, that the cœlestial Bodies are impassible, impenetrable, unpartable, *&c.* I answer, that none of the conditions, whereby *Aristotle* distinguisheth the Cœlestial Bodies from Elementary, hath other foundation than what he deduceth from the diversity of the natural motion of those and these; insomuch that it being denied, that the circular motion is peculiar to Cœlestial Bodies, and affirmed, that it is agreeable to all Bodies naturally moveable, it is behoofull upon necessary consequence to say, either that the attributes of generable, or ingenerable, alterable, or unalterable, partable, or unpartable, *&c.* equally and commonly agree with all worldly bodies, namely, as well to the Cœlestial as to the Elementary; or that *Aristotle* hath badly and erroneously deduced those from the circular motion, which he hath assigned to Cœlestial Bodies.

Grave bodies may more rationally be affirmed to tend to the Centre of the Earth, than of the Universe.

The conditions and attributes which differ the cœlestial bodies from Elementary, depend on the motions assigned them by Arist.

SIMPL. This manner of argumentation tends to the subversion of all Natural Philosophy, and to the disorder and subversion of Heaven and Earth, and the whole Universe; but I believe the Fundamentals of the *Peripateticks* are such, that we need not fear that new Sciences can be erected upon their ruines.

SALV. Take no thought in this place for Heaven or the Earth, neither fear their subversion, or the ruine of Philosophy. As to Heaven, your fears are vain for that which you your self hold unalterable and impassible; as for the Earth, we strive to enoble and perfect it, whilst we make it like to the Cœlestial Bodies, and as it were place it in Heaven, whence your Philosophers have exiled it. Philosophy it self cannot but receive benefit from our Disputes, for if our conceptions prove true, new Discoveries will be made; if false, the first Doctrine will be more confirmed. Rather bestow your care upon some Philosophers, and help and defend them; for as to the Science it self, it cannot but improve. And that we may return to our purpose, be pleased freely to produce what presents it self to you in confirmation of that great difference which *Aristotle* puts between the Cœlestial Bodies, and the Elementary parts of the World, in making those ingenerable,

The disputes and contradictions of Philosophers may conduce to the benefit of Philosophy.

incorruptible, unalterable, *&c.* and this corruptible, alterable, *&c.*

SIMPL. I ſee not yet any need that *Ariſtotle* hath of help, ſtanding as he doth ſtoutly and ſtrongly on his feet; yea not being yet aſſaulted, much leſs foiled by you. And what ward will you chooſe in this combate for this firſt blow? *Ariſtotle* writeth, that whatever is generated, is made out of a contrary in ſome ſubject, and likewiſe is corrupted in ſome certain ſubject from a contrary into a contrary; ſo that (obſerve) corruption and generation is never but onely in contraries; If therefore to a Cœleſtial Body no contrary can be aſſigned, for that to the circular motion no other motion is contrary, then Nature hath done very well to make that exempt from contraries, which was to be ingenerable and incorruptible; This fundamental firſt confirmed, it immediately followeth of conſequence, that it is inaugmentable, inalterable, impaſſible, and finally eternal, and a proportionate habitation to the immortal Deities, conformable to the opinion even of all men that have any conceit of the Gods. He afterwards confirmeth the ſame by ſenſe; in regard, that in all times paſt, according to memory or tradition, we ſee nothing removed, according to the whole outward Heaven, nor any of its proper parts. Next, as to the circular motion, that no other is contrary to it, *Ariſtotle* proveth many ways; but without reciting them all, it is ſufficiently demonſtrated, ſince ſimple motions are but three, to the *medium*, from the *medium*, and about the *medium*, of which the two right, *ſurſum* and *deorſum*, are manifeſtly contrary; and becauſe one onely hath onely one for contrary, therefore there reſts no other motion which may be contrary to the circular. You ſee the ſubtle and moſt concluding diſcourſe of *Ariſtotle*, whereby he proveth the incorruptibility of Heaven.

Ariſtotles diſcourſe to prove the incorruptibility of Heaven.

Generation & corruption is onely amongſt contraries, according to Ariſt.

To the circular motion no other motion is contrary.

Heaven an habitation for the immortal Gods.

Immutability of Heaven evident to ſenſe.

He proveth that the circular motion hath no contrary.

SALV. This is nothing more, ſave the pure progreſs of *Ariſtotle*, by me hinted before; wherein, beſides that I affirm, that the motion which you attribute to the Cœleſtial Bodies agreeth alſo to the Earth, its illation proves nothing. I tell you therefore, that that circular motion which you aſſign to Cœleſtial Bodies, ſuiteth alſo to the Earth, from which, ſuppoſing that the reſt of your diſcourſe were concludent, will follow one of theſe three things, as I told you a little before, and ſhall repeat; namely, either that the Earth it ſelf is alſo ingenerable, and incorruptible, as the Cœleſtial bodies; or that the Cœleſtial bodies are, like as the Elementary generable, alterable &c. or that this difference of motion hath nothing to do with Generation and Corruption. The diſcourſe of *Ariſtotle*, and yours alſo contain many Propoſitions not to be lightly admitted, and the better to examine them, it will be convenient to reduce them to the moſt abſtracted and

diſtinct

distinct that can be possible; and excuse me *Sagredus*, if haply with some tediousness you hear me oft repeat the same things, and fancie that you see me reassume my argument in the publick circle of Disputations. You say Generation and Corruption are onely made where there are contraries; contraries are onely amongst simple natural bodies, moveable with contrary motions; contrary motions are onely those which are made by a right line between contrary terms; and these are onely two, that is to say, from the *medium*, and towards the *medium*; and such motions belong to no other natural bodies, but to the *Earth*, the *Fire*, and the other two Elements: therefore Generation and Corruption is onely amongst the Elements. And because the third simple motion, namely, the circular about the *medium*, hath no contrary, (for that the other two are contraries, and one onely, hath but onely one contrary) therefore that natural body with which such motion agreeth, wants a contrary; and having no contrary is ingenerable and incorruptible, &c. Because where there is no contrariety, there is no generation or corruption, &c. But such motion agreeth onely with the Cœlestial bodies; therefore onely these are ingenerable, incorruptible, &c. And to begin, I think it a more easie thing, and sooner done to resolve, whether the Earth (a most vast Body, and for its vicinity to us, most tractable) moveth with a speedy motion, such as its revolution about its own axis in twenty four hours would be, than it is to understand and resolve, whether Generation and Corruption ariseth from contrariety, or else whether there be such things as generation, corruption and contrariety in nature. And if you, *Simplicius*, can tell me what method Nature observes in working, when she in a very short time begets an infinite number of flies from a little vapour of the Must of wine, and can shew me which are there the contraries you speak of, what it is that corrupteth, and how; I should think you would do more than I can; for I profess I cannot comprehend these things. Besides, I would very gladly understand how, and why these corruptive contraries are so favourable to Daws, and so cruel to Doves; so indulgent to Stags, and so hasty to Horses, that they do grant to them many more years of life, that is, of incorruptibility, than weeks to these. Peaches and Olives are planted in the same soil, exposed to the same heat and cold, to the same wind and rains, and, in a word, to the same contrarieties; and yet those decay in a short time, and these live many hundred years. Furthermore, I never was thorowly satisfied about this substantial transmutation (still keeping within pure natural bounds) whereby a matter becometh so transform'd, that it should be necessarily said to be destroy'd, so that nothing remaineth of its first being, and that another body

Its easier to prove the Earth to move, than that corruption is made by contraries.

Bare tranſpoſition of parts may repreſent bodies under diverſe aſpects.

quite differing there-from ſhould be thence produced; and if I fancy to my ſelf a body under one aſpect, and by and by under another very different, I cannot think it impoſſible but that it may happen by a ſimple tranſpoſition of parts, without corrupting or ingendring any thing a-new; for we ſee ſuch kinds of Metamorphoſes dayly: ſo that to return to my purpoſe, I anſwer you, that inaſmuch as you go about to perſwade me that the Earth can not move circularly by way of corruptibility and generability, you have undertook a much harder task than I, that with arguments more difficult indeed, but no leſs concluding, will prove the contrary.

SAGR. Pardon me, *Salviatus*, if I interrupt your diſcourſe, which, as it delights me much, for that I alſo am gravel'd with the ſame doubts; ſo I fear that you can never conclude the ſame, without altogether digreſſing from your chief deſign: therefore if it be permitted to proceed in our firſt argument, I ſhould think that it were convenient to remit this queſtion of generation and corruption to another diſtinct and ſingle conference; as alſo, if it ſhall pleaſe you and *Simplicius*, we may do by other particular queſtions which may fall in the way of our diſcourſe; which I will keep in my mind to propoſe, and exactly diſcuſs them ſome other time. Now as for the preſent, ſince you ſay, that if *Ariſtotle* deny circular motion to the Earth in common with other bodies Cœleſtial, it thence will follow, that the ſame which befalleth the Earth, as to its being generable, alterable, *&c.* will hold alſo of Heaven, let us enquire no further if there be ſuch things in nature, as generation and corruption, or not; but let us return to enquire what the Globe of the Earth doth.

By denying Principles in the Sciences, any Paradox may be maintained.

SIMPL. I cannot ſuffer my ears to hear it queſtion'd, whether generation and corruption be in *rerum naturâ*, it being a thing which we have continually before our eyes, and whereof *Ariſtotle* hath written two whole Books. But if you go about to deny the Principles of Sciences, and queſtion things moſt manifeſt, who knows not, but that you may prove what you will, and maintain any *Paradox*? And if you do not dayly ſee herbs, plants, animals to generate and corrupt, what is it that you do ſee? Alſo, do you not continually behold contrarieties contend together, and the Earth change into Water, the Water turn to Air, the Air into Fire, and again the Air to condenſe into Clouds, Rains, Hails and Storms?

SAGR. Yes, we ſee theſe things indeed, and therefore will grant you the diſcourſe of *Ariſtotle*, as to this part of generation and corruption made by contraries; but if I ſhall conclude by virtue of the ſame propoſitions which are granted to *Ariſtotle*, that the Cœleſtial bodies themſelves are alſo generable and corruptible

ruptible, aſwell as the Elementary, what will you ſay then?

SIMPL. I will ſay you have done that which is impoſſible to be done.

SAGR. Go to; tell me, *Simplicius*, are not theſe affections contrary to one another?

SIMPL. Which?

SAGR. Why theſe; Alterable, unalterable; paſſible, *impaſſible; generable, ingenerable; corruptible, incorruptible? *Or*, Impatible.

SIMPL. They are moſt contrary.

SAGR. Well then, if this be true, and it be alſo granted, that Cœleſtial Bodies are ingenerable and incorruptible; I prove that of neceſſity Cœleſtial Bodies muſt be generable and corruptible.

SIMPL. This muſt needs be a *Sophiſm*.

SAGR. Hear my Argument, and then cenſure and reſolve it. Cœleſtial Bodies, for that they are ingenerable and incorruptible, have in Nature their contraries, which are thoſe Bodies that be generable and corruptible: [illegible] where there is contrariety, there is alſo generation and corruption; therefore Cœleſtial Bodies are generable and corruptible. *Cœleſtial Bodies are generable and corruptible, becauſe they are ingenerable and incorruptible.*

SIMPL. Did I not ſay it could be no other than a *Sophiſm*? This is one of thoſe forked Arguments called *Soritæ*: like that of the *Cretan*, who ſaid that all *Cretans* were lyars; but he as being a *Cretan*, had told a lye, in ſaying that the *Cretans* were lyars; it followed therefore, that the *Cretans* were no lyars, and conſequently that he, as being a *Cretan*, had ſpoke truth: And yet in ſaying the *Cretans* were lyars, he had ſaid true, and comprehending himſelf as a *Cretan*, he muſt conſequently be a lyar. And thus in theſe kinds of *Sophiſms* a man may dwell to eternity, and never come to any concluſion. *The forked Syllogiſm call'd Sophiſtic.*

SAGR. You have hitherto cenſured it, it remaineth now that you anſwer it, ſhewing the fallacie.

SIMPL. As to the reſolving of it, and finding out its fallacie, do you not in the firſt place ſee a manifeſt contradiction in it? Cœleſtial Bodies are ingenerable and incorruptible; *Ergo*, Cœleſtial Bodies are generable and corruptible. And again, the contrariety is not betwixt the Cœleſtial Bodies, but betwixt the Elements, which have the contrariety of the Motions, *ſurſum* and *deorſum*, and of levity and gravity; But the Heavens which move circularly, to which motion no other motion is contrary, want contrariety, and therefore they are incorruptible. *Among ſt Cœleſtial Bodies there is no contrariety.*

SAGR. Fair and ſoftly, *Simplicius*; this contrariety whereby you ſay ſome ſimple Bodies become corruptible, reſides it in the ſame Body which is corrupted, or elſe hath it relation to ſome other? I ſay, for example, the humidity by which a piece of Earth

is

is corrupted, reſides it in the ſame Earth or in ſome other bodie, which muſt either be the Air or Water? I believe you will grant, that like as the Motions upwards and downwards, and gravity and levity, which you make the firſt contraries, cannot be in the ſame Subject, ſo neither can moiſt and dry, hot and cold: you muſt therefore conſequently acknowledg that when a bodie corrupteth, it is occaſioned by ſome quality reſiding in another contrary to its own: therefore to make the Cœleſtial Body become corruptible, it ſufficeth that there are in Nature, bodies that have a contrariety to that Cœleſtial body; and ſuch are the Elements, if it be true that corruptibility be contrary to incorruptibility.

Contraries which are the cauſes of corruption, reſide not in the ſame body that corrupteth.

SIMPL. This ſufficeth not, Sir; The Elements alter and corrupt, becauſe they are intermixed, and are joyn'd to one another, and ſo may exerciſe their contrariety; but Cœleſtial bodies are ſeparated from the Elements, by which they are not ſo much as toucht, though indeed they have an influence upon the Elements. It is requiſite, if you will prove generation and corruption in Cœleſtial bodies, that you ſhew, that there reſides contrarieties between them.

Cœleſtial Bodies touch, but are not touched by the Elements.

SAGR. See how I will find thoſe contrarieties between them. The firſt fountain from whence you derive the contrariety of the Elements, is the contrariety of their motions upwards and downwards: it therefore is neceſſary that thoſe Principles be in like manner contraries to each other, upon which thoſe motions depend: and becauſe that is moveable upwards by lightneſs, and this downwards by gravity, it is neceſſary that lightneſs and gravity are contrary to each other: no leſs are we to believe thoſe other Principles to be contraries, which are the cauſes that this is heavy, and that light: but by your own confeſſion, levity and gravity follow as conſequents of rarity and denſity; therefore rarity and denſity ſhall be contraries: the which conditions or affections are ſo amply found in Cœleſtial bodies, that you eſteem the ſtars to be onely more denſe parts of their Heaven: and if this be ſo, it followeth that the denſity of the ſtars exceeds that of the reſt of Heaven, by almoſt infinite degrees: which is manifeſt, in that Heaven is infinitely tranſparent, and the ſtars extremely opacous; and for that there are there above no other qualities, but more and leſs denſity and rarity, which may be cauſes of the greater or leſs tranſparency. There being then ſuch contrariety between the Cœleſtial bodies, it is neceſſary that they alſo be generable and corruptible, in the ſame manner as the Elementary bodies are; or elſe that contrariety is not the cauſe of corruptibility, &c.

Gravity & levity, rarity and denſity, are contrary qualities.

The ſtars infinitely ſurpaſs the ſubſtance of the reſt of Heaven in denſity.

Rarity & denſity in Cœleſtial bodies, is different from the rarity & denſity of the elements.

SIMPL. There is no neceſſity either of one or the other, for that denſity and rarity in Cœleſtial bodies, are not contraries to each

each other, as in Elementary bodies; for that they depend not on the primary qualities, cold and heat, which are contraries; but on the more or leſs matter in proportion to quantity: now much and little, ſpeak onely a relative oppoſition, that is, the leaſt of oppoſitions, and which hath nothing to do with generation and corruption.

SAGR. Therefore affirming, that denſity and rarity, which amongſt the Elements ſhould be the cauſe of gravity and levity, which may be the cauſes of contrary motions *ſurſùm* and *deorſùm*, on which, again, dependeth the contrarieties for generation and corruption; it ſufficeth not that they be thoſe denſneſſes and rareneſſes which under the ſame quantity, or (if you will) maſs contain much or little matter, but it is neceſſary that they be denſneſſes and rareneſſes cauſed by the primary qualities, hot and cold, otherwiſe they would operate nothing at all: but if this be ſo, *Ariſtotle* hath deceived us, for that he ſhould have told it us at firſt, and ſo have left written that thoſe ſimple bodies are generable and corruptible, that [illegible] with ſimple motions upwards and downwards, dependent on levity and gravity, cauſed by rarity and denſity, made by much or little matter, by reaſon of heat and cold; and not to have ſtaid at the ſimple motion *ſurſùm* and *deorſùm*: for I aſſure you that to the making of bodies heavy or light, whereby they come to be moved with contrary motions, any kind of denſity and rarity ſufficeth, whether it proceed from heat and cold, or what elſe you pleaſe; for heat and cold have nothing to do in this affair: and you ſhall upon experiment find, that a red hot iron, which you muſt grant to have heat, weigheth as much, and moves in the ſame manner as when it is cold. But to overpaſs this alſo, how know you but that Cœleſtial rarity and denſity depend on heat and cold?

Ariſtotle defective in aſſigning the cauſes why the elements are generable & corruptible.

SIMPL. I know it, becauſe thoſe qualities are not amongſt Cœleſtial bodies, which are neither hot nor cold.

SALV. I ſee we are again going about to engulph our ſelves in a bottomleſs ocean, where there is no getting to ſhore; for this is a Navigation without Compaſs, Stars, Oars or Rudder: ſo that it will follow either that we be forced to paſs from Shelf to Shelf, or run on ground, or to ſail continually in danger of being loſt. Therefore, if according to your advice we ſhall proceed in our main deſign, we muſt of neceſſity for the preſent overpaſs this general conſideration, whether direct motion be neceſſary in Nature, and agree with ſome bodies; and come to the particular demonſtrations, obſervations and experiments; propounding in the firſt place all thoſe that have been hitherto alledged by *Ariſtotle*, *Ptolomey*, and others, to prove the ſtability of the Earth, endeavouring in the next place to anſwer them: and producing in the

the laſt place, thoſe, by which others may be perſwaded, that the Earth is no leſs than the Moon, or any other Planet to be numbered amongſt natural bodies that move circularly.

SAGR. I ſhall the more willingly incline to this, in that I am better ſatisfied with your Architectonical and general diſcourſe, than with that of *Ariſtotle*, for yours convinceth me without the leaſt ſcruple, and the other at every ſtep croſſeth my way with ſome block. And I ſee no reaſon why *Simplicius* ſhould not be preſently ſatisfied with the Argument you alledg, to prove that there can be no ſuch thing in nature as a motion by a right line, if we do but preſuppoſe that the parts of the Univerſe are diſpoſed in an excellent conſtitution and perfect order.

SALV. Stay a little, good *Sagredus*, for juſt now a way comes into my mind, how I may give *Simplicius* ſatisfaction, provided that he will not be ſo ſtrictly wedded to every expreſſion of *Ariſtotle*, as to hold it hereſie to recede in any thing from him. Nor is there any queſtion to be made, but that if we grant the excellent diſpoſition and perfect order of the parts of the Univerſe, as to local ſcituation, that then there is no other but the circular motion, and reſt; for as to the motion by a right line, I ſee not how it can be of uſe for any thing, but to reduce to their natural conſtitution, ſome integral bodies, that by ſome accident were remov'd and ſeparated from their whole, as we ſaid above.

Let us now conſider the whole Terreſtrial Globe, and enquire the beſt we can, whether it, and the other Mundane bodies are to conſerve themſelves in their perfect and natural diſpoſition. It is neceſſary to ſay, either that it reſts and keeps perpetually immoveable in its place; or elſe that continuing always in its place, it revolves in its ſelf; or that it turneth about a Centre, moving by the circumference of a circle. Of which accidents, both *Ariſtotle* and *Ptolomey*, and all their followers ſay, that it hath ever obſerved, and ſhall continually keep the firſt, that is, a perpetual reſt in the ſame place. Now, why, I pray you, ought they not to have ſaid, that its natural affection is to reſt immoveable, rather than to make natural unto it the motion * downwards, with which motion it never did or ſhall move? And as to the motion by a right line, they muſt grant us that Nature maketh uſe of it to reduce the ſmall parts of the Earth, Water, Air, Fire, and every other integral Mundane body to their *Whole*, when any of them by chance are ſeparated, and ſo tranſported out of their proper place; if alſo haply, ſome circular motion might not be found to be more convenient to make this reſtitution. In my judgment, this primary poſition anſwers much better, even according to *Ariſtotles* own method, to all the other conſequences, than to attribute the ſtraight motion to be an intrinſick and natural principle

Ariſt. & Ptolomey *make the Terreſtrial Globe immoveable.*

It is better to ſay, that the Terreſtrial Globe naturally reſteth, than that it moveth directly downwards.

*The word is, *all' ingiù*, which the Latine verſion rendreth *ſurſùm*, which is quite contrary to the Authors ſenſe.

principle of the Elements. Which is manifeſt, for that if I aske the *Peripatetick*, if, being of opinion that Cœleſtial bodies are incorruptibe and eternal, he believeth that the Terreſtial Globe is not ſo, but corruptible and mortal, ſo that there ſhall come a time, when the Sun and Moon and other Stars, continuing their beings and operations, the Earth ſhall not be found in the World, but ſhall with the reſt of the Elements be deſtroyed and annihilated, I am certain that he would anſwer me, no: therefore generation and corruption is in the parts and not in the whole; and in the parts very ſmall and ſuperficial, which are, as it were, incenſible in compariſon of the whole maſſe. And becauſe *Ariſtotle* deduceth generation and corruption from the contrariety of ſtreight motions, let us remit ſuch motions to the parts, which onely change and decay, and to the whole Globe and Sphere of the Elements, let us aſcribe either the circular motion, or a perpetual conſiſtance in its proper place: the only affections apt for perpetuation, and maintaining of perfect order. This which is ſpoken of the Earth, may be ſaid with the ſame reaſon of Fire, and of the greateſt part of the Air; to which Elements, the *Peripatetick*s are forced to aſcribe for intrinſical and natural, a motion wherewith they were never yet moved, nor never ſhall be; and to call that motion preternatural to them, wherewith, if they move at all, they do and ever ſhall move. This I ſay, becauſe they aſſign to the Air aud Fire the motion upwards, wherewith thoſe Elements were never moved, but only ſome parts of them, and thoſe were ſo moved onely in order to the recovery of their perfect conſtitution, when they were out of their natural places; and on the contrary they call the circular motion preternatural to them, though they are thereby inceſſantly moved: forgeting, as it ſeemeth, what *Ariſtotle* oft inculcateth, that nothing violent can be permanent.

Right Motion with more reaſon attributed to the parts, than to the whole Elements.

*The Peripatetick*s *improperly aſſign thoſe motions to the Elements for Natural, with which they never were moved, and thoſe for Preternatural with which they alwayes are moved.*

SIMPL. To all theſe we have very pertinent anſwers, which I for this time omit, that we may come to the more particular reaſons, and ſenſible experiments, which ought in concluſion to be oppoſed, as *Ariſtotle* ſaith well, to whatever humane reaſon can preſent us with.

Senſible experiments to be preferred to humane Arguments.

SAGR. What hath been ſpoken hitherto, ſerves to clear up unto us which of the two general diſcourſes carrieth with it moſt of probability, I mean that of *Ariſtotle*, which would perſwade us, that the ſublunary bodies are by nature generable, and corruptible, *&c.* and therefore moſt different from the eſſence of Cœleſtial bodies, which are impaſſible, ingenerable, incorruptible, *&c.* drawn from the diverſity of ſimple motions; or elſe this of *Salviatus*, who ſuppoſing the integral parts of the World to be diſpoſed in a perfect conſtitution, excludes by neceſſary conſe-

quence the right or ſtraight motion of ſimple natural bodies, as being of no uſe in nature, and eſteems the Earth it ſelf alſo to be one of the Cœleſtial bodies adorn'd with all the prerogatives that agree with them; which laſt diſcourſe is hitherto much more likely, in my judgment, than that other. Therefore reſolve, *Simplicius*, to produce all the particular reaſons, experiments and obſervations, as well Natural as Aſtronomical, that may ſerve to perſwade us that the Earth differeth from the Cœleſtial bodies, is immoveable, and ſituated in the Centre of the World, and what ever elſe excludes its moving like to the Planets, as *Jupiter* or the *Moon*, &c. And *Salviatus* will be pleaſed to be ſo civil as to anſwer to them one by one.

SIMPL. See here for a begining, two moſt convincing Arguments to demonſtrate the Earth to be moſt different from the Cœleſtial bodies. Firſt, the bodies that are generable, corruptible, alterable, &c. are quite different from thoſe that are ingenerable, incorruptible, unalterable, &c. But the Earth is generable, corruptible, alterable, &c. and the Cœleſtial bodies ingenerable, incorruptible, unalterable, &c. Therefore the Earth is quite different from the Cœleſtial bodies.

SAGR. By your firſt Argument you ſpread the Table with the ſame Viands, which but juſt now with much adoe were voided.

SIMPL. Hold a little, Sir, and take the reſt along with you, and then tell me if this be not different from what you had before. In the former, the *Minor* was proved *à priori*, & now you ſee it proved *à poſteriori*: Judg then if it be the ſame. I prove the *Minor*, therefore (the *Major* being moſt manifeſt) by ſenſible experience, which ſhews us that in the Earth there are made continual generations, corruptions, alterations, &c. which neither our ſenſes, nor the traditions or memories of our Anceſtors, ever ſaw an inſtance of in Heaven; therefore Heaven is unalterable, &c. and the Earth alterable, &c. and therefore different from Heaven. I take my ſecond Argument from a principal and eſſential accident, and it is this. That body which is by its nature obſcure and deprived of light, is divers from the luminous and ſhining bodies; but the Earth is obſcure and void of light, and the Cœleſtial bodies ſplendid, and full of light; *Ergo*, &c. Anſwer to theſe Arguments firſt, that we may not heap up too many, and then I will alledge others.

Heaven immutable, becauſe there never was any mutation ſeen in it.

Bodies naturally lucid, are different from thoſe which are by nature obſcure.

SALV. As to the firſt, the ſtreſſe whereof you lay upon experience, I deſire that you would a little more diſtinctly produce me the alteration which you ſee made in the Earth, and not in Heaven; upon which you call the Earth alterable, and the Heavens not ſo.

SIMPL. I ſee in the Earth, plants and animals continually generating

nerating and decaying; winds, rains, tempeſts, ſtorms ariſing; and in a word, the aſpect of the Earth to be perpetually metamorphoſing; none of which mutations are to be diſcern'd in the Cœleſtial bodies; the conſtitution and figuration of which is moſt punctually conformable to that they ever were time out of mind; without the generation of any thing that is new, or corruption of any thing that was old.

SALV. But if you content your ſelf with theſe viſible, or to ſay better, ſeen experiments, you muſt conſequently account *China* and *America* Cœleſtial bodies, for doubtleſſe you never beheld in them theſe alterations which you ſee here in *Italy*, and that therefore according to your apprehenſion they are inalterable.

SIMPL. Though I never did ſee theſe alterations ſenſibly in thoſe places, the relations of them are not to be queſtioned; beſides that, *cum eadem ſit ratio totius, & partium*, thoſe Countreys being a part of the Earth, as well as ours, they muſt of neceſſity be alterable as theſe are.

SALV. And why have you not, without being put to believe other mens relations, examined and obſerved thoſe alterations with your own eyes?

SIMPL. Becauſe thoſe places, beſides that they are not expoſed to our eyes, are ſo remote, that our ſight cannot reach to comprehend therein ſuch like mutations.

SALV. See now, how you have unawares diſcovered the fallacy of your Argument; for, if you ſay that the alterations that are ſeen on the Earth neer at hand, cannot, by reaſon of the too great diſtance, be ſeen in *America*, much leſſe can you ſee them in the Moon, which is ſo many hundred times more remote: And if you believe the alterations in *Mexico* upon the report of thoſe that come from thence, what intelligence have you from the Moon, to aſſure you that there is no ſuch alterations in it? Therefore, from your not ſeeing any alterations in Heaven, whereas, if there were any ſuch, you could not ſee them by reaſon of their too great diſtance, and from your not having intelligence thereof, in regard that it cannot be had, you ought not to argue, that there are no ſuch alterations; howbeit, from the ſeeing and obſerving of them on Earth, you well argue that therein ſuch there are.

SIMPL. I will ſhew ſo great mutations that have befaln on the Earth; that if any ſuch had happened in the Moon, they might very well have been obſerved here below. We find in very antient records, that heretofore at the Streights of *Gibraltar*, the two great Mountains *Abila*, and *Calpen*, were continued together by certain other leſſe Mountains, which there gave check

The Mediterranian Sea made by the ſeparation of Abila and Calpen.

to the Ocean: but thoſe Hills, being by ſome cauſe or other ſeparated, and a way being opened for the Sea to break in, it made ſuch an inundation, that it gave occaſion to the calling of it ſince the Mid-land Sea: the greatneſs whereof conſidered, and the divers aſpects the ſurfaces of the Water and Earth then made, had it been beheld afar off, there is no doubt but ſo great a change might have been diſcerned by one that was then in the Moon; as alſo to us inhabitants of the Earth, the like alterations would be perceived in the Moon; but we find not in antiquity, that ever there was ſuch a thing ſeen; therefore we have no cauſe to ſay, that any of the Cœleſtial bodies are alterable, *&c.*

SALV. That ſo great alterations have hapned in the Moon, I dare not ſay, but for all that, I am not yet certain but that ſuch changes might occur; and becauſe ſuch a mutation could onely repreſent unto us ſome kind of variation between the more clear, and more obſcure parts of the Moon, I know not whether we have had on Earth obſervant Selenographers, who have for any conſiderable number of years, inſtructed us with ſo exact Selenography, as that we ſhould confidently conclude, that there hath no ſuch change hapned in the face of the Moon; of the figuration of which I find no more particular deſcription, than the ſaying of ſome, that it repreſents an humane face; of others, that it is like the muzle of a Lyon; and of others, that it is *Cain* with a bundle of thorns on his back: therefore, to ſay Heaven is unalterable, becauſe that in the Moon, or other Cœleſtial bodies, no ſuch alterations are ſeen, as diſcover themſelves on Earth, is a bad illation, and concludeth nothing.

SAGR. And there is another odd kind of ſcruple in this Argument of *Simplicius*, running in my mind, which I would gladly have anſwered; therefore I demand of him, whether the Earth before the Mediterranian inundation was generable and corruptible, or elſe began then ſo to be?

SIMPL. It was doubtleſs generable and corruptible alſo before that time; but that was ſo vaſt a mutation, that it might have been obſerved as far as the Moon.

SAGR. Go to; if the Earth was generable and corruptible before that Inundation, why may not the Moon be ſo likewiſe without ſuch a change? Or why ſhould that be neceſſary in the Moon, which importeth nothing on Earth?

SALV. It is a ſhrewd queſtion: But I am doubtfull that *Simplicius* a little altereth the Text of *Ariſtotle*, and the other *Peripateticks*, who ſay, they hold the Heavens unalterable, for that they ſee therein no one ſtar generate or corrupt, which is probably a leſs part of Heaven, than a City is of the Earth, and yet innumerable of theſe have been deſtroyed, ſo as that no mark of them hath remain'd.

SAGR.

SAGR. I verily believed otherwiſe, and conceited that *Simplicius* diſſembled this expoſition of the Text, that he might not charge his Maſter and Conſectators, with a notion more abſurd than the former. And what a folly it is to ſay the Cœleſtial part is unalterable, becauſe no ſtars do generate or corrupt therein? What then? hath any-one ſeen a Terreſtrial Globe corrupt, and another regenerate in its place? And yet is it not on all hands granted by Philoſophers, that there are very few ſtars in Heaven leſs than the Earth, but very many that are much bigger? So that for a ſtar in Heaven to corrupt, would be no leſs than if the whole Terreſtrial Globe ſhould be deſtroy'd. Therefore, if for the true proof of generation and corruption in the Univerſe, it be neceſſary that ſo vaſt bodies as a ſtar, muſt corrupt and regenerate, you may ſatisfie your ſelf and ceaſe your opinion; for I aſſure you, that you ſhall never ſee the Terreſtrial Globe or any other integral body of the World, to corrupt or decay ſo, that having been beheld by us for ſo many years paſt, they ſhould ſo diſſolve, as not to leave any footſteps of them.

Its no leſs impoſſible for a ſtar to corrupt, than for the whole Terreſtrial Globe.

SALV. But to give *Simplicius* yet fuller ſatisfaction, and to reclaim him, if poſſible, from his error; I affirm, that we have in our age new accidents and obſervations, and ſuch, that I queſtion not in the leaſt, but if *Ariſtotle* were now alive, they would make him change his opinion; which may be eaſily collected from the very manner of his diſcourſing: For when he writeth that he eſteemeth the Heavens inalterable, &c. becauſe no new thing was ſeen to be begot therein, or any old to be diſſolved, he ſeems implicitely to hint unto us, that when he ſhould ſee any ſuch accident, he would hold the contrary; and confront, as indeed it is meet, ſenſible experiments to natural reaſon: for had he not made any reckoning of the ſenſes, he would not then from the not ſeeing of any ſenſible mutation, have argued immutability.

Ariſtotle would change his opinion, did he ſee the novelties of our age.

SIMPL. *Ariſtotle* deduceth his principal Argument *à priori*, ſhewing the neceſſity of the inalterability of Heaven by natural, manifeſt and clear principles; and then ſtabliſheth the ſame *à poſteriori*, by ſenſe, and the traditions of the antients.

SALV. This you ſpeak of is the Method he hath obſerved in delivering his Doctrine, but I do not bethink it yet to be that wherewith he invented it; for I do believe for certain, that he firſt procured by help of the ſenſes, ſuch experiments and obſervations as he could, to aſſure him as much as it was poſſible, of the concluſion, and that he afterwards ſought out the means how to demonſtrate it: For this is the uſual courſe in demonſtrative Sciences, and the reaſon thereof is, becauſe when the concluſion is true, by help of reſolutive Method, one may hit upon ſome propoſition before demonſtrated, or come to ſome principle known per

The certainty of the concluſion helpeth by a reſolutive method to find the demonſtration.

per ſe; but if the concluſion be falſe, a man may proceed *in infinitum*, and never meet with any truth already known; but very oft he ſhall meet with ſome impoſſibility or manifeſt abſurdity. Nor need you queſtion but that *Pythagoras* along time before he found the demonſtration for which he offered the Hecatomb, had been certain, that the ſquare of the ſide ſubtending the right angle in a rectangle triangle, was equal to the ſquare of the other two ſides: and the certainty of the concluſion conduced not a little to the inveſtigating of the demonſtration, underſtanding me alwayes to mean in demonſtrative Sciences. But what ever was the method of *Ariſtotle*, and whether his arguing *à priori* preceded ſenſe *à poſteriori*, or the contrary; it ſufficeth that the ſame *Ariſtotle* preferreth (as hath been oft ſaid) ſenſible experiments before all diſcourſes; beſides, as to the Arugments *à priori* their force hath been already examined. Now returning to my purpoſed matter, I ſay, that the things in our times diſcovered in the Heavens, are, and have been ſuch, that they may give abſolute ſatisfaction to all Philoſophers; foraſmuch as in the particular bodies, and in the univerſal expanſion of Heaven, there have been, and are continually, ſeen juſt ſuch accidents as we call generations and corruptions, being that excellent Aſtronomers have obſerved many Comets generated and diſſolved in parts higher than the Lunar Orb, beſides the two new Stars, *Anno* 1572, and *Anno* 1604, without contradiction much higher than all the Planets; and in the face of the Sun it ſelf, by help of the *Teleſcope*, certain denſe and obſcure ſubſtances, in ſemblance very like to the foggs about the Earth, are ſeen to be produced and diſſolved; and many of theſe are ſo vaſt, that they far exceed not only the Mediterranian Streight, but all *Affrica* and *Aſia* alſo. Now if *Ariſtotle* had ſeen theſe things, what think you he would have ſaid, and done *Simplicius*?

Pythagoras offered an Hecatomb for a Geometrical demonſtration which he found.

New ſtars diſcovered in Heaven.

Spots generate and diſſolve in the face of the Sun.

Solar ſpots are bigger than all Aſia and Affrick.

SIMPL. I know not what *Ariſtotle* would have done or ſaid, that was the great Maſter of all the Sciences, but yet I know in part, what his Sectators do and ſay, and ought to do and ſay, unleſſe they would deprive themſelves of their guide, leader, and Prince in Philoſophy. As to the Comets, are not thoſe Modern Aſtronomers, who would make them Cœleſtial, convinced by the **Anti-Tycho*, yea, and overcome with their own weapons, I mean by way of Paralaxes and Calculations, every way tryed, concluding at the laſt in favour of *Ariſtotle*, that they are all Elementary? And this being overthrown, which was as it were their foundation, have theſe Novelliſts any thing more wherewith to maintain their aſſertion?

** Aſtronomers confuted by* Anti-Tycho.

SALV. Hold a little, good *Simplicius*, this modern Author, what ſaith he to the new Stars, *Anno* 1572, and 1604, and to the

the Solar ſpots? for as to the Comets, I for my own particular little care to make them generated under or above the Moon; nor did I ever put much ſtreſſe on the loquacity of *Tycho*; nor am I hard to believe that their matter is Elementary, and that they may elevate (ſublimate) themſelves at their pleaſure, without meeting with any obſtacle from the impenetrability of the *Peripatetick* Heaven, which I hold to be far more thin, yielding, and ſubtil than our Air; and as to the calculations of the Parallaxes, firſt, the uncertainty whether Comets are ſubject to ſuch accidents, and next, the inconſtancy of the obſervations, upon which the computations are made, make me equally ſuſpect both thoſe opinions: and the rather, for that I ſee him you call *Anti-Tycho*, ſometimes ſtretch to his purpoſe, or elſe reject thoſe obſervations which interfere with his deſign.

Anti-Tycho wreſteth Aſtronomical obſervations to his own purpoſe.

SIMPL. As to the new Stars, *Anti-Tycho* extricates himſelf finely in three or four words; ſaying, That thoſe modern new Stars are no certain parts of the Cœleſtial bodies, and that the adverſaries, if they will prove alteration and generation in thoſe ſuperior bodies, muſt ſhew ſome mutations that have been made in the Stars deſcribed ſo many ages paſt, of which there is no doubt but that they be Cœleſtial bodies, which they can never be able to do: Next, as to thoſe matters which ſome affirm, to generate and diſſipate in the face of the Sun, he makes no mention thereof; wherefore I conclude, that he believed them fictious, or the illuſions of the Tube, or at moſt, ſome petty effects cauſed by the Air, and in brief, any thing rather than matters Cœleſtial.

SALV. But you, *Simplicius*, what anſwer could you give to the oppoſition of theſe importunate ſpots which are ſtarted up to diſturb the Heavens, and more than that, the *Peripatetick* Philoſophy? It cannot be but that you, who are ſo reſolute a Champion of it, have found ſome reply or ſolution for the ſame, of which you ought not to deprive us.

SIMPL. I have heard ſundry opinions about this particular. One ſaith: "They are Stars which in their proper Orbs, like as "*Venus* and *Mercury*, revolve about the Sun, and in paſſing un- "der it, repreſent themſelves to us obſcure; and for that they "are many, they oft happen to aggregate their parts together, "and afterwards ſeperate again. Others believe them to be "aerial impreſſions; others, the illuſions of the chryſtals; and o- "thers, other things: But I incline to think, yea am verily per- "ſwaded, That they are an aggregate of many ſeveral opacous "bodies, as it were caſually concurrent among themſelves. And "therefore we often ſee, that in one of thoſe ſpots one may "number ten or more ſuch ſmall bodies, which are of irregu- "lar

Sundry opinions touching the Solar ſpots.

"lar figures, and ſeem to us like flakes of ſnow, or flocks of "wooll, or moaths flying : they vary ſite amongſt themſelves, "and one while ſever, another while meet, and moſt of all be- "neath the Sun, about which, as about their Centre, they con- "tinually move. But yet, muſt we not therefore grant, that "they are generated or diſſolved, but that at ſometimes they are "hid behind the body of the Sun, and at other times, though "remote from it, yet are they not ſeen for the vicinity of the "immeaſurable light of the Sun; in regard that in the eccentrick "Orb of the Sun, there is conſtituted, as it were, an Onion, com- "poſed of many folds one within another, each of which, being "* ſtudded with certain ſmall ſpots, doth move; and albeit their "motion at firſt ſeemeth inconſtant and irregular, yet neverthe- "leſſe, it is ſaid at laſt, to be obſerved that the very ſame ſpots, "as before, do within a determinate time return again. This ſeemeth to me the fitteſt anſwer that hath been found to aſſigne a reaſon of that ſame appearance, and withal to maintain the incorruptability and ingenerability of the Heavens; and if this doth not ſuffice; there wants not more elevated wits, which will give you other, more convincing.

* The Original faith [*tempeſtata ſi mnove*] which the Latine Tranſlation, (miſtaking *Tempeſtata*, a word in Heraldry, for *Tempeſtato*,) rendereth [*incitata movetur*] which ſignifieth a violent tranſportmeut, as in a ſtorm, that of a Ship.

In natural Sciences, the art of Oratory is of no force.

SALV. If this of which we diſpute, were ſome point of Law, or other part of the Studies called *Humanity*, wherein there is neither truth nor falſhood, if we will give ſufficient credit to the acuteneſſe of the wit, readineſſe of anſwers, and the general practice of Writers, then he who moſt aboundeth in theſe, makes his reaſon more probable and plauſible; but in Natural Sciences, the concluſions of which are true and neceſſary, and wherewith the judgment of men hath nothing to do, one is to be more cautious how he goeth about to maintain any thing that is falſe; for a man but of an ordinary wit, if it be his good fortune to be of the right ſide, may lay a thouſand *Demoſthenes* and a thouſand *Ariſtotles* at his feet. Therefore reject thoſe hopes and conceits, wherewith you flatter your ſelf, that there can be any men ſo much more learned, read, and verſed in Authors, than we, that in deſpite of nature, they ſhould be able to make that become true, which is falſe. And ſeeing that of all the opinions that have been hitherto alledged touching the eſſence of theſe Solar ſpots, this inſtanced in by you, is in your judgment the trueſt, it followeth (if this be ſo) that all the reſt are falſe; and to deliver you from this alſo, which doubtleſſe is a moſt falſe *Chimæra*, over-paſſing infinite other improbabilities that are therein, I ſhall propoſe againſt it onely two experiments; one is, that many of thoſe ſpots are ſeen to ariſe in the midſt of the Solar ring, and many likewiſe to diſſolve and vaniſh at a great diſtance from the circumference of the Sun; a neceſſary Argu-

An Argument that neceſſarily proveth the Solar ſpots to generate and diſſolve.

ment

ment that they generate and diſſolve; for if without generating or corrrupting, they ſhould appear there by onely local motion, they would all be ſeen to enter, and paſs out by the extreme circumference. The other obſervation to ſuch as are not ſituate in the loweſt degree of ignorance in Perſpective, by the mutation of the appearing figures, and by the apparent mutations of the velocity of motion is neceſſarily concluding, that the ſpots are contiguous to the body of the Sun, and that touching its ſuperficies, they move either with it or upon it, and that they in no wiſe move in circles remote from the ſame. The motion proves it, which towards the circumference of the Solar Circle, appeareth very ſlow, and towards the midſt, more ſwift; the figures of the ſpots confirmeth it, which towards the circumference appear exceeding narrow in compariſon of that which they ſeem to be in the parts nearer the middle; and this becauſe in the midſt they are ſeen in their full luſter, and as they truly be; and towards the circumference by reaſon of the convexity of the globous ſuperficies, they ſeem more compreſſ'd: And both theſe diminutions of figure and motion, to ſuch as know how to obſerve and calculate them exactly, preciſely anſwer to that which ſhould appear, the ſpots being contiguous to the Sun, and differ irreconcileably from a motion in circles remote, though but for ſmal intervalls from the body of the Sun; as hath been diffuſely demonſtrated by our * Friend, in his Letters about the Solar ſpots, to *Marcus Velſerus*. It may be gathered from the ſame mutation of figure, that none of them are ſtars, or other bodies of ſpherical figure; for that amongſt all figures the ſphere never appeareth compreſſed, nor can ever be repreſented but onely perfectly round; and thus in caſe any particular ſpot were a round body, as all the ſtars are held to be, the ſaid roundneſs would as well appear in the midſt of the Solar ring, as when the ſpot is near the extreme: whereas, its ſo great compreſſion, and ſhewing its ſelf ſo ſmall towards the extreme, and contrariwiſe, ſpatious and large towards the middle, aſſureth us, that theſe ſpots are flat plates of ſmall thickneſs or depth, in compariſon of their length and breadth. Laſtly, whereas you ſay that the ſpots after their determinate periods are obſerved to return to their former aſpect, believe it not, *Simplicius*, for he that told you ſo, will deceive you; and that I ſpeak the truth, you may obſerve them to be hid in the face of the Sun far from the circumference; nor hath your Obſervator told you a word of that compreſſion, which neceſſarily argueth them to be contiguous to the Sun. That which he tells you of the return of the ſaid ſpots, is nothing elſe but what is read in the forementioned Letters, namely, that ſome of them may ſometimes ſo happen that are of ſo long a duration, that they

A concluſive demonſtration, that the ſpots are contiguous to the body of the Sun.

The motion of the ſpots towards the circumference of the Sun appears ſlow.

The figure of the ſpots appears narrow towards the circumference of the Suns diſcus, & why.

* Under this word *Friend*, as alſo that of *Academick*, & *Common Friend*, *Galilæus* modeſtly conceals himſelf throughout theſe Dialogues.

The Solar ſpots are not ſpherical, but flat like thin plates.

they cannot be diſſipated by one ſole converſion about the Sun, which is accompliſhed in leſs than a moneth.

SIMPL. I, for my part, have not made either ſo long, or ſo exact obſervations, as to enable me to boaſt my ſelf Maſter of the *Quod eſt* of this matter: but I will more accurately conſider the ſame, and make tryal my ſelf for my own ſatisfaction, whether I can reconcile that which experience ſhews us, with that which *Ariſtotle* teacheth us; for it's a certain Maxim, that two Truths cannot be contrary to one another.

SALV. If you would reconcile that which ſenſe ſheweth you, with the ſolider Doctrines of *Ariſtotle*, you will find no great difficulty in the undertaking; and that ſo it is, doth not *Ariſtotle* ſay, that one cannot treat confidently of the things of Heaven, by reaſon of their great remoteneſs?

One cannot (ſaith Ariſtotle) *ſpeak confidently of Heaven, by reaſon of its great diſtance.*

SIMPL. He expreſly ſaith ſo.

SALV. And doth he not likewiſe affirm, that we ought to prefer that which ſenſe demonſtrates, before all Arguments, though in appearance never ſo well grounded? and ſaith he not this without the leaſt doubt or hæſitation?

Ariſtotle *prefers ſenſe before ratiocination.*

SIMPL. He doth ſo.

SALV. Why then, the ſecond of theſe propoſitions, which are both the doctrine of *Ariſtotle*, that ſaith, that ſenſe is to take place of Logick, is a doctrine much more ſolid and undoubted, than that other which holdeth the Heavens to be unalterable; and therefore you ſhall argue more *Ariſtotelically*, ſaying, the Heavens are alterable, for that ſo my ſenſe telleth me, than if you ſhould ſay, the Heavens are unalterable, for that Logick ſo perſwaded *Ariſtotle*. Furthermore, we may diſcourſe of Cœleſtial matters much better than *Ariſtotle*; becauſe, he confeſſing the knowledg thereof to be difficult to him, by reaſon of their remoteneſs from the ſenſes, he thereby acknowledgeth, that one to whom the ſenſes can better repreſent the ſame, may philoſophate upon them with more certainty. Now we by help of the Teleſcope, are brought thirty or forty times nearer to the Heavens, than ever *Ariſtotle* came; ſo that we may diſcover in them an hundred things, which he could not ſee, and amongſt the reſt, theſe ſpots in the Sun, which were to him abſolutely inviſible; therefore we may diſcourſe of the Heavens and Sun, with more certainty than *Ariſtolte*.

Its a doctrine more agreeing with Ariſtotle, *to ſay the Heavens are alterable, than that which affirms them inalterable.*

We may by help of the Teleſcope *diſcourſe better of cœleſtial matters, than* Ariſtot. *himſelf.*

SAGR. I ſee into the heart of *Simplicius*, and know that he is much moved at the ſtrength of theſe ſo convincing Arguments; but on the other ſide, when he conſidereth the great authority which *Ariſtotle* hath won with all men, and remembreth the great number of famous Interpreters, which have made it their buſineſs to explain his ſenſe; and ſeeth other Sciences, ſo neceſſary and profitable

profitable to the publick, to build a great part of their eſteem and reputation on the credit of *Ariſtotle* he is much puzzled and perplexed: and methinks I hear him ſay, To whom then ſhould we repair for the deciſion of our controverſies, if *Ariſtotle* were removed from the chair? What other Author ſhould we follow in the Schools, Academies and Studies? What Philoſopher hath writ all the parts of Natural Philoſophy, and that ſo methodically without omitting ſo much as one ſingle concluſion? Shall we then overthrow that Fabrick under which ſo many paſſengers find ſhelter? Shall we deſtroy that *Aſylum*, that *Prytaneum*, wherein ſo many Students meet with commodious harbour, where without expoſing themſelves to the injuries of the air, with the onely turning over of a few leaves, one may learn all the ſecrets of Nature? Shall we diſmantle that fort in which we are ſafe from all hoſtile aſſaults? But I pitie him no more than I do that Gentleman who with great expence of time and treaſure, and the help of many hundred artiſts, erects a very ſumptuous Pallace, and afterwards beholds it ready to fall, by reaſon of the bad foundation: but being extremely unwilling to ſee the Walls ſtript which are adorned with ſo many beautifull Pictures; or to ſuffer the columns to fall, that uphold the ſtately Galleries; or the gilded roofs, chimney-pieces, the freizes, the corniſhes of marble, with ſo much coſt erected, to be ruined; goeth about with girders, props, ſhoars, butteraſſes, to prevent their ſubverſion.

The Declamation of Simplicius.

SALV. But alaſs, *Simplicius* as yet fears no ſuch fall, and I would undertake to ſecure him from that miſchief at a far leſs charge. There is no danger that ſo great a multitude of ſubtle and wiſe Philoſophers, ſhould ſuffer themſelves to be *Hector'd* by one or two, who make a little bluſtering; nay, they will rather, without ever turning the points of their pens againſt them, by their ſilence onely render them the object of univerſal ſcorn and contempt. It is a fond conceit for any one to think to introduce new Philoſophy, by reproving this or that Author: it will be firſt neceſſary to new-mold the brains of men, and make them apt to diſtinguiſh truth from falſhood. A thing which onely God can do. But from one diſcourſe to another whither are we ſtray'd? your memory muſt help to guide me into the way again.

Peripatetick Philoſophy unchangeable.

SIMPL. I remember very well where we left. We were upon the anſwer of *Anti-Tycho*, to the objections againſt the immutability of the Heavens, among which you inſerted this of the Solar ſpots, not ſpoke of by him; and I believe you intended to examine his anſwer to the inſtance of the New Stars.

SALV. Now I remember the reſt, and to proceed, Methinks there are ſome things in the anſwer of *Anti-Tycho*, worthy of reprehenſion. And firſt, if the two New Stars, which he can do no leſs than place in the uppermoſt parts of the Heavens, and which were of a long duration, but finally vaniſhed, give him no obſtruction in maintaining the inalterability of Heaven, in that they were not certain parts thereof, nor mutations made in the antient Stars, why doth he ſet himſelf ſo vigorouſly and earneſtly againſt the Comets, to baniſh them by all ways from the Cœleſtial Regions? Was it not enough that he could ſay of them the ſame which he ſpoke of the New ſtars? to wit, that in regard they were no certain parts of Heaven, nor mutations made in any of the Stars, they could no wiſe prejudice either Heaven, or the Doctrine of *Ariſtotle*? Secondly, I am not very well ſatisfied of his meaning; when he ſaith that the alterations that ſhould be granted to be made in the Stars, would be deſtructive to the prerogative of Heaven; namely, its incorruptibility, *&c.* and this, becauſe the Stars are Cœleſtial ſubſtances, as is manifeſt by the conſent of every one; and yet is nothing troubled that the ſame alterations ſhould be made * without the Stars in the reſt of the Cœleſtial expanſion. Doth he think that Heaven is no Cœleſtial ſubſtance? I, for my part, did believe that the Stars were called Cœleſtial bodies, by reaſon that they were in Heaven, or for that they were made of the ſubſtance of Heaven; and yet I thought that Heaven was more Cœleſtial than they; in like ſort, as nothing can be ſaid to be more Terreſtrial, or more fiery than the Earth or Fire themſelves. And again, in that he never made any mention of the Solar ſpots, which have been evidently demonſtrated to be produced, and diſſolved, and to be neer the Sun, and to turn either with, or about the ſame, I have reaſon to think that this Author probably did write more for others pleaſure, than for his own ſatisfaction; and this I affirm, foraſmuch as he having ſhewn himſelf to be skilful in the Mathematicks, it is impoſſible but that he ſhould have been convinced by Demonſtrations, that thoſe ſubſtances are of neceſſity contiguous with the body of the Sun, and are ſo great generations and corruptions, that none comparable to them, ever happen in the Earth: And if ſuch, ſo many, and ſo frequent be made in the very Globe of the Sun, which may with reaſon be held one of the nobleſt parts of Heaven, what ſhould make us think that others may not happen in the other Orbs?

*Extra Stellas.

Generability and alteration is a greater perfection in the Worlds bodies than the contrary qualities.

SAGR. I cannot without great admiration, nay more, denial of my underſtanding, hear it to be attributed to natural bodies, for a great honour and perfection that they are * impaſſible, immutable, inalterable, *&c.* And on the contrary, to hear it to be

* Impatible.

be esteemed a great imperfection to be alterable, generable, mutable, &c. It is my opinion that the Earth is very noble and admirable, by reason of so many and so different alterations, mutations, generations, &c. which are incessantly made therein; and if without being subject to any alteration, it had been all one vast heap of sand, or a masse of *Jasper*, or that in the time of the Deluge, the waters freezing which covered it, it had continued an immense Globe of Christal, wherein nothing had ever grown, altered, or changed, I should have esteemed it a lump of no benefit to the World, full of idleness, and in a word superfluous, and as if it had never been in nature; and should make the same difference in it, as between a living and dead creature: The like I say of the *Moon*, *Jupiter*, and all the other Globes of the World. But the more I dive into the consideration of the vanity of popular discourses, the more empty and simple I find them. And what greater folly can there be imagined, than to call Jems, Silver and Gold pretious; and Earth and dirt vile? For do not these persons consider, that if there should be as great a scarcity of Earth, as there is of Jewels and pretious metals, there would be no Prince, but would gladly give a heap of Diamonds and Rubies, and many Wedges of Gold, to purchase onely so much Earth as should suffice to plant a Gessemine in a little pot, or to set therein a *China Orange*, that he might see it sprout, grow up, and bring forth so goodly leaves, so odoriferous flowers, and so delicate fruit? It is therefore scarcity and plenty that make things esteemed and contemned by the vulgar; who will say that same is a most beautiful Diamond, for that it resembleth a cleer water, and yet will not part with it for ten Tun of water: These men that so extol incorruptibility, inalterability, &c. speak thus I believe out of the great desire they have to live long, and for fear of death; not considering, that if men had been immortal, they should have had nothing to do in the World. These deserve to meet with a *Medusa*'s head, that would transform them into Statues of *Dimond* and *Jasper*, that so they might become more perfect than they are.

The Earth very noble, by reason of the many mutations made therein.

The Earth unprofitable and full of idleness, its alterations taken away

The Earth more noble than Gold and Jewels.

Scarcity and plenty enhanse and debase the price of things.

Incorruptibility esteemed by the vulgar out of their fear of death.

The disparagers of corruptibility deserve to be turned into Statua's.

SALV. And it may be such a *Metamorphosis* would not be altogether unprofitable to them; for I am of opinion that it is better not to discourse at all, than to argue erroniously.

SIMPL. There is not the least question to be made, but that the Earth is much more perfect, being as it is alterable, mutable, &c. than if it had been a masse of stone; yea although it were one entire Diamond, most hard and impassile. But look how much these qualifications enoble the Earth, they render the Heavenly bodies again on the other side so much the more imperfect, in which, such conditions would be superfluous; in regard that the Cœle-

The Cœlestial bodies designed to serve the Earth, need no more but motion and light.

Cœleſtial bodies, namely, the Sun, Moon, and the other Stars, which are ordained for no other uſe but to ſerve the Earth, need no other qualities for attaining of that end, ſave onely thoſe of light and motion.

SAGR. How? Will you affirm that nature hath produced and deſigned ſo many vaſt perfect and noble Cœleſtial bodies, impaſſible, immortal, and divine, to no other uſe but to ſerve the paſſible, frail, and mortal Earth? to ſerve that which you call the droſſe of the World, and ſink of all uncleanneſſe? To what purpoſe were the Cœleſtial bodies made immortal, *&c.* to ſerve a frail, *&c.* Take away this ſubſerviency to the Earth, and the innumerable multitude of Cœleſtial bodies become wholly unuſeful, and ſuperfluous, ſince they neither have nor can have any mutual operation betwixt themſelves; becauſe they are all unalterable, immutable, impaſſible: For if, for Example, the Moon be impaſſible, what influence can the Sun or any other Star have upon her? it would doubtleſſe have far leſſe effect upon her, than that of one who would with his looks or imagination, lignifie a piece of Gold. Moreover, it ſeemeth to me, that whilſt the Cœleſtial bodies concurre to the generation and alteration of the Earth, they themſelves are alſo of neceſſity alterable; for otherwiſe I cannot underſtand how the application of the Sun or Moon to the Earth, to effect production, ſhould be any other than to lay a marble Statue by a Womans ſide, and from that conjunction to expect children.

Cœleſtial bodies want an interchangeable operation upon each other.

SIMPL. Corruptibility, alteration, mutation, *&c.* are not in the whole Terreſtrial Globe, which as to its whole, is no leſſe eternal than the Sun or Moon, but it is generable and corruptible as to its external parts; but yet it is alſo true that likewiſe in them generation and corruption are perpetual, and as ſuch require the heavenly eternal operations; and therefore it is neceſſary that the Cœleſtial bodies be eternal.

Alterability, &c. are not in the whole Terreſtrial Globe, but in ſome of its parts.

SAGR. All this is right; but if the corruptibility of the ſuperficial parts of the Earth be nowiſe prejudicial to the eternity of its whole Globe, yea, if their being generable, corruptible, alterable, *&c.* gain them great ornament and perfection; why cannot, and ought not you to admit alteration, generation, *&c.* likewiſe in the external parts of the Cœleſtial Globes, adding to them ornament, without taking from them perfection, or bereaving them of action; yea rather encreaſing their effects, by granting not onely that they all operate on the Earth, but that they mutually operate upon each other, and the Earth alſo upon them all?

Cœleſtial bodies alterable in their outward parts.

SIMPL. This cannot be, becauſe the generations, mutations, *&c.* which we ſhould ſuppoſe *v. g.* in the Moon; would be vain and uſeleſſe, *& natura nihil fruſtra facit.* SAGR.

SAGR. And why ſhould they be vain and uſeleſſe?

SIMPL. Becauſe we cleerly ſee, and feel with our hands, that all generations, corruptions, &c. made in the Earth, are all either mediately or immediately directed to the uſe, convenience, and benefit of man; for the uſe of man are horſes brought forth, for the feeding of horſes, the Earth produceth graſſe, and the Clouds water it; for the uſe and nouriſhment of man, herbs, corn, fruits, beaſts, birds, fiſhes, are brought forth; and in ſum, if we ſhould one by one dilligently examine and reſolve all theſe things, we ſhould find the end to which they are all directed, to be the neceſſity, uſe, convenience, and delight of man. Now of what uſe could the generations which we ſuppoſe to be made in the Moon or other Planets, ever be to mankind? unleſſe you ſhould ſay that there were alſo men in the Moon, that might enjoy the benefit thereof; a conceit either fabulous or impious.

The generations & mutations happening in the Earth, are all for the good of Man.

SAGR. That in the Moon or other Planets, there are generated either herbs, or plants, or animals, like to ours, or that there are rains, winds, or thunders there, as about the Earth, I neither know, nor believe; and much leſſe, that it is inhabited by men: but yet I underſtand not, becauſe there are not generated things like to ours, that therefore it neceſſarily followeth, that no alteration is wrought therein, or that there may not be other things that change, generate, and diſſolve, which are not onely different from ours, but exceedingly beyond our imagination, and in a word, not to be thought of by us. And if, as I am certain, that one born and brought up in a ſpatious Forreſt, amongſt beaſts and birds, and that hath no knowledg at all of the Element of Water, could never come to imagine another World to be in Nature, different from the Earth, full of living creatures, which without legs or wings ſwiftly move, and not upon the ſurface onely, as beaſts do upon the Earth, but in the very bowels thereof; and not onely move, but alſo ſtay themſelves and ceaſe to move at their pleaſure, which birds cannot do in the air; and that moreover men live therein, and build Palaces and Cities, and have ſo great convenience in travailing, that without the leaſt trouble, they can go with their Family, Houſe, and whole Cities, to places far remote, like as I ſay, I am certain, ſuch a perſon, though of never ſo piercing an imagination, could never fancy to himſelf Fiſhes, the Ocean, Ships, Fleets, *Armado's* at Sea; thus, and much more eaſily, may it happn, that in the Moon, remote from us by ſo great a ſpace, and of a ſubſtance perchance very different from the Earth, there may be matters, and operations, not only wide off, but altogether beyond all our imaginations, as being ſuch as have no reſemblance to ours, and therefore wholly inexcogitable, in regard, that what we ima-

The Moon hath no generatings of things, like as we have, nor is it inhabited by men.

In the Moon may be a generation of things different from ours.

He that had not heard of the Element of Water, could never fancy to himſelf Ships and Fiſhes.

imagine to our ſelves, muſt neceſſarily be either a thing already ſeen, or a compoſition of things, or parts of things ſeen at another time; for ſuch are the *Sphinxes*, *Sirenes*, *Chimæra's*, *Centaurs*, &c.

SALV. I have very often let my fancy ruminate upon theſe ſpeculations, and in the end, have thought that I had found ſome things that neither are nor can be in the Moon; but yet I have not found therein any of thoſe which I believe are, and may be there, ſave onely in a very general acceptation, namely, things that adorn it by operating, moving and living; and perhaps in a way very different from ours; beholding and admiring the greatneſs and beauty of the World, and of its Maker and Ruler, and with continual *Encomiums* ſinging his prayſes; and in ſumme (which is that which I intend) doing what ſacred Writers ſo frequently affirm, to wit, all the creatures making it their perpetual imployment to laud God.

There may be ſubſtances in the Moon very different from ours.

SAGR. Theſe are the things, which ſpeaking in general terms, may be there; but I would gladly hear you inſtance in ſuch as you believe neither are nor can be there; which perchance may be more particularly named.

SALV. Take notice *Sagredus* that this will be the third time that we have unawares by running from one thing to another, loſt our principal ſubject; and if we continue theſe digreſſions, it will be long ere we come to a concluſion of our diſcourſe; therefore I ſhould judg it better to remit this, as alſo ſuch other points, to be decided on a particular occaſion.

SAGR. Since we are now got into the Moon, if you pleaſe, let us diſpatch ſuch things as concern her, that ſo we be not forced to ſuch another tedious journey.

SALV. It ſhall be as you would have it. And to begin with things more general; I believe that the Lunar Globe is far different from the Terreſtrial, though in ſome things they agree. I will recount firſt their reſemblances, and next their differences. The Moon is manifeſtly like to the Earth in figure, which undoubtedly is ſpherical, as may be neceſſarily concluded from the aſpect of its ſurface, which is perfectly Orbicular, and the manner of its receiving the light of the Sun, from which, if its ſurface were flat, it would come to be all in one and the ſame time illuminated, and likewiſe again in another inſtant of time obſcured, and not thoſe parts firſt, which are ſituate towards the Sun, and the reſt ſucceſſively, ſo that in its oppoſition, and not till then, its whole apparent circumference is enlightned; which would happen quite contrary, if the viſible ſurface were concave; namely, the illumination would begin from the parts oppoſite or averſe to the Sun. Secondly ſhe is as the Earth, in her ſelf obſcure and opacous, by which opacity it is enabled to receive, and reflect the light of the Sun;

The Firſt reſemblance between the Moon and Earth; which is that of figure; is proved by the manner of being illuminated by the Sun.

The Second conformity is the Moons being opacous as the Earth.

Sun; which were it not ſo, it could not do. Thirdly, I hold its matter to be moſt denſe and ſolid as the Earth is, which I clearly argue from the unevenneſs of its ſuperficies in moſt places, by means of the many eminencies and cavities diſcovered therein by help of the *Teleſcope*: of which eminencies there are many all over it, directly reſembling our moſt ſharp and craggy mountains, of which you ſhall there perceive ſome extend and run in ledges of an hundred miles long; others are contracted into rounder forms; and there are alſo many craggy, ſolitary, ſteep and cliffy rocks. But that of which there are frequenteſt appearances, are certain Banks (I uſe this word, becauſe I cannot thing of another that better expreſſeth them) pretty high raiſed, which environ and incloſe fields of ſeveral bigneſſes, and form ſundry figures, but for the moſt part circular; many of which have in the midſt a mount raiſed pretty high, and ſome few are repleniſhed with a matter ſomewhat obſcure, to wit, like to the great ſpots diſcerned by the bare eye, and theſe are of the greateſt magnitude; the number moreover of thoſe that are leſſer and leſſer is very great, and yet almoſt all circular. Fourthly, like as the ſurface of our Globe is diſtinguiſhed into two principal parts, namely, into the Terreſtrial and Aquatick: ſo in the Lunar ſurface we diſcern a great diſtinction of ſome great fields more reſplendant, and ſome leſs: whoſe aſpect makes me believe, that that of the Earth would ſeem very like it, beheld by any one from the Moon, or any other the like diſtance, to be illuminated by the Sun: and the ſurface of the ſea would appear more obſcure, and that of the Earth more bright. Fifthly, like as we from the Earth behold the Moon, one while all illuminated, another while half; ſometimes more, ſometimes leſs; ſometimes horned, ſometimes wholly inviſibly; namely, when its juſt under the Sun beams; ſo that the parts which look towards the Earth are dark: Thus in every reſpect, one ſtanding in the Moon would ſee the illumination of the Earths ſurface by the Sun, with the ſame periods to an hair, and under the ſame changes of figures. Sixtly,——

Thirdly, The matter of the Moon is denſe and monty-nous as the Earth.

Fourthly, The Moon is diſtinguiſhed into two different parts for clarity and obſcurity, as the Terreſtrial Globe into Sea and Land. The ſurface of the Sea would ſhew at a diſtance more obſcure than that of the Earth.

Fifthly, Mutation of figures in the Earth, like to thoſe of the Moon, and made with the ſame periods.

SAGR. Stay a little; *Salviatus*; That the illumination of the Earth, as to the ſeveral figures, would repreſent it ſelf to a perſon placed in the Moon, like in all things to that which we diſcover in the Moon, I underſtand very well, but yet I cannot conceive how it ſhall appear to be done in the ſame period; ſeeing that that which the Suns illumination doth in the Lunar ſuperficies in a month, it doth in the Terreſtrial in twenty four hours.

SALV. Its true, the effect of the Sun about the illuminating theſe two bodies, and repleniſhing with its ſplendor their whole ſurfaces, is diſpatch'd in the Earth in a Natural day, and in the Moon in a Month; but the variation of the figures in which the

illuminated parts of the Terreſtrial ſuperficies appear beheld from the Moon, depends not on this alone, but on the divers aſpects which the Moon is ſtill changing with the Sun; ſo that, if for inſtance, the Moon punctually followed the motion of the Sun, and ſtood, for example, always in a direct line between it and the Earth, in that aſpect which we call Conjunction, it looking always to the ſame Hemiſphere of the Earth which the Sun looks unto, ſhe would behold the ſame all light: as on the contrary, if it ſhould always ſtay in Oppoſition to the Sun, it would never behold the Earth, of which the dark part would be continually turn'd towards the Moon, and therefore inviſible. But when the Moon is in Quadrature of the *Sun*, that half of the Terreſtrial Hemiſphere expoſed to the ſight of the Moon which is towards the Sun, is luminous; and the other towards the contrary is obſcure: and therefore the illuminated part of the Earth would repreſent it ſelf to the Moon in a ſemi-circular figure.

SAGR. I clearly perceive all this, and underſtand very well, that the Moon departing from its Oppoſition to the Sun, where it ſaw no part of the illumination of the Terreſtrial ſuperficies, and approaching day by day nearer the Sun, ſhe begins by little and little to diſcover ſome part of the face of the illuminated Earth; and that which appeareth of it ſhall reſemble a thin ſickle, in regard the figure of the Earth is round: and the Moon thus acquiring by its motion day by day greater proximity to the Sun, ſucceſſively diſcovers more and more of the Terreſtrial Hemiſphere enlightned, ſo that at the Quadrature there is juſt half of it viſible, inſomuch that we may ſee the other part of her: continuing next to proceed towards the Conjunction, it ſucceſſively diſcovers more and more of its ſurface to be illuminated, and in fine, at the time of Conjunction ſeeth the whole Hemiſphere enlightned. And in ſhort, I very well conceive, that what befalls the Inhabitants of the Earth, in beholding the changes of the Moon, would happen to him that from the Moon ſhould obſerve the Earth; but in a contrary order, namely, that when the Moon is to us at her full, and in Oppoſition to the Sun, then the Earth would be in Conjunction with the Sun, and wholly obſcure and inviſible; on the contrary, that poſition which is to us a Conjunction of the Moon with the Sun, and for that cauſe a *Moon* ſilent and unſeen, would be there an Oppoſition of the Earth to the Sun, and, to ſo ſpeak, *Full Earth*, to wit, all enlightned. And laſtly, look what part of the Lunar ſurface appears to us from time to time illuminated, ſo much of the Earth in the ſame time ſhall you behold from the Moon to be obſcured: and look how much of the Moon is to us deprived of light, ſo much of the Earth is to the Moon illuminated. In one thing yet theſe mutual operations in my judgment ſeem to differ, and it is, that it being

being ſuppoſed, and not granted, that ſome one being placed in the Moon to obſerve the Earth, he would every day ſee the whole Terreſtrial ſuperficies, by means of the Moons going about the Earth in twenty four or twenty five hours; but we never ſee but half of the Moon, ſince it revolves not in it ſelf, as it muſt do to be ſeen in every part of it.

SALV. So that this, befals not contrarily, namely, that her revolving in her ſelf, is the cauſe that we ſee not the other half of her, for ſo it would be neceſſary it ſhould be, if ſhe had the Epicycle. But what other difference have you behind, to exchange for this which you have named?

SAGR. Let me ſee; Well for the preſent I cannot think of any other.

All the Earth ſeeth half onely of the Moon, & the half onely of the Moon ſeeth all the Earth.

SALV. And what if the Earth (as you have well noted) ſeeth no more than half the Moon, whereas from the Moon one may ſee all the Earth; and on the contrary, all the Earth ſeeth the Moon, and but onely half of it ſeeth the Earth? For the inhabitants, to ſo ſpeak, of the ſuperior Hemiſphere of the Moon, which is to us inviſible, are deprived of the ſight of the Earth: and theſe haply are the *Antichthones*. But here I remember a particular accident, newly obſerved by our *Academian*, in the Moon, from whch are gathered two neceſſary conſequences; one is, that we ſee ſomewhat more than half of the Moon; and the other is, that the motion of the Moon hath exact concentricity with the Earth: and thus he finds the *Phœnomenon* and obſervation. When the Moon hath a correſpondence and natural ſympathy with the Earth, towards which it hath its aſpect in ſuch a determinate part, it is neceſſary that the right line which conjoyns their centers, do paſſe ever by the ſame point of the Moons ſuperficies; ſo that, who ſo ſhall from the center of the Earth behold the ſame, ſhall alwayes ſee the ſame *Diſcus* or Face of the Moon punctually determined by one and the ſame circumference; But if a man be placed upon the Terreſtrial ſurface, the ray which from his eye paſſeth to the centre of the Lunar Globe, will not paſs by the ſame point of its ſuperficies, by which the line paſſeth that is drawn from the centre of the Earth to that of the Moon, ſave onely when it is vertical to him: but the Moon being placed in the Eaſt, or in the Weſt, the point of incidence of the viſual ray, is higher than that of the line which conjoyns the centres; and therefore the obſerver may diſcern ſome part of the Lunar Hemiſphere towards the upper circumference, and alike part of the other is inviſible: they are diſcernable and undiſcernable, in reſpect of the Hemiſphere beheld from the true centre of the Earth: and becauſe the part of the Moons circumference, which is ſuperiour in its riſing, is nethermoſt in its ſetting; therefore the difference of the ſaid ſuperiour and inferi-

From the Earth we ſee more than half the Lunar Globe.

our parts muſt needs be very obſervable; certain ſpots and other notable things in thoſe parts, being one while diſcernable, and another while not. A like variation may alſo be obſerved towards the North and South extremities of the ſame *Diſcus* (or Surface) according as the Moons poſition is in one or the other Section of its Dragon; For, if it be North, ſome of its parts towards the North are hid, and ſome of thoſe parts towards the South are diſcovered, and ſo on the contrary. Now that theſe conſequences are really true, is verified by the *Teleſcope*, for there be in the Moon two remarkable ſpots, one of which, when the Moon is in the meridian, is ſituate to the Northweſt, and the other is almoſt diametrically oppoſite unto it; and the firſt of theſe is viſible even without the *Teleſcope*; but the other is not. That towards the Northweſt is a reaſonable great ſpot of oval figure, ſeparated from the other great ones; the oppoſite one is leſſe, and alſo ſevered from the biggeſt, and ſituate in a very cleer field; in both theſe we may manifeſtly diſcern the foreſaid variations, and ſee them one after another; now neer the edge or limb of the Lunar *Diſcus*, and anon remote, with ſo great difference that the diſtance betwixt the Northweſt and the circumference of the *Diſcus* is more than twice as great at one time, as at the other; and as to the ſecond ſpot (becauſe it is neerer to the circumference) ſuch mutation importeth more, than twice ſo much in the former. Hence its manifeſt, that the Moon, as if it were drawn by a magnetick vertue, conſtantly beholds the Terreſtrial Globe with one and the ſame aſpect, never deviating from the ſame.

Two ſpots in the Moon, by which it is perceived that ſhe hath reſpect to the centre of the Earth in her motion.

SAGR. Oh! when will there be an end put to the new obſervations and diſcoveries of this admirable Inſtrument?

SALV. If this ſucceed according to the progreſſe of other great inventions, it is to be hoped, that in proceſſe of time, one may arrive to the ſight of things, to us at preſent not to be imagined. But returning to our firſt diſcourſe, I ſay for the ſixth reſemblance betwixt the Moon and Earth, that as the Moon for a great part of time, ſupplies the want of the Suns light, and makes the nights, by the reflection of its own, reaſonable clear; ſo the Earth, in recompence, affordeth it when it ſtands in moſt need, by reflecting the Solar rayes, a very cleer illumination, and ſo much, in my opinion, greater than that which cometh from her to us, by how much the ſuperficies of the Earth is greater than that of the Moon.

Sixthly, The Earth and Moon interchangeably do illuminate.

SAGR. Hold there, *Salviatus* hold there, and permit me the pleaſure of relating to you, how at this firſt hint I have penetrated the cauſe of an accident, which I have a thouſand times thought upon; but could never find out. You would ſay, that the imperfect light which is ſeen in the Moon, eſpecially when it is horned, comes

Light reflected from the Earth into the Moon.

comes from the reflection of the light of the Sun on the Superficies of the Earth and Sea; and that light is more clear, by how much the horns are leſſe, for then the luminous part of the Earth, beheld by the Moon, is greater, according to that which was a little before proved; to wit, that the luminous part of the Earth, expoſed to the Moon, is alway as great as the obſcure part of the Moon, that is viſible to the Earth; whereupon, at ſuch time as the Moon is ſharp-forked, and conſequently its tenebrous part great, great alſo is the illuminated part of the Earth beheld from the Moon, and its reflection of light ſo much the more potent.

SALV. This is exactly the ſame with what I was about to ſay. In a word, it is a great pleaſure to ſpeak with perſons judicious and apprehenſive, and the rather to me, for that whileſt others converſe and diſcourſe touching Axiomatical truths, I have many times creeping into my brain ſuch arduous Paradoxes, that though I have a thouſand times rehearſed this which you at the very firſt, have of your ſelf apprehended; yet could I never beat it into mens brains.

SIMPL. If you mean by your not being able to perſwade them to it, that you could not make them underſtand the ſame, I much wonder thereat, and am very confident that if they did not underſtand it by your demonſtration (your way of expreſſion, being, in my judgment, very plain) they would very hardly have apprehended it upon the explication of any other man; but if you mean you have not perſwaded them, ſo as to make them believe it, I wonder not, in the leaſt, at this; for I confeſſe my ſelf to be one of thoſe who underſtand your diſcourſes, but am not ſatisfied therewith; for there are in this, and ſome of the other ſix congruities, or reſemblances, many difficulties, which I ſhall inſtance in, when you have gone through them all.

SALV. The deſire I have to find out any truth, in the acquiſt whereof the objections of intelligent perſons (ſuch as your ſelf) may much aſſiſt me, will cauſe me to be very brief in diſpatching that which remains. For a ſeventh conformity, take their reciprocal reſponſion as well to injuries, as favours; whereby the Moon, which very often in the height of its illumination, by the interpoſure of the Earth betwixt it and the Sun, is deprived of light, and eclipſed, doth by way of revenge, in like manner, interpoſe it ſelf between the Earth and the Sun, and with its ſhadow obſcureth the Earth; and although the revenge be not anſwerable to the injury, for that the Moon often continueth, and that for a reaſonable long time, wholly immerſed in the Earths ſhadow, but never was the Earth wholly, nor for any long time, eclipſed by the Moon; yet, nevertheleſſe, having reſpect to the ſmal-

Seventhly, The Earth and Moon do mutually eclipſe.

ſmalneſſe of the body of this, in compariſon to the magnitude of the other, it cannot be denied but that the *will* and as it were *valour* of this, is very great. Thus much for their congruities or reſemblances. It ſhould next follow that we diſcourſe touching their diſparity; but becauſe *Simplicius* will favour us with his objections againſt the former, its neceſſary that we hear and examine them, before we proceed any farther.

SAGR. And the rather, becauſe it is to be ſuppoſed that *Simplicius* will not any wayes oppoſe the diſparities, and incongruities betwixt the Earth and Moon, ſince that he accounts their ſubſtances extremely different.

SIMPL. Amongſt the reſemblances by you recited, in the parallel you make betwixt the Earth and Moon, I find that I can admit none confidently ſave onely the firſt, and two others; I grant the firſt, namely, the ſpherical figure; howbeit, even in this there is ſome kind of difference, for that I hold that of the Moon to be very ſmooth and even, as a looking-glaſſe, whereas, we find and feel this of the Earth to be extraordinary montuous and rugged; but this belonging to the inequality of ſuperficies, it ſhall be anon conſidered, in another of thoſe Reſemblances by you alledged; I ſhall therefore reſerve what I have to ſay thereof, till I come to the conſideration of that. Of what you affirm next, that the Moon ſeemeth, as you ſay in your ſecond Reſemblance, opacous and obſcure in its ſelf, like the Earth; I admit not any more than the firſt attribute of opacity, of which the Eclipſes of the Sun aſſure me. For were the Moon tranſparent, the air in the total obſcuration of the Sun, would not become ſo duskiſh, as at ſuch a time it is, but by means of the tranſparency of the body of the Moon, a refracted light would paſſe through it, as we ſee it doth through the thickeſt clouds. But as to the obſcurity, I believe not that the Moon is wholly deprived of light, as the Earth; nay, that clarity which is ſeen in the remainder of its *Diſcus*, over and above the ſmall creſcent enlightened by the Sun, I repute to be its proper and natural light, and not a reflection of the Earth, which I eſteem unable, by reaſon of its aſperity (craggineſſe) and obſcurity, to reflect the raies of the Sun. In the third Parallel I aſſent unto you in one part, and diſſent in another: I agree in judging the body of the Moon to be moſt ſolid and hard, like the Earth, yea much more; for if from *Ariſtotle* we receive that the Heavens are impenetrable, and the Stars the moſt denſe parts of Heaven, it muſt neceſſarily follow, that they are moſt ſolid and moſt impenetrable.

The ſecond clarity of the Moon eſteemed to be its native light.

The Earth unable to reflect the Suns raies.

The ſubſtance of the Heavens impenetrable, according to Ariſtotle.

SAGR. What excellent matter would the Heavens afford us for to make Pallaces of, if we could procure a ſubſtance ſo hard and ſo tranſparent?

SALV.

SALV. Rather how improper, for being by its tranſparence, wholly inviſible, a man would not be able without ſtumbling at the threſholds, and breaking his head againſt the Walls, to paſs from room to room.

SAGR. This danger would not befall him, if it be true, as ſome *Peripateticks* ſay, that it is intangible: and if one cannot touch it, much leſs can it hurt him. *The ſubſtance of Heaven intangible.*

SALV. This would not ſerve the turn, for though the matter of the Heavens cannot be toucht, as wanting tangible qualities: yet may it eaſily touch the elementary bodies; and to offend us it is as ſufficient that it ſtrike us, nay worſe, than if we ſhould ſtrike it. But let us leave theſe *Pallaces*, or, to ſay better, theſe *Caſtles* in the air, and not interrupt *Simplicius*.

SIMPL. The queſtion which you have ſo caſually ſtarted, is one of the moſt difficulty that is diſputed in Philoſophy; and I have on that ſubject moſt excellent conceits of a very learned Doctor of *Padoua*, but it is not now time to enter upon them. Therefore returning to our purpoſe, I ſay that the Moon, in my opinion, is much more ſolid than the Earth, but do not infer the ſame, as you do, from the cragginess and montuoſity of its ſuperficies; but rather from the contrary, namely, from its aptitude to receive (as we ſee it experimented in the hardeſt ſtones) a poliſh and luſtre exceeding that of the ſmootheſt glaſs, for ſuch neceſſarily muſt its ſuperficies be, to render it apt to make ſo lively reflection of the Suns rays. And for thoſe appearances which you mention, of Mountains, Cliffs, Hills, Valleys, *&c.* they are all illuſions: and I have been preſent at certain publick diſputes, where I have heard it ſtrongly maintained againſt theſe introducers of novelties, that ſuch appearances proceed from nothing elſe, but from the unequal diſtribution of the opacous and perſpicuous parts, of which the Moon is inwardly and outwardly compoſed: as we ſee it often fall out in chryſtal, amber, and many other precious ſtones of perfect luſtre; in which by reaſon of the opacity of ſome parts, and the tranſparency of others, there doth appear ſeveral concavities and prominencies. In the fourth reſemblance, I grant, that the ſuperficies of Terreſtrial Globe beheld from afar, would make two different appearances, namely, one more clear, the other more dark; but I believe that ſuch diverſity would ſucceed quite contrary to what you ſay; that is, I hold that the ſurface of the water would appear lucid, becauſe that it is ſmooth and tranſparent; and that of the Earth would appear obſcure, by reaſon of its opacity and ſcabroſity, ill accommodated for reflecting the light of the Sun. Concerning the fifth compariſon, I grant it wholly, and am able, in caſe the Earth did ſhine as the Moon, to ſhow the ſame to any one that ſhould from thence above behold it, repreſented *The ſuperficies of the Moon more ſleek than any Looking-glaſs.* *The eminencies and cavities in the Moon are illuſions of its opacous and perſpicuous parts.*

ſented by figures anſwerable to thoſe which we ſee in the Moon: I comprehend alſo, how the period of its illumination and variation of figure, would be monthly, albeit the Sun revolves round about it in twenty four hours: and laſtly, I do not ſcruple to admit, that the half onely of the Moon ſeeth all the Earth, and that all the Earth ſeeth but onely half of the Moon. For what remains, I repute it moſt falſe, that the Moon can receive light from the Earth, which is moſt obſcure, opacous, and utterly unapt to reflect the Suns light, as the Moon doth reflect it to us: and as I have ſaid, I hold that that light which we ſee in the remainder of the Moons face (the ſplendid creſcents ſubducted) by the illumination, is the proper and natural light of the Moon, and no eaſie matter would induce me to believe otherwiſe. The ſeventh, touching the mutual Eclipſes, may be alſo admitted; howbeit that is wont to be called the eclipſe of the Sun, which you are pleaſed to phraſe the eclipſe of the Earth. And this is what *I* have at this time to ſay in oppoſition to your ſeven congruities or reſemblances, to which objections, if you are minded to make any reply, *I* ſhall willingly hear you.

SALV. If I have well apprehended what you have anſwered, it ſeems to me, that there ſtill remains in controverſie between us, certain conditions, which I made common betwixt the Moon & Earth, and they are theſe; You eſteem the Moon to be ſmooth and poliſht, as a Looking-glaſs, and as ſuch, able to reflect the Suns light; and contrarily, the Earth, by reaſon of its montuoſity, unable to make ſuch reflection: You yield the Moon to be ſolid and hard, and that you argue from its being ſmooth and polite, and not from its being montuous; and for its appearing montuous, you aſſign as the cauſe, that it conſiſts of parts more and leſs opacous and perſpicuous. And laſtly, you eſteem that ſecondary light, to be proper to the *Moon*, and not reflected from the Earth; howbeit you ſeem not to deny the ſea, as being of a ſmooth ſurface, ſome kind of reflection. As to the convincing you of that error, that the reflection of the *Moon* is made, as it were, like that of a Looking-glaſs, *I* have ſmall hope, whilſt *I* ſee, that what hath been read in the **Saggiator* and in the *Solar Letters* of our *Common Friend*, hath profited nothing in your judgment, if haply you have attentively read what he hath there written on this ſubject.

* *Il Saggiatore*, & *Lettere Solari*, two Treatiſes of *Galilæus*.

SIMPL. *I* have peruſed the ſame ſo ſuperficially, according to the ſmall time of leaſure allowed me from more ſolid ſtudies; therefore, if you think you can, either by repeating ſome of thoſe reaſons, or by alledging others, reſolve me theſe doubts, *I* will hearken to them attentively.

SALV. *I* will tell you what comes into my mind upon the inſtant,

inſtant, and its poſſible it may be a commixtion of my own conceipts, and thoſe which I have ſometime read in the fore-ſaid Books, by which I well remember, that I was then perfectly ſatisfied, although the concluſions, at firſt ſight ſeem'd unto me ſtrange Paradoxes. We enquire *Simplicius*, whether to the making a reflection of light, like that which we receive from the Moon, it be neceſſary that the ſuperficies from whence the reflection commeth, be ſo ſmooth and polite, as the face of a Looking-Glaſſe, or whether a ſuperficies not ſmooth or poliſht, but rough and uneven, be more apt for ſuch a purpoſe. Now ſuppoſing two reflections ſhould come unto us, one more bright, the other leſſe, from two ſuperficies oppoſite unto us, I demand of you, which of the two ſuperficies you think would repreſent it ſelf to our ſight, to be the cleareſt, and which the obſcureſt.

SIMPL. I am very confident, that that ſame, which moſt forcibly reflected the light upon me, would ſhew its ſelf in its aſpect the clearer, and the other darker.

SALV. Be pleaſed to take that Glaſſe which hangs on yonder Wall, and let us go out into the Court-yard. Come *Sagredus*. Now hang the glaſſe yonder, againſt that ſame Wall, on which the Sun ſhines, and now let us with-draw our ſelves into the ſhade. See yonder two ſuperficies beaten by the Sun, namely, the Wall and the Glaſſe. Tell me now which appears cleareſt unto you, that of the Wall or that of the Glaſſe? Why do you not anſwer me? *It is proved as large that the Moons ſurface is ſharp.*

SAGR. I leave the reply to *Simplicius*, who made the queſtion; but I, for my own part, am perſwaded upon this ſmall beginning of the experiment, that the Moon muſt be of a very unpoliſht ſurface.

SALV. What ſay you *Simplicius*, if you were to depaint that Wall, and that Glaſſe faſtened unto it, where would you uſe your darkeſt colours, in deſigning the Wall, or elſe in painting the Looking-Glaſſe.

SIMPL. Much the darker in depainting the Glaſſe.

SALV. Now if from the ſuperficies, which repreſents it ſelf more clear, there proceedeth a more powerful reflection of light, the Wall will more forcibly reflect the raies of the Sun, than the Glaſſe.

SIMPL. Very well, Sir, have you ever a better experiment than this? you have placed us where the Glaſſe doth not reverberate upon us; but come along with me a little this way; how, will you not ſtir?

SAGR. You perhaps ſeek the place of the reflection, which the Glaſſe makth.

SIMPL. I do ſo.

SAGR. Why look you, there it is upon the oppoſite Wall, juſt as big as the Glaſſe, and little leſſe bright than if the Sun had directly ſhined upon it.

SIMPL. Come hither therefore, and ſee from hence the ſurface of the Glaſſe, and tell me whether you think it more obſcure than that of the Wall.

SAGR. Look on it your ſelf, for I have no mind at this time, to dazle my eyes; and I know very well, without ſeeing it, that it there appears as ſplendid and bright as the Sun it ſelf, or little leſſe.

SIMPL. What ſay you therefore, is the reflection of a Glaſſe leſſe powerful than that of a Wall? I ſee, that in this oppoſite Wall, where the reflection of the other illuminated Wall comes together with that of the Glaſſe, this of the Glaſſe is much clearer; and I ſee likewiſe, that, from this place where I ſtand, the glaſſe it ſelf appears with much more luſtre than the Wall.

SALV. You have prevented me with your ſubtlety; for I ſtood in need of this very obſervation to demonſtrate what remains. You ſee then the difference which happens betwixt the two reflections made by the two ſuperficies of the Wall and Glaſſe, percu'ſt in the ſelf-ſame manner, by the rayes of the Sun; and you ſee, how the reflection which comes from the Wall, diffuſeth it ſelf towards all the parts oppoſite to it, but that of the Glaſſe goeth towards one part onely, not at all bigger than the Glaſſe it ſelf: you ſee likewiſe, how the ſuperficies of the Wall, beheld from what part ſoever, alwayes ſhews it ſelf of one and the ſame cleerneſſe, and every way, much clearer than that of the Glaſſe, excepting only in that little place, on which the Glaſſes reflection reverberates, for from thence indeed the Glaſſe appears much more lucid than the Wall. By theſe ſo ſenſible, and palpable experiments, my thinks one may ſoon come to know, whether the reflection which the Moon ſends upon us, proceed as from a Glaſſe, or elſe, as from a Wall, that is, from a ſmooth ſuperficies, or a rugged.

SAGR. If I were in the Moon it ſelf, I think I could not with my hands more plainly feel the unevenneſſe of its ſuperficies, than I do now perceive it, by apprehending your diſcourſe. The Moon beheld in any poſture, in reſpect of the Sun and us, ſheweth us its ſuperficies, touch't by the Suns rayes, alwayes equally clear; an effect, which anſwers to an hair that of the Wall, which beheld from what place ſoever, appeareth equally bright, and differeth from the Glaſſe, which from one place onely appeareth lucid, and from all others obſcure. Moreover, the light which cometh to me from the reflection of the Wall, is tollerable, and weak, in compariſon of that of the Glaſſe, which is little leſſe

leſſe forcible and offenſive to the ſight, than that primary and direct light of the Sun. And thus without trouble do we behold the face of the Moon; which were it as a Glaſſe, it appearing to us by reaſon of its vicinity, as big as the Sun it ſelf, its ſplendor would be abſolutely intollerable, and would ſeem as if we beheld another Sun.

SALV. Aſcribe not, I beſeech you *Sagredus*, more to my demonſtration, than it produceth. I will oppoſe you with an inſtance, which I ſee not well how you can eaſily reſolve. You inſiſt upon it as a grand difference between the Moon and Glaſſe, that it emits its reflection towards all parts equally, as doth the Wall; whereas the Glaſſe caſts it upon one onely determinate place; and from hence you conclude the Moon to be like to the Wall, and not to the Glaſſe: But I muſt tell you, that that ſame Glaſſe caſts its reflection on one place onely, becauſe its ſurface is flat, and the reflex rayes being to depart at angles equal to thoſe of the rayes of incidence, it muſt follow that from a plane or flat ſuperficies, they do depart unitedly towards the ſame place; but in regard that the ſuperficies of the Moon is not plain, but ſpherical, and the incident rayes upon ſuch a ſuperficies, being to reflect themſelves at angles equal to thoſe of the incidence towards all parts, by means of the infinity of the inclinations which compoſe the ſpherical ſuperficies, therefore the Moon may ſend forth its reflection every way; and there is no neceſſity for its repercuſſion upon one place onely, as that Glaſſe which is flat.

Flat Looking-glaſſes caſt forth the reflection towards but one place, but the ſpherical every way.

SIMPL. This is one of the very ſame objections, which I intended to have made againſt him.

SAGR. If this be one, you had need have more of them; yet I tell you, that as to this firſt, it ſeems to me to make more againſt you, than for you.

SIMPL. You have pronounced as a thing manifeſt, that the reflection made by that Wall, is as cleer and lucid as that which the Moon ſends forth, and I eſteem it nothing in compariſon thereto. "For, in this buſineſſe of the illumination, its requiſite to reſpect, "and to diſtinguiſh the *Sphere* of *Activity*; and who queſtions "but the Cœleſtial bodies have greater Spheres of activity, than "theſe our elementary, frail, and mortal ones? and that Wall, "finally, what elſe is it but a little obſcure Earth, unapt to "ſhine?

The ſphere of Activity greater in the Cœleſtial bodies than in Elementary.

SAGR. And here alſo I believe, that you very much deceive your ſelf. But I come to the firſt objecton moved by *Salviatus*; and I conſider, that to make a body appear unto us luminous, it ſufficeth not that the rayes of the illuminating body fall upon it, but it is moreover requiſite that the reflex rayes arrive to our eye; as is manifeſtly ſeen in the example of that Glaſſe, upon

which, without queſtion, the illuminating rayes of the Sun do come; yet nevertheleſſe, it appears not to us bright and ſhining, unleſſe we ſet our eye in that particular place, where the reflection arriveth. Now let us conſider what would ſucceed, were the glaſſe of a ſpherical figure; for without doubt, we ſhould find, that of the reflection made by the whole ſurface illuminated, that to be but a very ſmall part, which arriveth to the eye of a particular beholder; by reaſon that that is but an inconſiderable particle of the whole ſpherical ſuperficies, the inclination of which caſts the ray to the particular place of the eye; whence the part of the ſpherical ſuperficies, which ſhews it ſelf ſhining to the eye, muſt needs be very ſmall; all the reſt being repreſented obſcure. So that were the Moon ſmooth, as a Looking-glaſſe, a very ſmall part would be ſeen by any particular eye to be illuſtrated by the Sun, although its whole Hemiſphere were expoſed to the Suns rayes; and the reſt would appear to the eye of the beholder as not illuminated, and therefore inviſible; and finally, the whole Moon would be likewiſe inviſible, for ſo much as that particle, whence the reflection ſhould come, by reaſon of its ſmalneſſe and remoteneſſe, would be loſt. And as it would be inviſible to the eye, ſo would it not afford any light; for it is altogether impoſſible, that a bright body ſhould take away our darkneſſe by its ſplendor, and we not to ſee it.

The Moon if it were ſmooth, like a ſpherical glaſſe, would be inviſible.

SALV. Stay good *Sagredus*, for I ſee ſome emotions in the face and eyes of *Simplicius*, which are to me as indices that he is not either very apprehenſive of, or ſatisfied with this which you, with admirable proof, and abſolute truth have ſpoken. And yet I now call to mind, that I can by another experiment remove all ſcruple. I have ſeen above in a Chamber, a great ſpherical Looking-glaſſe; let us ſend for it hither, and whileſt it is in bringing, let *Simplicius* return to conſider, how great the clarity is which cometh to the Wall here, under the penthouſe, from the reflection of the flat glaſſe.

SIMPL. I ſee it is little leſſe ſhining, than if the Sun had directly beat upon it.

SALV. So indeed it is. Now tell me, if taking away that ſmall flat glaſſe, we ſhould put that great ſpherical one in the ſame place, what effect (think you) would its reflection have upon the ſame Wall?

SIMPL. I believe that it would eject upon it a far greater and more diffuſed light.

SALV. But if the illumination ſhould be nothing, or ſo ſmall, that you would ſcarſe diſcern it, what would you ſay then?

SIMPL. When I have ſeen the effect, I will bethink my ſelf of an anſwer.

SALV.

SALV. See here is the glaſſe, which I would have to be placed cloſe to the other. But firſt let us go yonder towards the reflection of that flat one, and attentively obſerve its clarity; ſee how bright it is here where it ſhines, and how diſtinctly one may diſcern theſe ſmall unevenneſſes in the Wall.

SIMPL. I have ſeen and very well obſerved the ſame, now place the other glaſſe by the ſide of the firſt.

SALV. See where it is. It was placed there aſſoon as you began to look upon the Walls ſmall unevenneſſes, and you perceived it not, ſo great was the encreaſe of the light all over the reſt of the Wall. Now take away the flat glaſſe. Behold now all reflection removed, though the great convex glaſſe ſtill remaineth. Remove this alſo, and place it there again if you pleaſe, and you ſhall ſee no alteration of light in all the Wall. See here then demonſtrated to ſenſe, that the reflection of the Sun, made upon a ſpherical convex glaſſe, doth not ſenſibly illuminate the places neer unto it. Now what ſay you to this experiment?

SIMPL. I am afraid that there may be ſome *Leigerdemain*, uſed in this affair; yet in beholding that glaſſe I ſee it dart forth a great ſplendor, which dazleth my eyes; and that which imports moſt of all, I ſee it from what place ſoever I look upon it; and I ſee it go changing ſituation upon the ſuperficies of the glaſſe, which way ſoever I place my ſelf to look upon it; a neceſſary argument, that the light is livelily reflected towards every ſide, and conſequently, as ſtrongly upon all that Wall, as upon my eye.

SALV. Now you ſee how cautiouſly and reſervedly you ought to proceed in lending your aſſent to that, which diſcourſe alone repreſenteth to you. There is no doubt but that this which you ſay, carrieth with it probability enough, yet you may ſee, how ſenſible experience proves the contrary.

SIMPL. How then doth this come to paſs?

SALV. I will deliver you my thoughts thereof, but I cannot tell how you may be pleaſ'd therewith. And firſt, that lively ſplendor which you ſee upon the glaſs, and which you think occupieth a good part thereof, is nothing near ſo great, nay is very exceeding ſmall; but its livelineſs occaſioneth in your eye, (by means of the reflection made on the humidity of the extream parts of the eye-brows, which diſtendeth upon the pupil) an adventitious irradiation, like to that blaze which we think we ſee about the flame of a candle placed at ſome diſtance; or if you will; you may reſemble it to the adventitious ſplendor of a ſtar; for if you ſhould compare the ſmall body *v. g.* of the *Canicula*, ſeen in the day time with the *Teleſcope*, when it is ſeen without ſuch irradiation, with the ſame ſeen by night by the eye it ſelf, you will doubtleſs comprehend that being irradiated, it appeareth above a thouſand times

The ſmall body of the ſtars fringed round about with rays, appeareth very much bigger than plain and naked, and in its native clarity.

times bigger than the naked and real body : and a like or greater augmentation doth the image of the Sun make, which you ſee in that glaſs. I ſay greater, for that it is more lively than the ſtar, as is manifeſt from our being able to behold the ſtar with much leſs offence, than this reflection of the glaſs. The reverberation therefore which is to diſpere it ſelf all over this wall, cometh from a ſmall part of that glaſs, and that which even now came from the whole flat glaſs diſperſed and reſtrain'd it ſelf to a very ſmall part of the ſaid wall. What wonder is it then, that the firſt reflection very lively illuminates, and that this other is almoſt imperceptible?

SIMPL. I find my ſelf more perplexed than ever, and there preſents it ſelf unto me the other difficulty, how it can be that that wall, being of a matter ſo obſcure, and of a ſuperficies ſo unpoliſh'd, ſhould be able to dart from it greater light, than a glaſs very ſmooth and polite.

SALV. Greater light it is not, but more univerſal; for as to the degree of brightneſs, you ſee that the reflection of that ſmall flat glaſs, where it beamed forth yonder under the ſhadow of the penthouſe, illuminateth very much; and the reſt of the wall which receiveth the reflection of the wall on which the glaſs is placed, is not in any great meaſure illuminated, as was the ſmall part on which the reflection of the glaſs fell. And if you would underſtand the whole of this buſineſs, you muſt conſider that the ſuperficies of that wall's being rough, is the ſame as if it were compoſed of innumerable ſmall ſuperficies, diſpoſed according to innumerable diverſities of inclinations: amongſt which it neceſſarily happens, that there are many diſpoſed to ſend forth their reflex rays from them into ſuch a place, many others into another: and in ſum, there is not any place to which there comes not very many rays, reflected from very many ſmall ſuperficies, diſperſed throughout the whole ſuperficies of the rugged body, upon which the rays of the Sun fall. From which it neceſſarily followeth, That upon any, whatſoever, part of any ſuperficies, oppoſed to that which receiveth the primary incident rays, there is produced reflex rays, and conſequently illumination. There doth alſo follow thereupon, That the ſame body upon which the illuminating rays fall, beheld from whatſoever place, appeareth all illuminated and ſhining: and therefore the Moon, as being of a ſuperficies rugged and not ſmooth, beameth forth the light of the Sun on every ſide, and to all beholders appeareth equally lucid. But if the ſurface of it, being ſpherical, were alſo ſmooth as a glaſs, it would become wholly inviſible; foraſmuch as that ſmall part, from which the image of the Sun ſhould be reflected unto the eye of

The reflex light of uneven bodies, is more univerſal than that of the ſmooth, & why.

The Moon, if it were ſmooth and ſleek, would be inviſible.

of a particular perſon, by reaſon of its great diſtance would be inviſible, as I have ſaid before.

SIMPL. I am very apprehenſive of your diſcourſe; yet methinks I am able to reſolve the ſame with very little trouble; and eaſily to maintain, that the Moon is rotund and polite, and that it reflects the Suns light unto us in manner of a glaſs; nor therefore ought the image of the Sun to be ſeen in the middle of it, for- "aſmuch as the ſpecies of the Sun it ſelf admits not its ſmall figure "to be ſeen at ſo great a diſtance, but the light produced by the "Sun may help us to conceive that it illuminateth the whole Lu- "nar Body: a like effect we may ſee in a plate gilded and well "polliſh'd, which touch't by a luminous body, appeareth to him "that beholds it at ſome diſtance to be all ſhining; and onely neat "at hand one may diſcover in the middle of it the ſmall image of "the luminous body.

SALV. Ingenuouſly confeſſing my dullneſs of apprehenſion, I muſt tell you, that I underſtand not any thing of this your diſcourſe, ſave onely what concerns the gilt plate: and if you permit me to ſpeak freely, I have a great conceit that you alſo underſtand not the ſame, but have learnt by heart thoſe words written by ſome one out of a deſire of contradiction, and to ſhew himſelf more intelligent than his adverſary; but it muſt be to thoſe, which to appear alſo more wiſe, applaud that which they do not underſtand, and entertain a greater conceit of perſons, the leſs they are by them underſtood: and the writer himſelf may be one of thoſe (of which there are many) who write what they do not underſtand, and conſequently underſtand not what they write. Therefore, omitting the reſt, I reply, as to the gilt plate, that if it be flat and not very big, it may appear at a diſtance very bright, whilſt a great light beameth upon it, but yet it muſt be when the eye is in a determinate line, namely in that of the reflex rays: and it will appear the more ſhining, if it were *v. g.* of ſilver, by means of its being burniſhed, and apt through the great denſity of the metal, to receive a perfect poliſh. And though its ſuperficies, being very well brightned, were not exactly plain, but ſhould have various inclinations, yet then alſo would its ſplendor be ſeen many ways; namely, from as many places as the various reflections, made by the ſeveral ſuperficies, do reach: for therefore are Diamonds ground to many ſides, that ſo their pleaſing luſtre might be beheld from many places. But if the Plate were very big, though it ſhould be all plain, yet would it not at a diſtance appear all over ſhining: and the better to expreſs my ſelf, Let us ſuppoſe a very large gilt plate expoſed to the Sun, it will ſhew to an eye far diſtant, the image of the Sun, to occupy no more but a certain part of the ſaid plate; to wit, that from whence the reflection of the incident ſolar

Some write what they underſtand not, and therefore underſtand not what they write.

Diamonds ground to divers ſides, & why.

ſolar rays come: but it is true that by the vivacity of the light, the ſaid image will appear fringed about with many rays, and ſo will ſeem to occupie a far greater part of the plate, than really it doth. And to ſhew that this is true, when you have noted the particular place of the plate from whence the reflection cometh, and conceived likewiſe how great the ſhining place appeared to you, cover the greater part of that ſame ſpace, leaving it only viſible about the midſt; and all this ſhall not any whit diminiſh the apparent ſplendor to one that beholds it from afar; but you ſhall ſee it largely diſpers'd upon the cloth or other matter, wherewith you covered it. If therefore any one, by ſeeing from a good diſtance a ſmall gilt plate to be all over ſhining, ſhould imagine that the ſame would alſo even in a plate as broad as the Moon, he is no leſs deceived, than if he ſhould believe the Moon to be no bigger than the bottom of a tub. If again the plate were turn'd into a ſpherical ſuperficies, the reflection would be ſeen ſtrong in but one ſole particle of it; but yet by reaſon of its livelineſs, it will appear fringed about with many glittering rays: the reſt of the Ball would appear according as it was burniſhed; and this alſo onely then when it was not very much poliſhed, for ſhould it be perfectly brightned, it would appear obſcure. An example of this we have dayly before our eyes in ſilver veſſels, which whilſt they are only boyl'd in the *Argol* and *Salt*, they are all as white as ſnow, and do not reflect any image; but if they be in any part burniſh'd, they become in that place preſently obſcure: and in them one may ſee the repreſentation of any thing as in Looking-glaſſes. And that change to obſcurity, proceeds from nothing elſe but the ſmoothing and plaining of a fine grain, which made the ſuperficies of the ſilver rough, and yet ſuch, as that it reflected the light into all parts, whereby it ſeemed from all parts equally illuminated: which ſmall unevenneſſes, when they come to be exquiſitely plained by the burniſh, ſo that the reflection of the rays of incidence are all directed unto one determinate place; then, from that ſame place, the burniſh'd part ſhall ſhew much more bright and ſhining than the reſt which is onely whitened by boyling; but from all other places it looks very obſcure. And note, that the diverſity of ſights of looking upon burniſh'd ſuperficies, occaſioneth ſuch difference in appearances, that to imitate and repreſent in picture, *v. g.* a poliſh'd Cuirace, one muſt couple black plains with white, one ſideways to the other, in thoſe parts of the arms where the light falleth equally.

Silver burniſhed appears more obſcure, than the not burniſhed, & why.

Burniſh'd Steel beheld from one place appears very bright, and from another, very obſcure.

SAGR. If therefore theſe great Philoſophers would acquieſe in granting, that the Moon, *Venus* and the other Planets, were not of ſo bright and ſmooth a ſurface as a Looking-glaſs, but wanted ſome ſmall matter of it, namely, were as a ſilver plate, onely boyled white,

white, but not burniſhed; would this yet ſuffice to the making of it viſible, and apt for darting forth the light of the Sun?

SALV. It would ſuffice in part; but would not give a light ſo ſtrong, as it doth being mountainous, and in ſum, full of eminencies and great cavities. But theſe Philoſophers will never yield it to be leſſe polite than a glaſſe; but far more, if more it can be imagined; for they eſteeming that to perfect bodies perfect figures are moſt ſutable; it is neceſſary, that the ſphericity of thoſe Cœleſtial Globes be moſt exact; beſides, that if they ſhould grant me ſome inequality, though never ſo ſmall, I would not ſcruple to take any other greater; for that ſuch perfection conſiſting in indiviſibles, an hair doth as much detract from its perfection as a mountain.

SAGR. Here I meet with two difficulties, one is to know the reaſon why the greater inequality of ſuperficies maketh the ſtronger reflection of light; the other is, why theſe *Peripatetick* Gentlemen are for this exact figure.

SALV. I will anſwer to the firſt; and leave to *Simplicius* the care of making reply to the ſecond. You muſt know therefore, that the ſame ſuperficies happen to be by the ſame light more or leſs illuminated, according as the rayes of illumination fall upon them more or leſſe obliquely; ſo that the greateſt illumination is where the rayes are perpendicular. And ſee, how I will prove it to your ſenſe. I bend this paper, ſo, that one part of it makes an angle upon the other: and expoſing both theſe parts to the reflection of the light of that oppoſite Wall, you ſee how this ſide which receiveth the rayes obliquely, is leſſe ſhining than this other, where the reflection fals at right angles; and obſerve, that as I by degrees receive the illumination more obliquely, it groweth weaker.

The more rough ſuperficies make greater reflection of light, than the leſs rough.

Perpendicular rays illuminate more than the oblique, and why.

SAGR. I ſee the effect, but comprehend not the cauſe.

SALV. If you thought upon it but a minute of an hour, you would find it; but that I may not waſte the time, ſee a kind of demonſtration thereof in *Fig.* 7.

SAGR. The bare ſight of this Figure hath fully ſatisfied me, therefore proceed.

SIMPL. Pray you let me hear you out, for I am not of ſo quick an apprehenſion.

SALV. Fancie to your ſelf, that all the paralel lines, which you ſee to depart from the terms A. B. are the rays which fall upon the line C. D. at right angles: then incline the ſaid C. D. till it hang as D. O. now do not you ſee that a great part of thoſe rays which peirce C. D. paſs by without touching D. O.? If therefore D. O. be illuminated by fewer rays, it is very reaſonable, that the light received by it be more weak. Let us return now to the Moon,

The more oblique Rayes illuminate leſs, and why.

which being of a ſpherical figure, if its ſuperficies were ſmooth, as this paper, the parts of its hemiſphere illuminated by the Sun, which are towards its extremity, would receive much leſs light, than the middle parts; the rays falling upon them moſt obliquely, and upon theſe at right angles; whereupon at the time of full Moon, when we ſee almoſt its whole Hemiſphere illuminated, the parts towards the midſt, would ſhew themſelves to us with more ſplendor, than thoſe others towards the circumference: which is not ſo in effect. Now the face of the Moon being repreſented to me full of indifferent high mountains, do not you ſee how their tops and continuate ridges, being elevated above the convexity of the perfect ſpherical ſuperficies, come to be expoſed to the view of the Sun, and accommodated to receive its rays much leſs obliquely, and conſequently to appear as luminous as the reſt?

SAGR. All this I well perceive: and if there are ſuch mountains, its true, the Sun will dart upon them much more directly than it would do upon the inclination of a polite ſuperficies: but it is alſo true, that betwixt thoſe mountains all the valleys would become obſcure, by reaſon of the vaſt ſhadows, which in that time would be caſt from the mountains, whereas the parts towards the middle, though full of valleys and hills, by reaſon they have the Sun elevated, would appear without ſhadow, and therefore more lucid by far than the extreme parts, which are no leſs diffuſed with ſhadow than light, and yet we can perceive no ſuch difference.

SIMPL. I was ruminating upon the like difficulty.

SALV. How much readier is *Simplicius* to apprehend the objections which favour the opinions of *Ariſtotle*, than their ſolutions? I have a kind of ſuſpition, that he ſtrives alſo ſometimes to diſſemble them; and in the preſent caſe, he being of himſelf able to hit upon the doubt, which yet is very ingenious, I cannot believe but that he alſo was adviſed of the anſwer; wherefore I will attempt to wreſt the ſame (as they ſay) out of his mouth. Therefore tell me, *Simplicius*, do you think there can be any ſhadow, where the rays of the Sun do ſhine?

SIMPL. I believe, nay I am certain that there cannot; for that it being the grand luminary, which with its rays driveth away darkneſs, it is impoſſible any tenebroſity ſhould remain where it cometh; moreover, we have the definition, that *Tenebræ ſunt privatio luminis.*

SALV. Therefore the Sun, beholding the Earth, Moon or other opacous body, never ſeeth any of its ſhady parts, it not having any other eyes to ſee with, ſave its rays, the conveyers of light: and conſequently, one ſtanding in the Sun would never ſee any thing of umbrage, foraſmuch as his viſive rays would ever

go

go accompanied with thoſe illuminating beams of the Sun.

SIMPL. This is true, without any contradiction.

SALV. But when the Moon is oppoſite to the Sun, what difference is there between the tract of the rayes of your ſight, and that motion which the Suns rayes make?

SIMPL. Now I underſtand you; for you would ſay, that the rayes of the ſight and thoſe of the Sun, moving by the ſame lines, we cannot perceive any of the obſcure valleys of the Moon. Be pleaſed to change this your opinion, that I have either ſimulation or diſſimulation in me; for I proteſt unto you, as I am a Gentleman, that I did not gueſſe at this ſolution, nor ſhould I have thought upon it, without your help, or without long ſtudy.

SAGR. The reſolutions, which between you two have been alledged touching this laſt doubt, hath, to ſpeak the truth, ſatisfied me alſo. But at the ſame time this conſideration of the viſible rayes accompanying the rayes of the Sun, hath begotten in me another ſcruple, about the other part, but I know not whether I can expreſſe it right, or no: for it but juſt now comming into my mind, I have not yet methodized it to my mind: but let us ſee if we can, all together, make it intelligible. There is no queſtion, but that the parts towards the circumference of that poliſh't, but not burniſh't Hemiſphere, which is illuminated by the Sun, receiving the rayes obliquely, receive much fewer thereof, than the middlemoſt parts, which receive them directly. And its poſſible, that a tract or ſpace of *v. g.* twenty degrees in breadth, and which is towards the extremity of the Hemiſphere, may not receive more rays than another towards the middle parts, of but four degree broad: ſo that that doubtleſs will be much more obſcure than this; and ſuch it will appear to whoever ſhall behold them both in the face, or (as I may ſay) in their full magnitude. But if the eye of the beholder were conſtituted in ſuch a place, that the breadth of the twenty degrees of the obſcure ſpace, appeared not to it longer than one of four degrees, placed in the midſt of the Hemiſphere, I hold it not impoſſible for it to appear to the ſaid beholder equally clear and lucid with the other; becauſe, finally, between two equal angles, to wit, of four degrees apiece, there come to the eye the reflections of two equal numbers of rayes: namely, thoſe which are reflected from the middlemoſt ſpace, four degrees in breadth, and thoſe reflected from the other of twenty degrees, but ſeen by compreſſion, under the quantity of four degrees: and ſuch a ſituation ſhall the eye obtain, when it is placed between the ſaid Hemiſphere, and the body which illuminates it; for then the ſight and rayes move in the ſame lines. It ſeemeth not impoſſible therefore, but that the Moon may be of a very equal ſuperficies; and that nevertheleſſe, it may appear when it is at the full, no leſs

light in the extremities, than in the middle parts.

SALV. The doubt is ingenious and worthy of conſideration, and as it but juſt now came into your mind unawares, ſo I will likewiſe anſwer with what firſt comes into my thoughts, and it may happily fall out, that by thinking more upon it, I may ſtumble upon a better reply. But before, that I labyrinth my ſelf any farther, it would be neceſſary, that we aſſure our ſelves by ſome experiment, whether your objection prove in effect, what it ſeemeth to conclude in appearance; and therefore taking once more the ſame paper, and making it to incline, by bending a little part thereof upon the remainder, let us try whether expoſing it to the Sun, ſo that the rayes of light fall upon the leſſer part directly, and upon the other obliquely; this which receiveth the rayes directly appeareth more lucid; and ſee here by manifeſt experience, that it is notably more clear. Now if your objection be concluſive, it will follow, that ſtooping with our eye ſo, that in beholding the other greater part, leſs illuminated, in compreſſion or foreſhortning, it appear unto us no bigger than the other, more ſhining; and that conſequently, it be not beheld at a greater angle than that; it will neceſſarily enſue, I ſay, that its light be encreaſed, ſo that it do ſeem to us as bright as the other. See how I behold, and look upon it ſo obliquely, that it appeareth to me narrower than the other; but yet, notwithſtanding its obſcurity, doth not to my perceiving, at all grow clearer. Try now if the ſame ſucceed to you.

SAGR. I have look't upon it, and though I have ſtooped with my eye, yet cannot I ſee the ſaid ſuperficies encreaſe in light or clarity; nay me thinks it rather grows more dusky.

SALV. We are hitherto confident of the invalidity of the objection; In the next place, as to the ſolution, I believe, that, by reaſon the Superficies of this paper is little leſſe than ſmooth, the rayes are very few, which be reflected towards the point of incidence, in compariſon of the multitude, which are reflected towards the oppoſite parts; and that of thoſe few more and more are loſt, the nearer the viſive rayes approach to thoſe lucid rayes of incidence; and becauſe it is not the incident rayes, but thoſe which are reflected to the eye, that make the object appear luminous; therefore, in ſtooping the eye, there is more loſt than got, as you your ſelf confeſſe to have ſeen in looking upon the obſcurer part of the paper.

SAGR. I reſt ſatisfied with this experiment and reaſon: It remains now, that *Simplicius* anſwer to my other queſtion, and tell me what moves the *Peripateticks* to require this ſo exact rotundity in the Cœleſtial bodies.

SIMPL. The Cœleſtial bodies being ingenerable, inalterable, impaſſible,

passible, immortal, &c. they must needs be absolutely perfect; and their being absolute perfect, necessarily implies that there is in them all kinds of perfection; and consequently, that their figure be also perfect, that is to say, spherical; and absolutely and perfectly spherical, and not rough and irregular.

Perfect sphericity why ascribed to Cœlestial bodies, by the Peripateticks.

SALV. And this incorruptibility, from whence do you prove it?

SIMPL. Immediately by its freedom from contraries, and mediately, by its simple circular motion.

SALV. So that; by what I gather from your discourse, in making the essence of the Cœlestial bodies to be incorruptible, inalterable, &c. there is no need of rotundity as a cause, or requisite; for if this should cause inalterability, we might at our pleasure make wood, wax, and other Elementary matters, incorruptible, by reducing them to a spherical figure.

The Figure is not the cause of incorruptibility, but of longer duration.

SIMPL. And is it not manifest that a ball of Wood will better and longer be preserved, than an oblong, or other angular figure, made of a like quantity of the same wood.

SALV. This is most certain; but yet it doth not of corruptible become incorruptible, but still remains corruptible, though of a much longer duration. Therefore you must note, that a thing corruptible, is capable of being more or lesse such, and we may properly say this is lesse corruptible than that; as for example, the *Jasper*, than the *Pietra Sirena*; but incorruptibility admits not of more, or lesse, so as that it may be said this is more incorruptible than that, if both be incorruptible and eternal. The diversity of figure therefore cannot operate: save onely in matters capable of more or lesse duration; but in the eternal, which cannot be other than equally eternal, the operation of figure ceaseth. And therefore, since the Cœlestial matter is not incorruptible by figure, but otherwayes no man needs to be so solicitous for this perfect sphericity; for if the matter be incorruptible, let it have what figure it will, it shall be alwayes such.

Corruptibility admits of more or lesse; so doth not incorruptibility.

The perfection of figure, operateth in corruptible bodies, but not in the eternal.

SAGR. But I am considering another thing, and say, that if we should grant the spherical figure a faculty of conferring incorruptibility, all bodies of whatsoever figure, would be incorruptible; forasmuch as if the rotund body be incorruptible, corruptibility would then subsist in those parts which alter the perfect rotundity; as for instance, there is in a *Die* a body perfectly round, and, as such, incorruptible; therefore it remaineth that those angles be corruptible which cover and hide the rotundity; so that the most that could happen, would be, that those angles, and (to so speak) excrescencies, would corrupt. But if we proceed to a more inward consideration, that in those parts also towards the angles, there are comprised other lesser balls of the same matter; and

If the spherical figure conferreth eternity, all bodies would be eternal.

and therefore they alſo, as being round, muſt be alſo incorruptible; and likewiſe in the remainders, which environ theſe eight leſſer Spheres, a man may underſtand that there are others: ſo that in the end, reſolving the whole *Die* into innumerable balls, it muſt neceſſarily be granted incorruptible. And the ſame diſcourſe and reſolution may be made in all other figures.

SALV. Your method in making the concluſion, for if *v. g.* a round Chryſtal were, by reaſon of its figure, incorruptible; namely, received from thence a faculy of reſiſting all internal and external alterations, we ſhould not find, that the joyning to it other Chryſtal, and reducing it *v. g.* into a Cube, would any whit alter it within, or without; ſo as that it would thereupon become leſſe apt to reſiſt the new ambient, made of the ſame matter, than it was to reſiſt the other, of a matter different; and eſpecially, if it be true, that corruption is generated by contraries, as *Ariſtotle* ſaith; and with what can you encloſe that ball of Cryſtal, that is leſſe contrary to it, than Cryſtal it ſelf? But we are not aware how time flies away; and it will be too late before we come to an end of our diſpute, if we ſhould make ſo long diſcourſes, upon every particular; beſides our memories are ſo confounded in the multiplicity of notions, that I can very hardly recal to mind the Propoſitions, which I propoſed in order to *Simplicius*, for our conſideration.

SIMPL. I very well remember them: And as to this particular queſtion of the montuoſity of the Moon, there yet remains unanſwered that which I have alledged, as the cauſe, (and which may very well ſerve for a ſolution) of that *Phænomenon*, ſaying, that it is an illuſion proceeding from the parts of the Moon, being unequally opacous, and perſpicuous.

SAGR. Even now, when *Simplicius* aſcribed the apparent Protnberancies or unevenneſſes of the Moon (according to the opinion of a certain *Peripatetick* his friend) to the diverſly opacous, and perſpicuous parts of the ſaid Moon, conformable to which the like illuſions are ſeen in Cryſtal, and Jems of divers kinds, I bethought my ſelf of a matter much more commodious for the repreſenting ſuch effects; which is ſuch, that I verily believe, that that Philoſopher would give any price for it; and it is the mother of Pearl, which is wrought into divers figures, and though it be brought to an extreme evenneſſe, yet it ſeemeth to the eye in ſeveral parts, ſo variouſly hollow and knotty, that we can ſcarce credit our feeling of their evenneſſe.

Mother of Pearl accommodated to imitate the apparent unevenneſſes of the Moons ſurface.

SALV. This invention is truly ingenious; and that which hath not been done already, may be done in time to come; and if there have been produced other Jems, and Cryſtals, which have nothing to do with the illuſions of the mother of Pearl, theſe may be

be produced alſo; in the mean time, that I may not prevent any one, I will ſuppreſſe the anſwer which might be given, and onely for this time betake my ſelf to ſatisfie the objections brought by *Simplicius*. I ſay therefore, that this reaſon of yours is too general, and as you apply it not to all the appearances one by one; which are ſeen in the Moon, and for which my ſelf and others are induced to hold it mountainous, I believe you will not find any one that will be ſatisfied with ſuch a doctrine; nor can I think, that either you, or the Author himſelf, find in it any greater quietude, than in any other thing wide from the purpoſe. Of the very many ſeveral appearances which are ſeen night by night in the courſe of Moon, you cannot imitate ſo much as one, by making a Ball at your choice, more or leſs opacous and perſpicuous, and that is of a polite ſuperficies; whereas on the contrary, one may make Balls of any ſolid matter whatſoever, that is not tranſparent, which onely with eminencies and cavities, and by receiving the illumination ſeveral ways, ſhall repreſent the ſame appearances and mutations to an hair, which from hour to hour are diſcovered in the Moon. In them you ſhall ſee the ledges of Hills expoſed to the Suns light, to be very ſhining, and after them the projections of their ſhadows very obſcure; you ſhall ſee them greater and leſs, according as the ſaid eminencies ſhall be more or leſs diſtant from the confines which diſtinguiſh the parts of the Moon illuminated, from the obſcure: you ſhall ſee the ſame term and confine, not equally diſtended, as it would be if the Ball were poliſh'd, but craggie and rugged. You ſhall ſee beyond the ſame term, in the dark parts of the Moon many bright prominencies, and diſtinct from the reſt of the illuminations: you ſhall ſee the ſhadows aforeſaid, according as the illumination gradually riſeth, to deminiſh by degrees, till they wholly diſappear; nor are there any of them to be ſeen when the whole Hemiſphere is enlightned. Again on the contrary, in the lights paſſage towards the other Hemiſphere of the Moon, you ſhall again obſerve the ſame eminencies that were marked, and you ſhall ſee the projections of their ſhadows to be made a contrary way, and to decreaſe by degrees: of which things, once more I ſay, you cannot ſhew me ſo much as one in yours, that are opacous and perſpicuous.

The apparent unevenneſſes of the Moon cannot be imitated by way of more and leſs opacity & perſpicuity.

The various aſpects of the Moon, imitable with any opacous matter.

Various appearances from which the Moons mountuoſity is argued.

SAGR. One of them certainly he may imitate, namely, that of the Full Moon, when by reaſon of its being all illuminated, there is not to be ſeen either ſhadow, or other thing, which receiveth any alteration from its eminencies and cavities. But I beſeech you, *Salviatus*, let us ſpend no more time on this Argument, for a perſon that hath had but the patience to make obſervation of but one or two Lunations, and is not ſatisfied with this moſt ſenſible truth, may well be adjudged void of all judgment; and upon ſuch

ſuch why ſhould we throw away our time and breath in vain?

SIMPL. I muſt confeſs I have not made the obſervations, for that I never had ſo much curioſity, or the Inſtruments proper for the buſineſs; but I will not fail to do it. In the mean time, we may leave this queſtion in ſuſpenſe, and paſs to that point which follows, producing the motives inducing you to think that the Earth may reflect the light of the Sun no leſs forceably than the Moon, for it ſeems to me ſo obſcure and opacous, that I judg ſuch an effect altogether impoſſible.

SALV. The cauſe for which you repute the Earth unapt for illumination, may rather evince the contrary: And would it not be ſtrange, *Simplicius*, if I ſhould apprehend your diſcourſes better than you your ſelf?

SIMPL. Whether I argue well or ill, it may be, that you may better underſtand the ſame than I; but be it ill or well that I diſcourſe, I ſhall never believe that you can penetrate what I mean better than I my ſelf.

SALV. Well, I will make you believe the ſame preſently. Tell me a little, when the Moon is near the Full, ſo that it may be ſeen by day, and alſo at midnight, at what do you think it more ſplendid, by day or by night?

The Moon appears brighter by night than by day.

SIMPL. By night, without all compariſon. And methinks the Moon reſembleth that pillar of Clouds and pillar of Fire, which guided the *Iſraelites*; which at the preſence of the Sun, appeared like a Cloud, but in the night was very glorious. Thus I have by day obſerved the Moon amidſt certain ſmall Clouds, juſt as if one of them had been coloured white, but by night it ſhines with much ſplendor.

The Moon beheld in the day time, is like to a little cloud.

SALV. So that if you had never happened to ſee the Moon, ſave onely in the day time, you would not have thought it more ſhining than one of thoſe Clouds.

SIMPL. I verily believe I ſhould not.

SALV. Tell me now; do you believe that the Moon is really more ſhining in the night than day, or that by ſome accident it ſeemeth ſo?

SIMPL. I am of opinion, that it reſplends in it ſelf as much in the day as night, but that its light appears greater by night, becauſe we behold it in the dark mantle of Heaven; and in the day time, the whole Atmoſphere being very clear, ſo that the little exceedeth it in luſtre, ſhe ſeems to us much leſs bright.

SALV. Now tell me, have you ever at midnight ſeen the Terreſtrial Globe illuminated by the Sun?

SIMPL. This ſeemeth to me a queſtion not to be ask'd, unleſs in jeſt, or of ſome perſon known to be altogether void of ſenſe.

SALV. No, no; I eſteem you to be a very rational man, and do

do ask the queſtion ſeriouſly; and therefore anſwer me: and if afterwards you ſhall think that I ſpeak impertinently, I will be content to be the ſenſeleſs man: for he is much more a fool who interrogates ſimply, than he to whom the queſtion is put.

SIMPL. If then you do not think me altogether ſimple, take it for granted that I have anſwered you already, and ſaid, that it is impoſſible, that one that is upon the Earth, as we are, ſhould ſee by night that part of the Earth where it is day, namely, that is illuminated by the Sun.

SALV. Therefore you have never ſeen the Earth enlightned, ſave onely by day; but you ſee the Moon to ſhine alſo in the dead of night. And this is the cauſe, *Simplicius*, which makes you believe that the Earth doth not ſhine like the Moon; but if you could ſee the Earth illuminated, whilſt you were in ſome dark place, like our night, you would ſee it ſhine brighter than the Moon. Now if you deſire that the compariſon may proceed well, you muſt compare the light of the Earth, with that of the Moon ſeen in the day time, and not with the ſame by night: for it is not in our power to ſee the Earth illuminated, ſave onely in the day. Is it not ſo?

SIMPL. So it ought to be.

SALV. And foraſmuch as you your ſelf have already confeſſ'd to have ſeen the Moon by day among ſome little white Clouds, and very nearly, as to its aſpect, reſembling one of them; you did thereby grant, that thoſe Clouds, which yet are Elementary matters, are as apt to receive illumination, as the Moon, yea more, if you will but call to mind that you have ſometimes ſeen ſome Clouds of vaſt greatneſs, and as perfect white as the Snow; and there is no queſtion, but that if ſuch a Cloud could be continued ſo luminous in the deep of night, it would illuminate the places near about it, more than an hundred Moons. If therefore we were aſſured that the Earth is illuminated by the Sun, like one of thoſe Clouds, it would be undubitable, but that it would be no leſs ſhining than the Moon. But of this there is no queſtion to be made, in regard we ſee thoſe very Clouds in the abſence of the Sun, to remain by night, as obſcure as the Earth: and that which is more, there is not any one of us, but hath ſeen many times ſome ſuch Clouds low, and far off, and queſtioned whether they were Clouds or Mountains: an evident ſign that the Mountains are no leſs luminous than thoſe Clouds.

Clouds are no leſs apt than the Moon to be illuminated by the Sun.

SAGR. But what needs more diſcourſe? See yonder the Moon is riſen, and more than half of it illuminated; ſee there that wall, on which the Sun ſhineth; retire a little this way, ſo that you ſee the Moon ſideways with the wall: look now; which of them ſhews more lucid? Do not you ſee, that if there is any advantage,

A wall illuminated by the Sun, compared to the Moon ſhineth no leſs than it.

the wall hath it? The Sun ſhineth on that wall; from thence it is reverberated upon the wall of the Hall, from thence it's reflected upon that chamber, ſo that it falls on it at the third reflection: and I am very certain, that there is in that place more light, than if the Moons light had directly faln upon it.

The third reflection of a Wall illuminates more than the firſt of the Moon.

SIMPL. But this I cannot believe; for the illumination of the Moon, eſpecially when it is at the full, is very great.

SAGR. It ſeemeth great by reaſon of the circumjacent dark places; but abſolutely it is not much, and is leſs than that of the twilight half an hour after the Sun is ſet; which is manifeſt, becauſe you ſee not the ſhadows of the bodies illuminated by the Moon till then, to begin to be diſtinguiſhed on the Earth. Whether, again, that third reflection upon that chamber, illuminates more than the firſt of the Moon, may be known by going thether, and reading a Book, and afterwards ſtanding there in the night by the Moons light, which will ſhew by which of them lights one may read more or leſs plainly, but I believe without further tryal, that one ſhould ſee leſs diſtinctly by this later.

The light of the Moon weaker than that of the twilight.

SALV. Now, *Simplicius*, (if haply you be ſatisfied) you may conceive, as you your ſelf know very well, that the Earth doth ſhine no leſs than the Moon; and the only-remembring you of ſome things, which you knew of your ſelf, and learn'd not of me, hath aſſured you thereof: for I taught you not that the Moon ſhews lighter by night than by day, but you underſtood it of your ſelf; as alſo you could tell me that a little Cloud appeareth as lucid as the Moon: you knew alſo, that the illumination of the Earth cannot be ſeen by night; and in a word, you knew all this, without knowing that you knew it. So that you have no reaſon to be ſcrupulous of granting, that the dark part of the Earth may illuminate the dark part of the Moon, with no leſs a light than that wherewith the Moon illuminates the obſcurities of the night, yea rather ſo much the greater, inaſmuch as the Earth is forty times bigger than the Moon.

SIMPL. I muſt confeſs that I did believe, that that ſecondary light had been the natural light of the Moon.

SALV. And this alſo you know of your ſelf, and perceive not that you know it. Tell me, do not you know without teaching, that the Moon ſhews it ſelf more bright by night than by day, in reſpect of the obſcurity of the ſpace of the ambient? and conſequently, do you not know *in genere*, that every bright body ſhews the clearer, by how much the ambient is obſcurer?

Luminous bodies appear the brighter in an obſcurer ambient.

SIMPL. This I know very well.

SALV. When the Moon is horned, and that ſecondary light ſeemeth to you very bright, is it not ever nigh the Sun, and conſequently, in the light of the *crepuſculum*, (twilight?)

SIMPL.

SIMPL. It is ſo; and I have oftentimes wiſh'd that the Air would grow thicker, that I might be able to ſee that ſame light more plainly; but it ever diſappeared before dark night.

SALV. You know then very certainly, that in the depth of night, that light would be more conſpicuous.

SIMPL. I do ſo; and alſo more than that, if one could but take away the great light of the creſcent illuminated by the Sun, the preſence of which much obſcureth the other leſſer.

SALV. Why, doth it not ſometimes come to paſs, that one may in a very dark night ſee the whole face of the Moon, without being at all illuminated by the Sun?

SIMPL. I know not whether this ever happeneth, ſave onely in the total Ecclipſes of the Moon.

SALV. Why, at that time this its light would appear very clear, being in a moſt obſcure *medium*, and not darkned by the clarity of the luminous creſcents: but in that poſition, how light did it appear to you?

SIMPL. I have ſometimes ſeen it of the colour of braſs, and a little whitiſh; but at other times it hath been ſo obſcure, that I have wholly loſt the ſight of it.

SALV. How then can that light be ſo natural, which you ſee ſo cleer in the cloſe of the twilight, notwithſtanding the impediment of the great and contiguous ſplendor of the creſcents; and which again, in the more obſcure time of night, all other light removed, appears not at all?

SIMPL. I have heard of ſome that believed that ſame light to be participated to theſe creſcents from the other Stars, and in particular from *Venus*, the Moons neighbour.

SALV. And this likewiſe is a vanity; becauſe in the time of its total obſcuration, it ought to appear more ſhining than ever; for you cannot ſay, that the ſhadow of the Earth intercepts the ſight of *Venus*, or the other Stars. But to ſay true, it is not at that inſtant wholly deprived thereof, for that the Terreſtrial Hemiſphere, which in that time looketh towards the Moon, is that where it is night, that is, an intire privation of the light of the Sun. And if you but diligently obſerve, you will very ſenſibly perceive, that like as the Moon, when it is ſharp-horned, doth give very little light to the Earth; and according as in her the parts illuminated by the Suns light do encreaſe: ſo likewiſe the ſplendor to our ſeeming encreaſeth, which from her is reflected towards us; thus the Moon, whilſt it is ſharp-forked, and that by being between the Sun and the Earth, it diſcovereth a very great part of the Terreſtrial Hemiſphere illuminated, appeareth very clear: and departing from the Sun, and paſſing towards the *Quadrature, you may ſee the ſaid light by degrees to grow dim; and after the Quadra-

*By the Moons two Quadratures you are to underſtand its firſt and laſt quarters, as Aſtrologers call them

Quadrature, the ſame appears very weak, becauſe it continuall loſeth more and more of the view of the luminous part of the Earth: and yet it ſhould ſucceed quite contrary, if that light were its own, or communicated to it from the Stars; for then we ſhould ſee it in the depth of night, and in ſo very dark an ambient.

SIMPL. Stay a little; for I juſt now remember, that I have read in a little modern tract, full of many novelties; "That this "ſecondary light is not derived from the Stars, nor innate in the "Moon, and leaſt of all communicated by the Earth, but that it is "received from the ſame illumination of the Sun, which, the ſub- "ſtance of the Lunar Globe being ſomewhat tranſparent, pene- "trateth thorow all its body; but more livelily illuminateth the "ſuperficies of the Hemiſphere expoſed to the rays of the Sun: "and its profundity imbuing, and (as I may ſay) ſwallowing that "light, after the manner of a cloud or chryſtal, tranſmits it, and "renders it viſibly lucid. And this (if I remember aright) he "proveth by Authority, Experience and Reaſon; citing *Cleomedes*, "*Vitellon*, *Macrobius*, and a certain other modern Author: and "adding, That it is ſeen by experience to ſhine moſt in the days "neareſt the Conjunction, that is, when it is horned, and is chiefly "bright about its limb. And he farther writes, That in the Solar "Eclipſes, when it is under the *Diſcus* of the Sun, it may be ſeen "tranſlucid, and more eſpecially towards its utmoſt Circle. And "in the next place, for Arguments, as I think, he ſaith, That it not "being able to derive that light either from the Earth, or from the "Stars, or from it ſelf, it neceſſarily follows, that it cometh from "the Sun. Beſides that, if you do but grant this ſuppoſition, one "may eaſily give convenient reaſons for all the particulars that "occur. For the reaſon why that ſecundary light ſhews more "lively towards the outmoſt limb, is, the ſhortneſs of the ſpace "that the Suns rays hath to penetrate, in regard that of the lines "which paſs through a circle, the greateſt is that which paſſeth "through the centre; and of the reſt, thoſe which are fartheſt from "it, are always leſs than thoſe that are nearer. From the ſame "principle, he ſaith, may be ſhewn why the ſaid light doth not "much diminiſh. And laſtly, by this way the cauſe is aſſigned "whence it comes, that that ſame more ſhining circle about the "utmoſt edge of the Moon, is ſeen at the time of the Solar Ec- "clipſe, in that part which lyeth juſt under the *Diſcus* of the Sun, "but not in that which is beſide the *Diſcus*: which happeneth "becauſe the rays of the Sun paſs directly to our eye, through the "parts of the Moon underneath: but as for the parts which are "beſides it, they fall beſides the eye.

The ſecondary light of the Moon cauſed by the Sun, according to ſome.

SALV. If this Philoſopher had been the firſt Author of this opinion, I would not wonder that he ſhould be ſo affectionate to it,

as

as to have received it for truth; but borrowing it from others, I cannot find any reason sufficient to excuse him for not perceiving its fallacies; and especially after he had heard the true cause of that effect, and had it in his power to satisfie himself by a thousand experiments, and manifest circumstances, that the same proceeded from the reflection of the Earth, and from nothing else: and the more this speculation makes something to be desired, in the judgment of this Author, and of all those who give no credit to it: so much the more doth their not having understood and remembred it, excuse those more recess Antients, who, I am very certain, did they now understand it, would without the least repugnance admit thereof. And if I may freely tell you what I think, I cannot believe but that this *Modern* doth in his heart believe it; but I rather think, that the conceit he should not be the first Author thereof, did a little move him to endeavour to suppresse it, or to disparage it at least amongst the simple, whose number we know to be very great; and many there are, who much more affect the numerous applauds of the people, than the approbation of a few not vulgar judgments.

SAGR. Hold good *Salviatus*, for me thinks, I see that you go not the way to hit the true mark in this your discourse, for these that * confound all propriety, know also how to make themselves Authors of others inventions, provided they be not so stale, and publick in the Schools and Market-places, as that they are more then notorious to every one.

* Tendono le parte al commune.

SALV. Ha! well aimed, you blame me for roving from the point in hand; but what have you to do with Schools and Markets? Is it not all one, whether opinions and inventions be new to men, or the men new to them? If you * contend about the esteem of the Founders of Sciences, which in all times do start up, you may make your self their inventor, even to the Alphabet it self, and so gain admiration amongst that illiterate rabble; and though in processe of time your craft should be perceived, that would but little prejudice your designe; for that others would succeed them in maintaining the number of your fautors; but let us return to prove to *Simplicius* the invalidity of the reasons of his modern Author, in which there are several falsities, inconsequencies, and incredible Paradoxes. And first, it is false that this secondary light is clearer about the utmost limb than in the middle parts, so as to form, as it were, a ring or circle more bright than the rest of its space or contence. True it is, indeed, that looking on the Moon at the time of twilight, at first sight there is the resemblance of such a circle, but by an illusion arising from the diversity of confines that bound the Moons *Discus*, which are confused by means of this secondary light; forasmuch as on the part towards

Its all one whether opinions be new to men, or men new to opinions.

* *Contestare* falsly rendered in the Latine Translation *contentare*.

The secondary light of the Moon appears in form of a Ring, that is to say, bright in the extreme circumference, and not in the midst, and why.

towards the Sun it is bounded by the lucid horns of the Moon, and on the other part, its confining term is the obſcure tract of the twilight; whoſe relation makes us think the candor of the Moons *Diſcus* to be ſo much the clearer; the which happens to be obfuſcated in the oppoſite part, by the greater clarity of the creſcents; but if this modern Author had eſſaied to make an interpoſition between the eye and the primary ſplendor, by the ridg of ſome houſe, or ſome other ſcreen, ſo as to have left viſible only the groſe of the Moon, the horns excluded, he might have ſeen it all alike luminous.

The way to obſerve the ſecondary light of the Moon.

SIMPL. I think, now I remember, that he writes of his making uſe of ſuch another Artifice, to hide from us the falſe *lucidum.*

SALV. Oh! how is this (as I believed) inadvertency of his, changed into a lie, bordering on raſhneſſe; for that every one may frequently make proof of the contrary. That in the next place, at the Suns Eclipſe, the Moons *Diſcus* is ſeen otherwayes than by privation, I much doubt, and ſpecially when the Eclipſe is not total, as thoſe muſt neceſſarily have been, which were obſerved by the Author; but if alſo he ſhould have diſcovered ſomewhat of light, this contradicts not, rather favoureth our opinion; for that at ſuch a time, the whole Terreſtrial Hemiſphere illuminated by the Sun, is oppoſite to the Moon, ſo that although the Moons ſhadow doth obſcure a part thereof, yet this is very ſmall in compariſon of that which remains illuminated. That which he farther adds, that in this caſe, the part of the limb, lying under the Sun, doth appear very lucid, but that which lyeth beſides it, not ſo; and that to proceed from the coming of the ſolar rayes directly through that part to the eye, but not through this, is really one of thoſe fopperies, which diſcover the other fictions, of him which relates them: For if it be requiſite to the making a ſecondary light viſible in the lunar *Diſcus*, that the rayes of the Sun came directly through it to our eyes, doth not this pitiful Philoſopher perceive, that we ſhould never ſee this ſame ſecondary light, ſave onely at the Eclipſe of the Sun? And if a part onely of the Moon, far leſſe than half a degree, by being remote from the Suns *Diſcus*, can deflect or deviate the rayes of the Sun, ſo that they arrive not at our eye; what ſhall it do when it is diſtant twenty or thirty degrees, as it is at its firſt apparition? and what courſe ſhall the rayes of the Sun keep, which are to paſſe thorow the body of the Moon, that they may find out our eye? This man doth go ſucceſſively conſidering what things ought to be, that they may ſerve his purpoſe, but doth not gradually proceed, accommodating his conceits to the things, as really they are. As for inſtance, to make the light of

The Moons Diſcus in a ſolar Eclipſe can be ſeen onely by privation.

The Author of the Book of concluſions, accommodates the things to his purpoſes, and not his purpoſes to the things.

of the Sun capable to penetrate the ſubſtance of the Moon, he makes her in part diaphanous, as is *v. g.* the tranſparence of a cloud, or cryſtal: but I know not what he would think of ſuch a tranſparency, in caſe the ſolar rayes were to paſſe a depth of clouds of above two thouſand miles; but let it be ſuppoſed that he ſhould boldly anſwer, that might well be in the Cœleſtial, which are quite other things from theſe our Elementary, impure, and feculent bodies; and let us convict his error by ſuch wayes, as admit him no reply, or (to ſay better) ſubter-fuge. If he will maintain, that the ſubſtance of the Moon is diaphanous, he muſt ſay that it is ſo, whileſt that the rayes of the Sun are to penetrate its whole profundity, that is, more than two thouſand miles; but that if you oppoſe unto them onely one mile, or leſſe, they ſhould no more penetrate that, than they penetrate one of our mountains.

SAGR. You put me in mind of a man, who would have ſold me a ſecret how to correſpond, by means of a certain ſympathy of magnetick needles, with one, that ſhould be two or three thouſand miles diſtant; and I telling him, that I would willingly buy the ſame, but that I deſired firſt to ſee the experiment thereof, and that it did ſuffice me to make it, I being in one Chamber, and he in the next, he anſwered me, that in ſo ſmall a diſtance one could not ſo well perceive the operation; whereupon I turn'd him going, telling him, that I had no mind, at that time, to take a journey unto *Grand Cairo*, or to *Muſcovy*, to make the experiment; but that, if he would go himſelf, I would perform the other part, ſtaying in *Venice*. But let us hear whither the deduction of our Author tendeth, and what neceſſity there is, that he muſt grant the matter of the Moon to be moſt perforable by the rayes of the Sun, in a depth of two thouſand miles, but more opacous than one of our mountains, in a thickneſſe of one mile onely.

A jeſt put upon one that would ſell a certain ſecret for holding correſpondency with a perſon a thouſand miles off.

SALV. The very mountains of the Moon themſelves are a proof thereof, which percuſſed on one ſide of the Sun, do caſt on the contrary ſide very dark ſhadows, terminate, and more diſtinct by much, than the ſhadows of ours; but had theſe mountains been diaphanous, we could never have come to the knowledg of any unevenneſſe in the ſuperficies of the Moon, nor have ſeen thoſe luminous montuoſities diſtinguiſhed by the terms which ſeparate the lucid parts from the dark: much leſſe, ſhould we ſee this ſame term ſo diſtinct, if it were true, that the Suns light did penetrate the whole thickneſſe of the Moon; yea rather, according to the Authors own words, we ſhould of neceſſity diſcern the paſſage, and confine, between the part of the Sun ſeen, and the part not ſeen, to be very confuſed, and mixt with light and dark-

darkneſſe; for that that matter which admits the paſſage of the Suns rayes thorow a ſpace of two thouſand miles, muſt needs be ſo tranſparent, that it would very weakly reſiſt them in a hundredth, or leſſer part of that thickneſſe; nevertheleſſe, the term which ſeparateth the part illuminated from the obſcure, is incident, and as diſtinct, as white is diſtinct from black; and eſpecially where the Section paſſeth through the part of the Moon, that is naturally more clear and montanous; but where the old ſpots do part, which are certain plains, that by means of their ſpherical inclination, receive the rayes of the Sun obliquely, there the term is not ſo diſtinct, by reaſon of the more dimme illumination. That, laſtly, which he ſaith, how that the ſecondary light doth not diminiſh and languiſh, according as the Moon encreaſeth, but conſerveth it ſelf continually in the ſame efficacy; is moſt falſe; nay it is hardly ſeen in the quadrature, when, on the contrary, it ſhould appear more ſplendid, and be viſible after the *crepuſculum* in the dark of night. Let us conclude therefore, that the Earths reflection is very ſtrong upon the Moon; and that, which you ought more to eſteem, we may deduce from thence another admirable congruity between the Moon and Earth; namely, that if it be true, the Planets operate upon the Earth by their motion and light, the Earth may probably be no leſſe potent in operating reciprocally upon them with the ſame light, and peradventure, motion alſo. And though it ſhould not move, yet may it retain the ſame operation; becauſe, as it hath been proved already, the action of the light is the ſelf ſame, I mean of the light of the Sun reflected; and motion doth nothing, ſave only vary the aſpects, which fall out in the ſame manner, whether we make the Earth move, and the Sun ſtand ſtill, or the contrary.

The Earth may reciprocally operate upon Cœleſtial bodies, with its light.

SIMPL. None of the Philoſophers are found to have ſaid, that theſe inferiour bodies operate on the Cœleſtial, nay, *Ariſtotle* affirmes the direct contrary.

SALV. *Ariſtotle* and the reſt, who knew not that the Earth and Moon mutually illuminated each other, are to be excuſed; but they would juſtly deſerve our cenſure, if whileſt they deſire that we ſhould grant and believe with them, that the Moon operateth upon the Earth with light, they ſhould deny to us, who have taught them that the Earth illuminates the Moon, the operation the Earth hath on the Moon.

SIMPL. In ſhort, I find in my ſelf a great unwillingneſſe to admit this commerce, which you would perſwade me to be betwixt the Earth and Moon, placing it, as we ſay, amongſt the number of the Stars; for if there were nothing elſe, the great ſeparation and diſtance between it and the Cœleſtial bodies, doth in my opinion neceſſarily conclude a vaſt diſparity between them.

SALV.

SALV. See *Simplicius* what an inveterate affection and radicated opinion can do, since it is so powerful, that it makes you think that those very things favour you, which you produce against your self. For if separation and distance are accidents sufficient to perswade with you a great diversity of natures, it must follow that proximity and contiguity import similitude. Now how much more neerer is the Moon to the Earth, than to any other of the Cœlestial Orbs? You must acknowledg therefore, according to your own concession (and you shall have other Philosophers bear you company) that there is a very great affinity betwixt the Earth and Moon. Now let us proceed, and see whether any thing remains to be considered, touching those objections which you made against the resemblances that are between these two bodies.

Affinity between the Earth & Moon in respect of their vicinity.

SIMPL. It rests, that we say something touching the solidity of the Moon, which I argued from its being exquisite smooth and polite, and you from its montuosity. There is another scruple also comes into my mind, from an opinion which I have, that the Seas reflection ought by the equality of its surface, to be rendered stronger than that of the Earth, whose superficies is so rough and opacous.

SALV. As to the first objection; I say, that like as among the parts of the Earth, which all by their gravity strive to approach the neerest they can possible to the center, some of them alwayes are more remote from it than the rest, as the mountains more than the valleys, and that by reason of their solidity and firmnesse (for if they were of fluid, they would be even) so the seeing some parts of the Moon to be elevated above the sphericity of the lower parts, argueth their hardnesse; for it is probable that the matter of the Moon is reduced into a spherical form by the harmonious conspiration of all its parts to the same sentense. Touching the second doubt, my thinks that the particulars already observed to happen in the Looking-glasses, may very well assure us, that the reflection of light comming from the Sea, is far weaker than that which cometh from Land; understanding it alwayes of the universal reflection; for as to that particular, on which the water being calm, casteth upon a determinate place, there is no doubt, but that he who shall stand in that place, shall see a very great reflection in the water, but every way else he shall see the surface of the Water more obscure than that of the Land; and to prove it to your senses, let us go into yonder Hall, and power forth a little water upon the Pavement. Tell me now, doth not this wet brick shew more dull than the other dry ones? Doubtlesse it doth, and will so appear, from what place soever you behold it, except one onely, and this is that way which the light cometh, that entereth in at yonder window; go backwards therefore by a little and a little.

Solidity of the Lunar Globe argued from its being montainous.

The Seas reflection of light much weaker than that of the Earth.

An experiment to prove the reflection of the Water lesse clear than that of the Land.

SIMPL. Here I ſee the weſt part ſhine more than all the reſt of the pavement, and I ſee that it ſo hapneth, becauſe the reflection of the light which entereth in at the window, cometh towards me.

SALV. That moiſture hath done no more but filled thoſe little cavities which are in the brick with water, and reduced its ſuperficies to an exact eveneſſe; whereupon the reflex rayes iſſue unitedly towards one and the ſame place; but the reſt of the pavement which is dry, hath its protuberances, that is, an innumerable variety of inclinations in its ſmalleſt particles; whereupon the reflections of the light ſcatter towards all parts, but more weakly than if they had gone all united together; and therefore, the ſame ſheweth almoſt all alike, beheld ſeveral wayes, but far leſſe clear than the moiſtned brick. I conclude therefore, that the ſurface of the Sea, beheld from the Moon, in like manner, as it would appear moſt equal, (the Iſlands and Rocks deducted) ſo it would ſhew leſſe clear than that of the Earth, which is montanous and uneven. And but that I would not ſeem, as the ſaying is, to harp too much on one ſtring, I could tell you that I have obſerved in the Moon that ſecondary light which I told you came to her from the reflection of the Terreſtrial Globe, to be notably more clear two or three dayes before the conjunction, than after, that is, when we ſee it before break of day in the Eaſt, than when it is ſeen at night after Sun-ſet in the Weſt; of which difference the cauſe is, that the Terreſtrial Hemiſphere, which looks towards the Eaſtern Moon, hath little Sea, and much Land, to wit, all *Aſia*, whereas, when it is in the Weſt, it beholds very great Seas, that is, the whole *Atlantick* Ocean as far as *America:* An Argument ſufficiently probable that the ſurface of the water appears leſſe ſplendid than that of the Earth.

The ſecondary light of the Moon clearer before the conjunction, than after.

SIMPL. So that perhaps you believe, thoſe great ſpots diſcovered in the face of the Moon, to be Seas, and the other clearer parts to be Land, or ſome ſuch thing?

SALV. This which you ask me, is the beginning of thoſe incongruities which I eſteem to be between the Moon and the Earth, out of which it is time to diſ-ingage our ſelves, for we have ſtayed too long in the Moon. I ſay therefore, that if there were in nature but one way onely, to make two ſuperficies illuſtrated by the Sun, to appear one more clear than the other, and that this were by the being of the one Earth, and the other Water; it would be neceſſary to ſay that the ſurface of the Moon were part earthy and part aquatick; but becauſe we know many wayes to produce the ſame effect (and others there may be which we know not of;) therefore I dare not affirm the Moon to conſiſt of one thing more than another: It hath been ſeen already that

that a ſilver plate boiled, being toucht with the Burniſher, becometh of white obſcure; that the moiſt part of the Earth ſhews more obſcure than the dry; that in the tops of Hills, the woody parts appear more gloomy than the naked and barren; which hapneth becauſe there falleth very much ſhadow among the Trees, but the open places are illuminated all over by the Sun. And this mixtion of ſhadow hath ſuch operation, that in tufted velvet, the ſilk which is cut, is of a far darker colour than that which is not cut, by means of the ſhadows diffuſed betwixt thred and thred, and a plain velvet ſhews much blacker than a Taffata, made of the ſame ſilk. So that if there were in the Moon things which ſhould look like great Woods, their aſpect might repreſent unto us the ſpots which we diſcover; alike difference would be occaſioned, if there were Seas in her: and laſtly, nothing hindreth, but that thoſe ſpots may really be of an obſcurer colour than the reſt; for thus the ſnow makes the mountains ſhew brighter. That which is plainly obſerved in the Moon is, that its moſt obſcure parts are all plains, with few riſes and bancks in them; though ſome there be; the reſt which is of a brighter colour, is all full of rocks, mountains, hillocks of ſpherical and other figures; and in particular, round about the ſpots are very great ledges of mountains. That the ſpots be plain ſuperficies, we have aſſuredproof, in that we ſee, how that the term which diſtinguiſheth the part illuminated from the obſcure, in croſſing the ſpots makes the interſection even, but in the clear parts it ſhews all craggy and ſhagged. But I know not as yet whether this evenneſſe of ſuperficies may be ſufficient of it ſelf alone, to make the obſcurity appear, and I rather think not. Beſides, I account the Moon exceeding different from the Earth; for although I imagine to my ſelf that thoſe are not idle and dead Regions, yet I affirm not, that there are in them motion and life, much leſs that there are bred plants, animals or other things like to ours; but, if ſuch there be, they ſhould nevertheleſs be very different, and remote from our imagination. And I am induced ſo to think, becauſe in the firſt place, I eſteem that the matter of the Lunar Globe conſiſts not of Earth and Water; and this alone ſufficeth to take away the generations and alterations reſembling ours: but now ſuppoſing that there were in the Moon, Water and Earth, yet would they not produce plants and animals like to ours; and this for two principal reaſons: The firſt is, that unto our productions there are required ſo many variable aſpects of the Sun, that without them they would all miſcarry: now the habitudes of the Sun towards the Earth are far different from thoſe towards the Moon. We as to the diurnal illumination, have, in the greater part of the Earth, every twenty four hours part day, and part night, which effect in the Moon is monethly: and that annual decli-

The obſcurer parts of the Moon are plains, and the more bright mountainous.

Long ledges of mountains about the ſpots of the Moon.

There are not generated in the Moon things like to ours, but if there be any productions, they are very different.

The Moon not compoſed of Water and Earth.

Thoſe aſpects of the Sun neceſſary for our generations, are not ſo in the Moon.

Natural dayes in the Moon are of a Moneth long.

nation and elevation of the Sun in the Zodiack, by which it produceth diverſity of Seaſons, and inequality of dayes and nights, are finiſhed in the Moon in a moneth; and whereas the Sun to us

To the Moon the Sun aſcendeth and declineth with a difference of ten degrees, and to the Earth of forty ſeven degrees.

riſeth and declineth ſo much, that from the greateſt to the leaſt altitude, there is a difference of almoſt 47 degrees, for ſo much is the diſtance from one to the other Tropick; this is in the Moon but ten degrees only, or little more; namely, as much as the greateſt Latitudes of the Dragon on each ſide the Ecliptick. Now conſider what effect the Sun would have in the torrid Zone, ſhould it continually for fifteen dayes together beam forth its Rayes upon it; which without all queſtion would deſtroy plants, herbs, and living creatures: and if it ſhould chance that there were any production, it would be of herbs, plants, and creatures very different from thoſe which are now there. Secondly, I verily believe

There are no rains in the Moon.

that in the Moon there are no rains, for if Clouds ſhould gather in any part thereof, as they do about the Earth, they would thereupon hide from our ſight ſome of thoſe things, which we with the *Teleſcope* behold in the Moon, and in a word, would ſome way or other change its *Phænomenon*, an effect which I could never by long and diligent obſervations diſcover; but alwayes beheld it in a even and pure ſerenity.

SAGR. To this may be anſwered, either that there might be great miſts, or that it might rain in the time of their night, that is, when the Sun doth not illuminate it.

SALV. If other paſſages did but aſſure us, that there were generations in it like to ours, and that there was onely wanting the concourſe of rains, we might find out this, or ſome other temperament to ſerve inſtead thereof, as it happens in *Egypt* by the inundation of *Nile*: but not meeting with any accident, which correſponds with ours, of many that have been ſought out for the production of the like effects, we need not trouble our ſelves to introduce one alone; and that alſo, not becauſe we have certain obſervation of it, but for a bare non-repugnance that we find therein. Moreover, if I was demanded what my firſt apprehenſion, and pure natural reaſon dictated to me concerning the production of things like or unlike there above, I would alwayes reply, that they are moſt different, and to us altogether unimaginable, for ſo me thinks the riches of Nature, and the omnipotence of our Creator and Governour, do require.

SAGR. I ever accounted extraordinary madneſſe that of thoſe, who would make humane comprehenſion the meaſure of what nature hath a power or knowledge to effect; whereas on the contrary there is not any the leaſt effect in Nature, which can be fully underſtood by the moſt ſpeculative wits in the world. This their ſo vain preſumption of knowing all, can take beginning from no-

The having a perfect knowledg of nothing, maketh ſome believe they underſtand all things.

thing

thing, unleſſe from their never having known any thing; for if one hath but once onely experienced the perfect knowledg of one onely thing, and but truly taſted what it is to know, he ſhall perceive that of infinite other concluſions, he underſtands not ſo much as one.

SALV. Your diſcourſe is very concluding; in confirmation of which we have the example of thoſe who underſtand, or have known ſome thing, which the more knowing they are, the more they know, and freely confeſſe that they know little; nay, the wiſeſt man in all *Greece*, and for ſuch pronounced by the Oracle, openly profeſſed to know that he knew nothing.

SIMPL. It muſt be granted therefore, either that *Socrates* or that the *Oracle* it ſelf was a lyar, *that declaring him to be moſt wiſe, and he confeſſing that he knew himſelf to be moſt ignorant.*

SALV. Neither one nor the other doth follow, for that both the aſſertions may be true. The *Oracle* adjudged *Socrates* the wiſeſt of all men, whoſe knowledg is limited; *Socrates* acknowledgeth that he knew nothing in relation to abſolute wiſdome, which is infinite; and becauſe of infinite, much is the ſame part, as is little, and as is nothing (for to arrive *v. g.* to the infinite number, it is all one to accumulate thouſands, tens, or ciphers,) therefore *Socrates* well perceived his wiſdom to be nothing, in compariſon of the infinite knowledg which he wanted. But yet, becauſe there is ſome knowledg found amongſt men, and this not equally ſhared to all, *Socrates* might have a greater ſhare thereof than others; and therefore verified the anſwer of the *Oracle*. *The anſwer of the Oracle true in judging Socrates the wiſeſt of his time.*

SAGR. I think I very well underſtand this particular amongſt men, *Simplicius* there is a power of operating, but not equally diſpenſed to all; and it is without queſtion, that the power of an Emperor is far greater than that of a private perſon; but, both this and that are nothing in compariſon of the Divine Omnipotence. Amongſt men, there are ſome that better underſtand Agriculture than many others; but the knowledg of planting a Vine in a trench, what hath it to do with the knowledg of making it to ſprout forth, to attract nouriſhment, to ſelect this good part from that other, for to make thereof leaves, another to make ſprouts, another to make grapes, another to make raiſins, another to make the huskes of them, which are the works of moſt wiſe Nature? This is one only particular act of the innumerable, which Nature doth, and in it alone is diſcovered an infinite wiſdom, ſo that Divine Wiſdom may be concluded to be infinitely infinite. *Divine Wiſdom infinitely infinite.*

SALV. Take hereof another example. Do we not ſay that the judi-

Buonarruotti, a ſtatuary of admirable ingennity.

judicious diſcovering of a moſt lovely *Statua* in a piece of Marble, hath ſublimated the wit of *Buonarruotti* far above the vulgar wits of other men? And yet this work is onely the imitation of a meer aptitude and diſpoſition of exteriour and ſuperficial members of an immoveable man; but what is it in compariſon of a man made by nature, compoſed of as many exteriour and interiour members, of ſo many muſcles, tendons, nerves, bones, which ſerve to ſo many and ſundry motions? but what ſhall we ſay of the ſenſes, and of the powers of the ſoul, and laſtly, of the underſtanding? May we not ſay, and that with reaſon, that the ſtructure of a Statue fals far ſhort of the formation of a living man, yea more of a contemptible worm?

SAGR. And what difference think you, was there betwixt the Dove of *Architas*, and one made by Nature?

SIMPL. Either I am none of theſe knowing men, or elſe there is a manifeſt contradiction in this your diſcourſe. You account underſtanding amongſt the greateſt (if you make it not the chief of the) *Encomiums* aſcribed to man made by Nature, and a little before you ſaid with *Socrates*, that he had no knowledg at all; therefore you muſt ſay, that neither did Nature underſtand how to make an underſtanding that underſtandeth.

SALV. You argue very cunningly, but to reply to your objection I muſt have recourſe to a Philoſophical diſtinction, and ſay that the underſtanding is to be taken too ways, that is *intenſivè*, or *extenſivè*; and that *extenſivè*, that is, as to the multitude of intelligibles, which are infinite, the underſtanding of man is as nothing, though he ſhould underſtand a thouſand propoſitions; for that a thouſand, in reſpect of infinity is but as a cypher: but taking the underſtanding *intenſive*, (in as much as that term imports) intenſively, that is, perfectly ſome propoſitions, I ſay, that humane wiſdom underſtandeth ſome propoſitions ſo perfectly, and is as abſolutely certain thereof, as Nature her ſelf; and ſuch are the pure Mathematical ſciences, to wit, Geometry and Arithmetick: in which Divine Wiſdom knows infinite more propoſitions, becauſe it knows them all; but I believe that the knowledge of thoſe few comprehended by humane underſtanding, equalleth the divine, as to the certainty *objectivè*, for that it arriveth to comprehend the neceſſity thereof, than which there can be no greater certainty.

Man underſtandeth very well intenſivè, *but little* extenſivè.

SIMPL. This ſeemeth to me a very bold and raſh expreſſion.

SALV. Theſe are common notions, and far from all umbrage of temerity, or boldneſs, and detract not in the leaſt from the Majeſty of divine wiſdom; as it nothing diminiſheth the omnipotence thereof to ſay, that God cannot make what is once done, to be undone: but I doubt, *Simplicius*, that your ſcruple ariſeth from an opinion you have, that my words are ſomewhat equivocal; therefore

fore the better to expreſs my ſelf I ſay, that as to the truth, of which Mathematical demonſtrations give us the knowledge, it is the ſame, which the divine wiſdom knoweth; but this I muſt grant you, that the manner whereby God knoweth the infinite propoſitions, of which we underſtand ſome few, is highly more excellent than ours, which proceedeth by ratiocination, and paſſeth from concluſion to concluſion, whereas his is done at one ſingle thought or intuition; and whereas we, for example, to attain the knowledg of ſome paſſion of the Circle, which hath infinite, beginning from one of the moſt ſimple, and taking that for its definition, do proceed with argumentation to another, and from that to a third, and then to a fourth, &c. the Divine Wiſdom, by the apprehenſion of its eſſence comprehends, without temporary ratiocination, all theſe infinite paſſions; which notwithſtanding, are in effect virtually compriſed in the definitions of all things; and, to conclude, as being infinite, perhaps are but one alone in their nature, and in the Divine Mind; the which neither is wholly unknown to humane underſtanding, but onely be-clouded with thick and groſſe miſts; which come in part to be diſſipated and clarified, when we are made Maſters of any concluſions, firmly demonſtrated, and ſo perfectly made ours, as that we can ſpeedily run through them; for in ſum, what other, is that propoſition, that the ſquare of the ſide ſubtending the right angle in any triangle, is equal to the ſquares of the other two, which include it, but onely the Paralellograms being upon common baſes, and between parallels equal amongſt themſelves? and this, laſtly, is it not the ſame, as to ſay that thoſe two ſuperficies are equal, of which equal parts applyed to equal parts, poſſeſſe equal place? Now theſe inferences, which our intellect apprehendeth with time and a gradual motion, the Divine Wiſdom, like light, penetrateth in an inſtant, which is the ſame as to ſay, hath them alwayes preſent: I conclude therefore, that our underſtanding, both as to the manner and the multitude of the things comprehended by us, is infinitely ſurpaſt by the Divine Wiſdom; but yet I do not ſo vilifie it, as to repute it abſolutely nothing; yea rather, when I conſider how many and how great miſteries men have underſtood, diſcovered, and contrived, I very plainly know and underſtand the mind of man to be one of the works, yea one of the moſt excellent works of God.

Gods manner of knowing different from that of men.

Humane underſtanding done by ratiocination.

Definitions contein virtually all the paſſions of the things defined.

Infinite Paſſions are perhaps but one onely.

The diſcourſes which humane reaſon makes in a certain time, the Divine Wiſdom reſolveth in a moment; that is, hath them alwayes preſent.

SAGR. I have oft times conſidered with my ſelf, in purſuance of that which you ſpeak of, how great the wit of man is; and whil'ſt I run thorow ſuch and ſo many admirable inventions found out by him, as well in the Arts, as Sciences; and again reflecting upon my own wit, ſo far from promiſing me the diſcovery of any thing new, that I deſpair of comprehending what is already diſcovered;

The wit of man admirably acute.

covered, confounded with wonder, and ſurpriſed with deſperation, I account my ſelf little leſſe than miſerable. If I behold a Statue of ſome excellent Maſter, I ſay with my ſelf; When wilt thou know how to chizzle away the refuſe of a piece of Marble, and diſcover ſo lovely a figure, as lyeth hid therein? When wilt thou mix and ſpread ſo many different colours upon a Cloth, or Wall, and repreſent therewith all viſible objects, like a *Michael Angelo*, a *Raphaello*, or a *Tizvano*? If I behold what inventions men have in comparting Muſical intervals, in eſtabliſhing Precepts and Rules for the management thereof with admirable delight to the ear: When ſhall I ceaſe my aſtoniſhment? What ſhall I ſay of ſuch and ſo various Inſtruments of that Art? The reading of excellent Poets, with what admiration doth it ſwell any one that attentively conſidereth the invention of conceits, and their explanation? What ſhall we ſay of Architecture? What of Navigation? But, above all other ſtupendious inventions, what ſublimity of mind was that in him, that imagined to himſelf to find out a way to communicate his moſt ſecret thoughts to any other perſon, though very far diſtant from him either in time, or place, ſpeaking with thoſe that are in the *India's*; ſpeaking to thoſe that are not yet born, nor ſhall be this thouſand, or ten thouſand years? and with how much facility? but by the various collocation of * twenty little letters upon a paper? Let this be the Seal of all the admirable inventions of man, and the cloſe of our Diſcourſe for this day: For the warmer hours being paſt, I ſuppoſe that *Salviatus* hath a deſire to go and take the air in his Gondelo; but too morrow we will both wait upon you, to continue the Diſcourſes we have begun, *&c.*

The invention of writing ſtupendious above all others.

* For of ſo many only the Italian Alphabet conſiſts.

GAL-

GALILÆUS

Galilæus Lyncæus,

HIS

SYSTEME

OF THE

WORLD.

The Second Dialogue.

INTERLOCUTORS.

SALVIATUS, SAGREDUS, and SIMPLICIUS.

SALV.

THe yeſter-dayes diverſions which led us out of the path of our principal diſcourſe, were ſuch and ſo many, that I know not how I can without your aſſiſtance recover the track in which I am to proceed.

SAGR. I wonder not, that you, who have your fancy charged and laden with both what hath been, and is to be ſpoken, do find your ſelf in ſome confuſion; but I, who as being onely an Auditor, have nothing to burthen my memory withal, but ſuch things as I have heard, may haply by a ſuccinct rehearſal of them, recover the firſt thred of our Diſcourſe. As far therefore as my memory ſerves me, the ſum of yeſter-dayes conferences were an examination of the Prin-

ciples of *Ptolomy* and *Copernicus*, and which of their opinions is the more probable and rational; that, which affirmeth the ſubſtance of the Cœleſtial bodies to be ingenerable, incorruptible, unalterable, impaſſible, and in a word, exempt from all kind of change, ſave that of local, and therefore to be a *fifth eſſence*, quite different from this of our Elementary bodies, which are generable, corruptible, alterable, *&c.* or elſe the other, which taking away ſuch deformity from the parts of the World, holdeth the Earth to enjoy the ſame perfections as the other integral bodies of the univerſe; and eſteemeth it a moveable and erratick Globe, no leſſe than the Moon, *Jupiter*, *Venus*, or any other Planet: And laſtly, maketh many particular parallels betwixt the Earth and Moon; and more with the Moon, than with any other Planet; haply by reaſon we have greater and more certain notice of it, as being leſſe diſtant from us. And having, laſtly, concluded this ſecond opinion to have more of probability with it than the firſt, I ſhould think it beſt in the ſubſequent diſcourſes to begin to examine whether the Earth be eſteemed immoveable, as it hath been till now believed by moſt men, or elſe moveable, as ſome ancient *Philoſophers* held, and others of not very receſſe times, were of opinion; and if it be moveable, to enquire of what kind its motion may be?

SALV. I ſee already what way I am to take; but before we offer to proceed any farther, I am to ſay ſomething to you touching thoſe laſt words which you ſpake, how that the opinion which holds the Earth to be endued with the ſame conditions that the Cœleſtial bodies enjoy, ſeems to be more true than the contrary; for that I affirmed no ſuch thing, nor would I have any of the Propoſitions in controverſie, be made to ſpeak to any definitive ſenſe: but I onely intended to produce on either part, thoſe reaſons and anſwers, arguments and ſolutions, which have been hitherto thought upon by others, together with certain others, which I have ſtumbled upon in my long ſearching thereinto, alwayes remitting the deciſion thereof to the judgment of others.

SAGR. I was unawares tranſported by my own ſenſe of the thing; and believing that others ought to judg as I did, I made that concluſion univerſal, which ſhould have been particular; and therefore confeſſe I have erred, and the rather, in that I know not what *Simplicius* his judgment is in this particular.

SIMPL. I muſt confeſſe, that I have been ruminating all this night of what paſt yeſterday, and to ſay the truth, I meet therein with many acute, new, and plauſible notions; yet nevertheleſs, I find my ſelf over-perſwaded by the authority of ſo many great *Writers*, and in particular —— *&c.* I ſee you ſhake your head *Sagredus*, and ſmile to your ſelf, as if I had uttered ſome great abſurdity.

SAGR.

SAGR. I not onely ſmile, but to tell you true, am ready to burſt with holding in my ſelf from laughing outright, for you have put me in mind of a very pretty paſſage, that I was a witneſſe of, not many years ſince, together with ſome others of my worthy friends, which I could yet name unto you.

SALV. It would be well that you told us what it was, that ſo *Simplicius* may not ſtill think that he gave you the occaſion of laughter.

SAGR. I am content. I found one day, at home in his houſe, at *Venice*, a famous Phiſician, to whom ſome flockt for their ſtudies, and others out of curioſity, ſometimes came thither to ſee certain Anatomies diſſected by the hand of a no leſſe learned, than careful and experienced Anatomiſt. It chanced upon that day, when I was there, that he was in ſearch of the original and riſe of the Nerves, about which there is a famous controverſie between the *Galeniſts* and *Peripateticks*; and the Anatomiſt ſhewing, how that the great number of Nerves departing from the Brain, as their root, and paſſing by the nape of the Neck, diſtend themſelves afterwards along by the Back-bone, and branch themſelves thorow all the Body; and that a very ſmall filament, as fine as a thred went to the Heart; he turned to a Gentleman whom he knew to be a *Peripatetick* Philoſopher, and for whoſe ſake he had with extraordinary exactneſſe, diſcovered and proved every thing, and demanded of him, if he was at length ſatisfied and perſwaded that the original of the Nerves proceeded from the Brain, and not from the Heart? To which the Philoſopher, after he had ſtood muſing a while, anſwered; you have made me to ſee this buſineſſe ſo plainly and ſenſibly, that did not the *Text* of *Ariſtotle* aſſert the contrary, which poſitively affirmeth the Nerves to proceed from the Heart, I ſhould be conſtrained to confeſſe your opinion to be true.

The original of the Nerves according to Ariſtotle, and according to Phiſicians.

The ridiculous anſwer of a Philoſopher, determining the original of the Nerves.

SIMPL. I would have you know my Maſters, that this controverſie about the original of the Nerves is not yet ſo proved and decided, as ſome may perhaps perſwade themſelves.

SAGR. Nor queſtionleſſe ever ſhall it be, if it find ſuch like contradictors; but that which you ſay, doth not at all leſſen the extravagance of the anſwer of that *Peripatetick*, who againſt ſuch ſenſible experience produced not other experiments, or reaſons of *Ariſtotle*, but his bare authority and pure *ipſe dixit*.

SIMPL. *Ariſtotle* had not gained ſo great authority, but for the force of his Demonſtrations, and the profoundneſſe of his arguments; but it is requiſite that we underſtand him, and not onely underſtand him, but have ſo great familiarity with his Books, that we form a perfect *Idea* thereof in our minds, ſo as that every ſaying of his may be alwayes as it were, preſent in our

memory for he did not write to the vulgar, nor is he obliged to ſpin out his Sillogiſmes with the trivial method of diſputes; nay rather, uſing a freedome, he hath ſometimes placed the proof of one Propoſition amongſt Texts, which ſeem to treat of quite another point; and therefore it is requiſite to be maſter of all that vaſt *Idea*, and to learn how to connect this paſſage with that, and to combine this Text with another far remote from it; for it is not to be queſtioned but that he who hath thus ſtudied him, knows how to gather from his Books the demonſtrations of every knowable deduction, for that they contein all things.

Requiſites to fit a man to philoſophate well after the manner of Ariſtotle.

SAGR. But good *Simplicius*, like as the things ſcattered here and there in *Ariſtotle*, give you no trouble in collecting them, but that you perſwade your ſelf to be able by comparing and connecting ſeveral ſmall ſentences to extract thence the juice of ſome deſired concluſion, ſo this, which you and other egregious Philoſophers do with the Text of *Ariſtotle*, I could do by the verſes of *Virgil*, or of *Ovid*, compoſing thereof * *Centones*, and therewith explaining all the affairs of men, and ſecrets of Nature. But what talk I of *Virgil*, or any other Poet? I have a little Book much ſhorter than *Ariſtotle* and *Ovid*, in which are conteined all the Sciences, and with very little ſtudy, one may gather out of it a moſt perfect *Idea*, and this is the *Alphabet*; and there is no doubt but that he who knows how to couple and diſpoſe aright this and that vowel, with thoſe, or thoſe other conſonants, may gather thence the infallible anſwers to all doubts, and deduce from them the principles of all Sciences and Arts, juſt in the ſame manner as the Painter from divers ſimple colours, laid ſeverally upon his *Pallate*, proceedeth by mixing a little of this and a little of that, with a little of a third, to repreſent to the life men, plants, buildings, birds, fiſhes, and in a word, counterfeiting what ever object is viſible, though there be not on the *Pallate* all the while, either eyes, or feathers, or fins, or leaves, or ſtones. Nay, farther, it is neceſſary, that none of the things to be imitated, or any part of them, be actually among colours, if you would be able therewith to repreſent all things; for ſhould there be amongſt them *v. gr.* feathers, theſe would ſerve to repreſent nothing ſave birds, and plumed creatures.

A cunning way to gather Philoſophy out of any book whatſoever.

* A word ſignifying works compoſed of many fragments of verſes collected out of the Poets.

SALV. And there are certain Gentlemen yet living, and in health, who were preſent, when a Doctor, that was Profeſſor in a famous Academy, hearing the deſcription of the *Teleſcope*, by him not ſeen as then, ſaid, that the invention was taken from *Ariſtotle*, and cauſing his works to be fetch't, he turned to a place where the Philoſopher gives the reaſon, whence it commeth, that from the bottom of a very deep Well, one may ſee the ſtars in Heaven, at noon day; and, addreſſing himſelf to the company, ſee

Invention of the Teleſcope *taken from* Ariſtotle.

ſee here, ſaith he, the Well, which repreſenteth the Tube, ſee here the groſs vapours, from whence is taken the invention of the Cryſtals, and ſee here laſtly the ſight fortified by the paſſage of the rays through a diaphanous, but more denſe and obſcure *medium*.

SAGR. This is a way to comprehend all things knowable, much like to that wherewith a piece of marble conteineth in it one, yea, a thouſand very beautiful Statua's, but the difficulty lieth in being able to diſcover them; or we may ſay, that it is like to the propheſies of Abbot *Joachim*, or the anſwers of the Heathen *Oracles*, which are not to be underſtood, till after the things fore-told are come to paſſe.

SALV. And why do you not adde the predictions of the *Genethliacks*, which are with like cleerneſſe ſeen after the event, in their Horoſcopes, or, if you will, Configurations of the Heavens.

Chymiſts interpret the Fables of the Poets to be ſecrets for making of Gold.

SAGR. In this manner the Chymiſts find, being led by their melancholly humour, that all the ſublimeſt wits of the World have writ of nothing elſe in reality, than of the way to make Gold; but, that they might tranſmit the ſecret to poſterity without diſcovering it to the vulgar, they contrived ſome one way, and ſome another how to conceal the ſame under ſeveral maskes; and it would make one merry to hear their comments upon the ancient *Poets*, finding out the important miſteries, which lie hid under their Fables; and the ſignification of the Loves of the *Moon*, and her deſcending to the Earth for *Endimion*; her diſpleaſure againſt *Acteon*, and what was meant by *Jupiters* turning himſelf into a ſhowre of *Gold*; and into flames of fire; and what great ſecrets of Art lare conteined in that *Mercury* the *Interpreter*; in thoſe thefts of *Pluto*; and in thoſe *Branches* of *Gold*.

SIMPL. I believe, and in part know, that there want not in the World very extravagant heads, the vanities of whom ought not to redound to the prejudice of *Ariſtotle*, of whom my thinks you ſpeak ſometimes with too little reſpect, and the onely antiquity and bare name that he hath acquired in the opinions of ſo many famous men, ſhould ſuffice to render him honourable with all that profeſſe themſelves learned.

Some of Ariſtotles *Sectators impare the reputation of their Maſter, in going about to enhanſe it.*

SALV. You ſtate not the matter rightly, *Simplicius*; There are ſome of his followers that fear before they are in danger, who give us occaſion, or, to ſay better, would give us cauſe to eſteem him leſſe, ſhould we conſent to applaud their *Capricio's*. And you, pray you tell me, are you for your part ſo ſimple, as not to know that had *Ariſtotle* been preſent, to have heard the Doctor that would have made him Author of the *Teleſcope*, he would have been much more diſpleaſed with him, than with thoſe, who laught at the Doctor and his Comments? Do you queſtion whe-

whether *Ariſtotle*, had he but ſeen the novelties diſcovered in Heaven, would not have changed his opinion, amended his Books, and embraced the more ſenſible Doctrine; rejecting thoſe ſilly Gulls, which too ſcrupulouſly go about to defend what ever he hath ſaid; not conſidering, that if *Ariſtotle* were ſuch a one as they fancy him to themſelves, he would be a man of an untractable wit, an obſtinate mind, a barbarous ſoul, a ſtubborn will, that accounting all men elſe but as ſilly ſheep, would have his Oracles preferred before the Senſes, Experience, and Nature her ſelf? They are the Sectators of *Ariſtotle* that have given him this Authority, and not he that hath uſurped or taken it upon him; and becauſe it is more eaſie for a man to ſculk under anothers ſhield than to ſhew himſelf openly, they tremble, and are affraid to ſtir one ſtep from him; and rather than they will admit ſome alterations in the Heaven of *Ariſtotle*, they will impertinently deny thoſe they behold in the Heaven of *Nature*.

A ridiculous paſſage of a certain Statuary.

SAGR. Theſe kind of Drolleries put me in mind of that Statuary which having reduced a great piece of Marble to the Image of an *Hercules*, or a thundring *Jupiter*, I know not whether, and given it with admirable Art ſuch a vivacity and threatning fury, that it moved terror in as many as beheld it; he himſelf began alſo to be affraid thereof, though all its ſprightfulneſſe, and life was his own workmanſhip; and his affrightment was ſuch, that he had no longer the courage to affront it with his Chizzels and Mallet.

SALV. I have many times wondered how theſe nice maintainers of what ever fell from *Ariſtotle*, are not aware how great a prejudice they are to his reputation and credit; and how that the more they go about to encreaſe his Authority, the more they diminiſh it; for whileſt I ſee them obſtinate in their attempts to maintain thoſe Propoſitions which I palpably diſcover to be manifeſtly falſe; and in their deſires to perſwade me that ſo to do, is the part of a Philoſopher; and that *Ariſtotle* himſelf would do the ſame, it much abates in me of the opinion that he hath rightly philoſophated about other concluſions, to me more abſtruſe: for if I could ſee them concede and change opinion in a manifeſt truth, I would believe, that in thoſe in which they ſhould perſiſt, they may have ſome ſolid demonſtrations to me unknown, and unheard of.

SAGR. Or when they ſhould be made to ſee that they have hazarded too much of their own and *Ariſtotle*'s repuatation in confeſſing, that they had not underſtood this or that concluſion found out by ſome other man; would it not be a leſs evil for them to ſeek for it amongſt his Texts, by laying many of them together, according to the art intimated to us by *Simplicius*? for if his works

works contain all things knowable, it muſt follow alſo that they may be therein diſcovered.

SALV. Good *Sagredus*, make no jeſt of this advice, which me thinks you rehearſe in too Ironical a way; for it is not long ſince that a very eminent Philoſopher having compoſed a Book *de animâ*, wherein, citing the opinion of *Ariſtotle*, about its being or not being immortal, he alledged many Texts, (not any of thoſe heretofore quoted by *Alexander ab Alexandro*: for in thoſe he ſaid, that *Ariſtotle* had not ſo much as treated of that matter, much leſs determined any thing pertaining to the ſame, but others) by himſelf found out in other more abſtruſe places, which tended to an erroneous ſenſe: and being adviſed, that he would find it an hard matter to get a Licence from the Inquiſitors, he writ back unto his friend, that he would notwithſtanding, with all expedition procure the ſame, for that if no other obſtacle ſhould interpoſe, he would not much ſcruple to change the Doctrine of *Ariſtotle*, and with other expoſitions, and other Texts to maintain the contrary opinion, which yet ſhould be alſo agreeable to the ſenſe of *Ariſtotle*.

A brave reſolution of a certain Peripatetick *Philoſopher.*

SAGR. Oh moſt profound Doctor, this I that can command me that I ſtir not a ſtep from *Ariſtotle*, but will himſelf lead him by the noſe, and make him ſpeak as he pleaſeth. See how much it importeth to learn to take *Time* by the *Fore-top*. Nor is it ſeaſonable to have to do with *Hercules*, whil'ſt he is enraged, and amongſt the Furies, but when he is telling merry tales amongſt the *Meonian Damoſels*. Ah, unheard of ſordidneſſe of ſervile ſouls! to make themſelves willing ſlaves to other mens opinions; to receive them for inviolable Decrees, to engage themſelves to ſeem ſatisfied and convinced by arguments, of ſuch efficacy, and ſo manifeſtly concludent, that they themſelves cannot certainly reſolve whether they were really writ to that purpoſe, or ſerve to prove that aſſumption in hand, or the contrary. But, which is a greater madneſſe, they are at variance amongſt themſelves, whether the Author himſelf hath held the affirmative part, or the negative. What is this, but to make an Oracle of a Log, and to run to that for anſwers, to fear that, to reverence and adore that?

The ſervile ſpirit of ſome of Ariſtotles *followers.*

SIMPL. But in caſe we ſhould recede from *Ariſtotle*, who have we to be our Guid in Philoſophy? Name you ſome Author.

SALV. We need a Guid in unknown and uncouth wayes, but in champion places, and open plains, the blind only ſtand in need of a Leader; and for ſuch, it is better that they ſtay at home. But he that hath eyes in his head, and in his mind, him ſhould a man chooſe for his Guid. Yet miſtake me not, thinking that I ſpeak this, for that I am againſt hearing of *Ariſtotle*; for on the con-

Too cloſe adhering to Ariſtotle *is blameable.*

contrary, I commend the reading, and diligently ſtudying of him; and onely blame the ſervile giving ones ſelf up a ſlave unto him, ſo, as blindly to ſubſcribe to what ever he delivers, and without ſearch of any farther reaſon thereof, to receive the ſame for an inviolable decree. Which is an abuſe, that carrieth with it another great inconvenience, to wit, that others will no longer take pains to underſtand the validity of his Demonſtrations. And what is more ſhameful, than in the middeſt of publique diſputes, whileſt one perſon is treating of demonſtrable concluſions, to hear another interpoſe with a paſſage of *Ariſtotle*, and not ſeldome writ to quite another purpoſe, and with that to ſtop the mouth of his opponent? But if you will continue to ſtudy in this manner, I would have you lay aſide the name of Philoſophers; and call your ſelves either Hiſtorians or Doctors of Memory, for it is not fit, that thoſe who never philoſophate, ſhould uſurp the honourable title of Philoſophers. But it is beſt for us to return to ſhore, and not lanch farther into a boundleſſe Gulph, out of which we ſhall not be able to get before night. Therefore *Simplicius*, come either with arguments and demonſtrations of your own, or of *Ariſtotle*, and bring us no more Texts and naked authorities, for our diſputes are about the Senſible World, and not one of Paper. And foraſmuch as in our diſcourſes yeſterday, we retriev'd the Earth from darkneſſe, and expoſed it to the open skie, ſhewing, that the attempt to enumerate it amongſt thoſe which we call Cœleſtial bodies, was not a poſition ſo foil'd, and vanquiſh't, as that it had no life left in it; it followeth next, that we proceed to examine what probability there is for holding of it fixt, and wholly immoveable, *ſcilicet* as to its entire Globe, what likelihood there is for making it moveable with ſome motion, and of what kind that may be. And foraſmuch as in this ſame queſtion I am ambiguous, and *Simplicius* is reſolute, as likewiſe *Ariſtotle* for the opinion of its immobility, he ſhall one by one produce the arguments in favour of their opinion, and I will alledge the anſwers and reaſons on the contrary part; and next *Sagredus* ſhall tell us his thoughts, and to which ſide he finds himſelf inclined.

It is not juſt, that thoſe who never philoſophate, ſhould uſurp the title of Philoſophers.

The Senſible World.

SAGR. Content; provided alwayes that I may reſerve the liberty to my ſelf of alledging what pure natural reaſon ſhall ſometimes dictate to me.

SALV. Nay more; it is that which I particularly beg of you; for, amongſt the more eaſie, and, to ſo ſpeak, material conſiderations, I believe there are but few of them that have been omitted by Writers, ſo that onely ſome of the more ſubtle, and remote can be deſired, or wanting; and to inveſtigate theſe, what other ingenuity can be more fit than that of the moſt acute and piercing wit of *Sagredus*? SAGR.

SAGR. I am what ever pleaſeth *Salviatus*, but I pray you, let us not ſally out into another kind of digreſſion complemental; for at this time I am a Philoſopher, and in the Schools, not in the Court.

SALV. Let our contemplation begin therefore with this conſideration, that whatſoever motion may be aſcribed to the Earth, it is neceſſary that it be to us, (as inhabitants upon it, and conſequently partakers of the ſame) altogether imperceptible, and as if it were not at all, ſo long as we have regard onely to terreſtrial things; but yet it is on the contrary, as neceſſary that the ſame motion do ſeem common to all other bodies, and viſible objects, that being ſeparated from the Earth, participate not of the ſame. So that the true method to find whether any kind of motion may be aſcribed to the Earth, and that found, to know what it is, is to conſider and obſerve if in bodies ſeparated from the Earth, one may diſcover any appearance of motion, which equally ſuiteth to all the reſt; for a motion that is onely ſeen, *v.gr.* in the *Moon*, and that hath nothing to do with *Venus* or *Jupiter*, or any other Stars, cannot any way belong to the Earth, or to any other ſave the Moon alone. Now there is a moſt general and grand motion above all others, and it is that by which the Sun, the Moon, the other Planets, and the Fixed Stars, and in a word, the whole Univerſe, the Earth onely excepted, appeareth in our thinking to move from the Eaſt towards the Weſt, in the ſpace of twenty four hours; and this, as to this firſt appearance, hath no obſtacle to hinder it, that it may not belong to the Earth alone, as well as to all the World beſides, the Earth excepted; for the ſame aſpects will appear in the one poſition, as in the other. Hence it is that *Ariſtotle* and *Ptolomy*, as having hit upon this conſideration, in going about to prove the Earth to be immoveable, argue not againſt any other than this *Diurnal* Motion; ſave onely that *Ariſtotle* hinteth ſomething in obſcure terms againſt another Motion aſcribed to it by an *Ancient*, of which we ſhall ſpeak in its place.

The motions of the Earth are imperceptible to its inhabitants.

The Earth can have no other motions, than thoſe which to us appear commune to all the reſt of the Univerſe, the Earth excepted.

The Diurnal Motion, ſeemeth commune to all the Univerſe, ſave onely the Earth excepted.

Ariſtotle *and* Ptolomy *argue againſt the Diurnal Motion attributed to the Earth.*

SAGR. I very well perceive the neceſſity of your illation: but I meet with a doubt which I know not how to free my ſelf from, and this it is, That *Copernicus* aſſigning to the Earth another motion beſide the Diurnal, which, according to the rule even now laid down, ought to be to us, as to appearance, imperceptible in the Earth, but viſible in all the reſt of the World; me thinks I may neceſſarily infer, either that he hath manifeſtly erred in aſſigning the Earth a motion, to which there appears not a general correſpondence in Heaven; or elſe that if there be ſuch a congruity therein, *Ptolomy* on the other hand hath been deficient in not confuting this, as he hath done the other.

SALV. You have good cauſe for your doubt: and when we come to treat of the other Motion, you ſhall ſee how far *Copernicus* excelled *Ptolomey* in clearneſs and ſublimity of wit, in that he ſaw what the other did not, I mean the admirable harmony wherein that Motion agreed with all the other Cœleſtial Bodies. But for the preſent we will ſuſpend this particular, and return to our firſt conſideration; touching which I will proceed to propoſe (begining with things more general) thoſe reaſons which ſeem to favour the mobility of the Earth, and then wait the anſwers which *Simplicius* ſhall make thereto. And firſt, if we conſider onely the immenſe magnitude of the Starry Sphere, compared to the ſmalneſs of the Terreſtrial Globe, contained therein ſo many millions of times; and moreover weigh the velocity of the motion which muſt in a day and night make an entire revolution thereof, I cannot perſwade my ſelf, that there is any man who believes it more reaſonable and credible, that the Cœleſtial Sphere turneth round, and the Terreſtrial Globe ſtands ſtill.

Why the diurnal motion more probably ſhould belong to the Earth, than to the reſt of the Univerſe.

SAGR. If from the univerſality of effects, which may in nature have dependence upon ſuch like motions, there ſhould indifferently follow all the ſame conſequences to an hair, aſwell in one *Hypotheſis* as in the other; yet I for my part, as to my firſt and general apprehenſion, would eſteem, that he which ſhould hold it more rational to make the whole Univerſe move, and thereby to ſalve the Earths mobility, is more unreaſonable than he that being got to the top of your Turret, ſhould deſire, to the end onely that he might behold the City, and the Fields about it, that the whole Country might turn round, that ſo he might not be put to the trouble to ſtir his head. And yet doubtleſs the advantages would be many and great which the *Copernican Hypotheſis* is attended with, above thoſe of the *Ptolomaique*, which in my opinion reſembleth, nay ſurpaſſeth that other folly; ſo that all this makes me think that far more probable than this. But haply *Ariſtotle*, *Ptolomey*, and *Simplicius* may find the advantages of their Syſteme, which they would do well to communicate to us alſo, if any ſuch there be; or elſe declare to me, that there neither are or can be any ſuch things.

SALV. For my part, as I have not been able, as much as I have thought upon it, to find any diverſity therein; ſo I think I have found, that no ſuch diverſity can be in them: in ſo much that I eſteem it to no purpoſe to ſeek farther after it. Therefore obſerve: Motion is ſo far Motion, and as Motion operateth, by how far it hath relation to things which want Motion: but in thoſe things which all equally partake thereof it hath nothing to do, and is as if it never were. And thus the Merchandiſes with which a ſhip is laden, ſo far move, by how far leaving *London*, they paſs by

Motion, as to the things that equally move thereby, is as if it never were, & ſo far operates as it hath relation to things deprived of motion.

by *France*, *Spain*, *Italy*, and ſail to *Aleppo*, which *London*, *France*, *Spain* &c. ſtand ſtill, not moving with the ſhip : but as to the Cheſts, Bales and other Parcels, wherewith the ſhip is ſtow'd and and laden; and in reſpect of the ſhip it ſelf, the Motion from *London* to *Syria* is as much as nothing ; and nothing-altereth the relation which is between them : and this, becauſe it is common to all, and is participated by all alike : and of the Cargo which is in the ſhip, if a Bale were romag'd from a Cheſt but one inch onely, this alone would be in that Cargo, a greater Motion in reſpect of the Cheſt, than the whole Voyage of above three thouſand miles, made by them as they were ſtived together.

SIMPL. This Doctrine is good, ſound, and altogether *Peripatetick*.

SALV. I hold it to be much more antient : and ſuſpect that *Ariſtotle* in receiving it from ſome good School, did not fully underſtand it, and that therefore, having delivered it with ſome alteration, it hath been an occaſion of confuſion amongſt thoſe, who would defend whatever he ſaith. And when he writ, that whatſoever moveth, doth move upon ſomething immoveable, I ſuppoſe that he equivocated, and meant, that whatever moveth, moveth in reſpect to ſomething immoveable ; which propoſition admitteth no doubt, and the other many.

A propoſition taken by Ariſtotle *from the Antients, but ſomewhat altered by him.*

SAGR. Pray you make no digreſſion, but proceed in the diſſertation you began.

SALV. It being therefore manifeſt, that the motion which is common to many moveables, is idle, and as it were, null as to the relation of thoſe moveables between themſelves, becauſe that among themſelves they have made no change : and that it is operative onely in the relation that thoſe moveables have to other things, which want that motion, among which the habitude is changed : and we having divided the Univerſe into two parts, one of which is neceſſarily moveable, and the other immoveable ; for the obtaining of whatſoever may depend upon, or be required from ſuch a motion, it may as well be done by making the Earth alone, as by making all the reſt of the World to move : for that the operation of ſuch a motion conſiſts in nothing elſe, ſave in the relation or habitude which is between the Cœleſtial Bodies, and the Earth, the which relation is all that is changed. Now if for the obtaining of the ſame effect *ad unguem*, it be all one whether the Earth alone moveth, the reſt of the Univerſe ſtanding ſtill ; or that, the Earth onely ſtanding ſtill, the whole Univerſe moveth with one and the ſame motion ; who would believe, that Nature (which by common conſent, doth not that by many things, which may be done by few) hath choſen to make an innumerable number of moſt vaſt bodies move, and that with an unconceivable

The firſt diſcourſe to prove that the diurnal motion belongs to the Earth.

Nature never doth that by many things, which may be done by a few.

velocity, to perform that, which might be done by the moderate motion of one alone about its own Centre?

SIMPL. I do not well underſtand, how this grand motion ſignifieth nothing as to the Sun, as to the Moon, as to the other Planets, and as to the innumerable multitude of fixed ſtars: or why you ſhould ſay that it is to no purpoſe for the Sun to paſs from one Meridian to another; to riſe above this Horizon, to ſet beneath that other; to make it one while day, another while night: the like variations are made by the Moon, the other Planets, and the fixed ſtars themſelves.

The diurnal motion cauſeth no mutation amongſt the Cœleſtial Bodies, but all changes have relation to the Earth.

SALV. All theſe alterations inſtanced by you, are nothing, ſave onely in relation to the Earth: and that this is true, do but imagine the Earth to move, and there will be no ſuch thing in the World as the riſing or ſetting of the Sun or Moon, nor Horizons, nor Meridians, nor days, nor nights; nor, in a word, will ſuch a motion cauſe any mutation between the Moon and Sun, or any other ſtar whatſoever, whether fixed or erratick; but all theſe changes have relation to the Earth: which all do yet in ſum import no other than as if the Sun ſhould ſhew it ſelf now to *China*, anon to *Perſia*, then to *Egypt*, *Greece*, *France*, *Spain*, *America*, *&c.* and the like holdeth in the Moon, and the reſt of the Cœleſtial Bodies: which ſelf ſame effect falls out exactly in the ſame manner, if, without troubling ſo great a part of the Univerſe, the Terreſtrial Globe be made to revolve in it ſelf. But we will augment the difficulty by the addition of this other, which is a very great one, namely, that if you will aſcribe this *Great* Motion to Heaven, you muſt of neceſſity make it contrary to the particular motion of all the Orbs of the Planets, each of which without controverſie hath its peculiar motion from the Weſt towards the Eaſt, and this but very eaſie and moderate: and then you make them to be hurried to the contrary part, *i. e.* from Eaſt to Weſt, by this moſt furious diurnal motion: whereas, on the contrary, making the Earth to move in it ſelf, the contrariety of motions is taken away, and the onely motion from Weſt to Eaſt is accommodated to all appearances, and exactly ſatisfieth every *Phænomenon.*

A ſecond confirmation that the diurnal motion belongs to the Earth.

Circular motions are not contrary, according to Ariſtotle.

SIMPL. As to the contrariety of Motions it would import little, for *Ariſtotle* demonſtrateth, that circular motions, are not contrary to one another; and that theirs cannot be truly called contrariety.

SALV. Doth *Ariſtotle* demonſtrate this, or doth he not rather barely affirm it, as ſerving to ſome certain deſign of his? If contraries be thoſe things, that deſtroy one another, as he himſelf affirmeth, I do not ſee how two moveables that encounter each other in a circular line, ſhould leſſe prejudice one another, than if they interfered in a right line.

SAGR.

SAGR. Hold a little, I pray you. Tell me *Simplicius*, when two Knights encounter each other, tilting in open field, or when two whole Squadrons, or two Fleets at Sea, make up to grapple, and are broken and ſunk, do you call theſe encounters contrary to one another?

SIMPL. Yes, we ſay they are contrary.

SAGR. How then, is there no contrariety in circular motions. Theſe motions, being made upon the ſuperficies of the Earth or Water, which are, as you know, ſpherical, come to be circular. Can you tell, *Simplicius*, which thoſe circular motions be, that are not contrary to each other? They are (if I miſtake not) thoſe of two circles, which touching one another without, one thereof being turn'd round, naturally maketh the other move the contrary * way; but if one of them ſhall be within the other, it is impoſſible that their motion being made towards different points, they ſhould not juſtle one another.

* As you ſee in a Mill, wherein the implicated cogs ſet the wheels on moving.

SALV. But be they contrary, or not contrary, theſe are but alterations of words; and I know, that upon the matter, it would be far more proper and agreeable with Nature, if we could ſalve all with one motion onely, than to introduce two that are (if you will not call them contrary) oppoſite; yet do I not cenſure this introduction (of contrary motions) as impoſſible; nor pretend I from the denial thereof, to inferre a neceſſary Demonſtration, but onely a greater probability, of the other. A third reaſon which maketh the *Ptolomaique Hypotheſis* leſſe probable is, that it moſt unreaſonably confoundeth the order, which we aſſuredly ſee to be amongſt thoſe Cœleſtial Bodies, the circumgyration of which is not queſtionable, but moſt certain. And that Order is, that according as an Orb is greater, it finiſheth its revolution in a longer time, and the leſſer, in ſhorter. And thus *Saturn* deſcribing a greater Circle than all the other Planets, compleateth the ſame in thirty yeares: *Jupiter* finiſheth his; that is leſſe, in twelve years: *Mars* in two: The Moon runneth thorow hers, ſo much leſſe than the reſt, in a Moneth onely. Nor do we leſſe ſenſibly ſee that of the *Medicean Stars*, which is neareſt to *Jupiter*, to make its revolution in a very ſhort time, that is, in four and forty hours, or thereabouts, the next to that in three dayes and an half, the third in ſeven dayes, and the moſt remote in ſixteen. And this rate holdeth well enough, nor will it at all alter, whileſt we aſſign the motion of 24 hours to the Terreſtrial Globe, for it to move round its own center in that time; but if you would have the Earth immoveable, it is neceſſary, that when you have paſt from the ſhort period of the Moon, to the others ſucceſſively bigger, until you come to that of *Mars* in two years, and from thence to that of the bigger Sphere of *Jupiter* in twelve years, and from

A third confirmation of the ſame Doctrine.

The greater Orbs make their converſions in greater times.

The times of the Medicean *Planets converſions.*

from this to the other yet bigger of *Saturn*, whoſe period is of thirty years, it is neceſſary, I ſay, that you paſſe to another Sphere incomparably greater ſtill than that, and make this to accompliſh an entire revolution in twenty four hours. And this yet is the leaſt diſorder that can follow. For if any one ſhould paſſe from the Sphere of *Saturn* to the Starry Orb, and make it ſo much bigger than that of *Saturn*, as proportion would require, in reſpect of its very ſlow motion, of many thouſands of years, then it muſt needs be a *Salt* much more abſurd, to skip from this to another bigger, and to make it convertible in twenty four hours. But the motion of the Earth being granted, the order of the periods will be exactly obſerved, and from the very ſlow Sphere of *Saturn*, we come to the fixed Stars, which are wholly immoveable, and ſo avoid a fourth difficulty, which we muſt of neceſſity admit, if the Starry Sphere be ſuppoſed moveable, and that is the immenſe diſparity between the motions of thoſe ſtars themſelves; of which ſome would come to move moſt ſwiftly in moſt vaſt circles, others moſt ſlowly in circles very ſmall, according as thoſe or theſe ſhould be found nearer, or more remote from the Poles; which ſtill is accompanied with an inconvenience, as well becauſe we ſee thoſe, of whoſe motion there is no queſtion to be made, to move all in very immenſe circles; as alſo, becauſe it ſeems to be an act done with no good conſideration, to conſtitute bodies, that are deſigned to move circularly, at immenſe diſtances from the centre, and afterwards to make them move in very ſmall circles. And not onely the magnitudes of the circles, and conſequently the velocity of the motions of theſe Stars, ſhall be moſt different from the circles and motions of thoſe others, but (which ſhall be the fifth inconvenience) the ſelf-ſame Stars ſhall ſucceſſively vary its circles and velocities: For that thoſe, which two thouſand years ſince were in the Equinoctial, and conſequently did with their motion deſcribe very vaſt circles, being in our dayes many degrees diſtant from thence, muſt of neceſſity become more ſlow of motion, and be reduced to move in leſſer circles, and it is not altogether impoſſible but that a time may come, in which ſome of them which in aforetime had continually moved, ſhall be reduced by uniting with the Pole, to a ſtate of reſt, and then after ſome time of ceſſation, ſhall return to their motion again; whereas the other Stars, touching whoſe motion none ſtand in doubt, do all deſcribe, as hath been ſaid, the great circle of their Orb, and in that maintain themſelves without any variation. The abſurdity is farther enlarged (which let be the ſixth inconvenience) to him that more ſeriouſly examineth the thing, in that no thought can comprehend what ought to be the ſolidity of that immenſe Sphere, whoſe depth ſo ſtedfaſtly holdeth

The motion of 24 hours aſcribed to the higheſt Sphere diſorders the period of the inferiour.

The fourth Confirmation.

Great diſparity amongſt the motions of the particular fixed ſtars, if their Sphere be moveable.

The fifth Confirmation.

The motions of the fixed ſtars would accelerate and grow ſlow in divers times, if the ſtarry Sphere were moveable.

The ſixth Confirmation.

holdeth faſt ſuch a multitude of Stars, which without ever changing ſite among themſelves, are with ſo much concord carried about, with ſo great diſparity of motions. Or elſe, ſuppoſing the Heavens to be fluid, as we are with more reaſon to believe, ſo as that every Star wandereth to and fro in it, by wayes of its own, what rules ſhall regulate their motions, and to what purpoſe, ſo, as that being beheld from the Earth, they appear as if they were made by one onely Sphere? It is my opinion, that they might ſo much more eaſily do that, and in a more commodious manner, by being conſtituted immoveable, than by being made errant, by how much more facile it is to number the quarries in the Pavement of a *Piazza*, than the rout of boyes which run up and down upon them. And laſtly, which is the ſeventh inſtance, if we atribute the Diurnal Motion to the higheſt Heaven, it muſt be conſtituted of ſuch a force and efficacy, as to carry along with it the innumerable multitude of fixed Stars, Bodies all of vaſt magnitude, and far bigger than the Earth; and moreover all the Spheres of the Planets; notwithſtanding that both theſe and thoſe of their own nature move the contrary way. And beſides all this, it muſt be granted, that alſo the Element of Fire, and the greater part of the Air, are likewiſe forcibly hurried along with the reſt, and that the ſole little Globe of the Earth pertinaciouſly ſtands ſtill, and unmoved againſt ſuch an impulſe; a thing, which in my thinking, is very difficult; nor can I ſee how the Earth, a pendent body, and equilibrated upon its centre, expoſed indifferently to either motion or reſt, and environed with a liquid *ambient*, ſhould not yield alſo as the reſt, and be carried about. But we find none of theſe obſtacles in making the Earth to move; a ſmall body, and inſenſible, compared to the Univerſe, and therefore unable to offer it any violence.

The Seventh Confirmation.

The Earth a pendent Body, and equilibrated in a fluid Medium *ſeems unable to reſiſt the rapture of the Diurnal Motion.*

SAGR. I find my fancy diſturbed with certain conjectures ſo confuſedly ſprung from your later diſcourſes; that, if I would be enabled to apply my ſelf with atention to what followeth, I muſt of neceſſity attempt whether I can better methodize them, and gather thence their true conſtruction, if haply any can be made of them; and peradventure, the proceeding by interrogations may help me the more eaſily to expreſſe my ſelf. Therefore I demand firſt of *Simplicius*, whether he believeth, that divers motions may naturally agree to one and the ſame moveable body, or elſe that it be requiſite its natural and proper motion be onely one.

SIMPL. To one ſingle moveable, there can naturally agree but one ſole motion, and no more; the reſt all happen accidentally and by participation; like as to him that walketh upon the Deck of a Ship, his proper motion is that of his walk, his motion by participation that which carrieth him to his Port, whither he would

A ſingle moveable hath but onely one natural motion, and all the reſt are by participation.

would never with his walking have arrived, if the Ship with its motion had not wafted him thither.

SAGR. Tell me ſecondly. That motion, which is communicated to any moveable by participation, whileſt it moveth by it ſelf, with another motion different from the participated, is it neceſſary, that it do reſide in ſome certain ſubject by it ſelf, or elſe can it ſubſiſt in nature alone, without other ſupport.

Motion cannot be made without its moveable ſubject.

SIMPL. *Ariſtotle* giveth you an anſwer to all theſe queſtions, and tels you, that as of one ſole moveable the motion is but one; ſo of one ſole motion the moveable is but one; and conſequently, that without the inherence in its ſubject, no motion can either ſubſiſt, or be imagined.

SAGR. I would have you tell me in the third place, whether you beblieve that the Moon and the other Planets and Cœleſtial bodies, have their proper motions, and what they are.

SIMPL. They have ſo, and they be thoſe according to which they run through the Zodiack, the Moon in a Moneth, the Sun in a Year, *Mars* in two, the Starry Sphere in thoſe ſo many thouſand. And theſe are their proper, or natural motions.

SAGR. But that motion wherewith I ſee the fixed Stars, and with them all the Planets go unitedly from Eaſt to Weſt, and return round to the Eaſt again in twenty four hours, how doth it agree with them?

SIMPL. It ſuiteth with them by participation.

SAGR. This then reſides not in them, and not reſiding in them, nor being able to ſubſiſt without ſome ſubject in which it is reſident, it muſt of force be the proper and natural motion of ſome other Sphere.

SIMPL. For this purpoſe Aſtronomers, and Philoſophers have found another high Sphere, above all the reſt, without Stars, to which Natural agreeth the Diurnal Motion; and this they call the *Primum mobile*; the which carrieth along with it all the inferiour Spheres, contributing and imparting its motion to them.

SAGR. But when, without introducing other Spheres unknown and hugely vaſt, without other motions or communicated raptures, with leaving to each Sphere its ſole and ſimple motion, without intermixing contrary motions, but making all turn one way, as it is neceſſary that they do, depending all upon one ſole principle, all things proceed orderly, and correſpond with moſt perfect harmony, why do we reject this *Phœnomenon*, and give our aſſent to thoſe prodigious and laborious conditions?

SIMPL. The difficulty lyeth in finding out this ſo natural and expeditious way.

SAGR.

SAGR. In my judgment this is found. Make the Earth the *Primum mobile*, that is, make it turn round its own *axis* in twenty four hours, and towards the ſame point with all the other Spheres; and without participating this ſame motion to any other Planet or Star, all ſhall have their riſings, ſettings, and in a word, all their other appearances.

SIMPL. The buſineſs is, to be able to make the Earth move without athouſand inconveniences.

SALV. All the inconveniences ſhall be removed as faſt as you propound them: and the things ſpoken hitherto are onely the primary and more general inducements which give us to believe that the diurnal converſion may not altogether without probability be applyed to the Earth, rather than to all the reſt of the Univerſe: the which inducements I impoſe not upon you as inviolable Axioms, but as hints, which carry with them ſomewhat of likelihood. And in regard I know very well, that one ſole experiment, or concludent demonſtration, produced on the contrary part, ſufficeth to batter to the ground theſe and a thouſand other probable Arguments; therefore it is not fit to ſtay here, but proceed forwards and hear what *Simplicius* anſwereth, and what greater probabilities, or ſtronger arguments he alledgeth on the contrary.

One ſingle experiment, or ſound demonſtration batereth down all arguments meerly probable.

SIMPL. I will firſt ſay ſomething in general upon all theſe conſiderations together, and then I will deſcend to ſome particulars. It ſeems that you univerſally bottom all you ſay upon the greater ſimplicity and facility of producing the ſame effects, whilſt you hold, that as to the cauſing of them, the motion of the Earth alone, ſerveth *as well* as that of all the reſt of the World, the Earth deducted: but as to the operations, you eſteem that much eaſier than this. To which I reply, that I am alſo of the ſame opinion, ſo long as I regard my own not onely finite, but feeble power; but having a reſpect to the ſtrength of the *Mover*, which is infinite, its no leſſe eaſie to move the Univerſe, than the Earth, yea than a ſtraw. And if his power be infinite, why ſhould he not rather exerciſe a greater part thereof than a leſſe? Therefore, I hold that your diſcourſe in general is not convincing.

Of an infinite power one would think a greater part ſhould rather be imploy'd than a leſſe.

SALV. If I had at any time ſaid, that the Univerſe moved not for want of power in the *Mover*, I ſhould have erred, and your reproof would have been ſeaſonable; and I grant you, that to an infinite power, it is as eaſie to move an hundred thouſand, as one. But that which I did ſay, concerns not the Mover, but onely hath reſpect to the Moveables; and in them, not onely to their reſiſtance, which doubtleſſe is leſſer in the Earth, than in the Univerſe; but to the many other particulars, but even now conſidered. As to what you ſay in the next place, that of an infinite power it is better to exerciſe a great part than a ſmall: I an-

ſwer, that of infinite one part is not greater than another, ſince both are infinite; nor can it be ſaid, that of the infinite number, an hundred thouſand is a greater part than two, though that be fifty thouſand times greater than this; and if to the moving of the Univerſe there be required a finite power, though very great in compariſon of that which ſufficeth to move the Earth onely; yet is there not implied therein a greater part of the infinite power, nor is that part leſſe infinite which remaineth unimploy'd. So that to apply unto a particular effect, a little more, or a little leſſe power, importeth nothing; beſides that the operation of ſuch vertue, hath not for its bound or end the Diurnal Motion onely; but there are ſeveral other motions in the World, which we know of, and many others there may be, that are to us unknown: Therefore if we reſpect the Moveables, and granting it as out of queſtion, that it is a ſhorter and eaſier way to move the Earth, than the Univerſe; and moreover, having an eye to the ſo many other abreviations, and facilities that onely this way are to be obtained, an infallible Maxime of *Ariſtotle*, which he teacheth us, that, *fruſtra fit per plura, quod poteſt fieri per pauciora*, rendereth it more probable that the Diurnal Motion belongs to the Earth alone; than to the Univerſe, the Earth ſubducted.

Of infinity, one part is no bigger than another, although they are comparatively unequal.

SIMPL. In reciting that Axiom, you have omitted a ſmall clauſe, which importeth as much as all the reſt, eſpecially in our caſe, that is to ſay, the words *æquè bene*. It is requiſite therefore to examine whether this *Hypotheſis* doth *equally well* ſatisfie in all particulars, as the other.

SALV. The knowledg whether both theſe poſitions do *æquè bene*, ſatisfie, may be comprehended from the particular examination of the appearances which they are to ſatisfie; for hitherto we have diſcourſed; and will continue to argue *ex hypotheſi*, namely, ſuppoſing, that as to the ſatisfaction of the appearances, both the aſſumptions are equally accomodated. As to the clauſe which you ſay was omitted by me, I have more reaſon to ſuſpect that it was ſuperfluouſly inſerted by you. For the expreſſion *æquè bene*, is a relative that neceſſarily requireth two terms at leaſt; for a thing cannot have relation to its ſelf, nor do we ſay, *v. gr.* reſt to be *equally good*, as reſt. And becauſe, when we ſay, *that is done in vain by many means, which may be done with fewer*, we mean, that that which is to be done, ought to be the ſame thing, not two different ones; and becauſe the ſame thing cannot be ſaid to be done as well as its ſelf; therefore, the addition of the Phraſe *æquè bene* is ſuperfluous, and a relation, that hath but one term onely.

In the Axiome Fruſtra fit per plura, &c. *the addition of* æque benè, *is ſuperfluous.*

SAGR. Unleſſe you will have the ſame befal us, as did yeſterday, let us return to our matter in hand; and let *Simplicius* begin

gin to produce those difficulties that seem in his opinion, to thwart this new disposition of the World.

SIMPL. That disposition is not new, but very old; and that you may see it is so, *Aristotle* confuteth it; and his confutations are these: "First if the Earth moveth either in it self about its "own Centre, or in an Excentrick Circle, it is necessary that that "same motion be violent; for it is not its natural motion, for "if it were, each of its parts would partake thereof; but each "of them moveth in a right line towards its Centre. It being "therefore violent and pteternatural, it could never be perpetu- "al: But the order of the World is perpetual. Therefore, *&c.* "Secondly, all the other moveables that move circularly, seem "to *stay behind, and to move with more than one motion, the "*Primum Mobile* excepted: Whence it would be necessary that "the Earth also do move with two motions; and if that should "be so, it would inevitably follow, that mutations should be "made in the Fixed Stars, the which none do perceive; nay "without any variation, the same Stars alwayes rise from towards "the same places, and in the same places do set. Thirdly, the mo- "tion of the parts is the same with that of the whole, and natural- "ly tendeth towards the Centre of the Universe; and for the same "cause rest, being arrived thither. He thereupon moves the que- "stion whether the motion of the parts hath a tendency to the "centre of the Universe, or to the centre of the Earth; and conclu- "deth that it goeth by proper instinct to the centre of the Universe, "and *per accidence* to that of the Earth; of which point we largely "discoursed yesterday. He lastly confirmeth the same with a fourth "argument taken from the experiment of grave bodies, which fal- "ing from on high, descend perpendicularly unto the Earths surface; "and in the same manner *Projections* shot perpendicularly upwards, "do by the same lines return perpendicularly down again, though "they were shot to a very great height. All which arguments neces- "sarily prove their motion to be towards the Centre of the Earth, "which without moving at all waits for, and receiveth them. He "intimateth in the last place that the Astronomers alledg other "reasons in confirmation of the same conclusions, I mean of the "Earths being in the Centre of the Universe, and immoveable; "and instanceth onely in one of them, to wit, that all the *Phæ-* "*nomena* or appearances that are seen in the motions of the Stars, "perfectly agree with the position of the Earth in the Centre; "which would not be so, were the Earth seated otherwise. "The rest produced by *Ptolomy* and the other Astronomers, I can "give you now if you please, or after you have spoken what you "have to say in answer to these of *Aristotle*.

Aristotles *Arguments for the Earths quiescence.*

* *Restimo indietro*, which is meant here of that motion which a bowl makes when it's born by its byas to one side or other, and so hindered in its direct motion.

SALV. The arguments which are brought upon this occasion

Two kindes of Arguments touching the Earths motion or reſt.

are of two kinds: ſome have reſpect to the accidents Terreſtrial, without any relation to the Stars, and others are taken from the *Phænomena* and obſervations of things Cœleſtial. The arguments of *Ariſtotle* are for the moſt part taken from things neer at hand, and he leaveth the others to *Aſtronomers*; and therefore it is the beſt way, if you like of it, to examine theſe taken from experiments touching the Earth, and then proceed to thoſe of the other kind. And becauſe *Ptolomy*, *Tycho*, and the other *Aſtronomers* and *Philoſophers*, beſides the arguments of *Ariſtotle* by them aſſumed, confirmed, and made good, do produce certain others; we will put them all together, that ſo we may not anſwer twice to the ſame, or the like objections. Therefore *Simplicius*, chooſe whether you will recite them your ſelf, or cauſe me to eaſe you of this task, for I am ready to ſerve you.

Arguments of Ptolomy *and* Tycho, *and other perſons, over and above thoſe of* Ariſtotle.

SIMPL. It is better that you quote them, becauſe, as having taken more pains in the ſtudy of them, you can produce them with more readineſſe, and in greater number.

The firſt argument taken from grave bodies falling from on high to the ground.

SALV. All, for the ſtrongeſt reaſon, alledge that of grave bodies, which falling downwards from on high, move by a right line, that is perpendicular to the ſurface of the Earth, an argument which is held undeniably to prove that the Earth is immoveable: for in caſe it ſhould have the diurnal motion, a Tower, from the top of which a ſtone is let fall, being carried along by the converſion of the Earth, in the time that the ſtone ſpends in falling, would be tranſported many hundred yards Eaſtward, and ſo far diſtant from the Towers foot would the ſtone come to ground. The which effect they back with another experiment; to wit, by letting a bullet of lead fall from the round top of a Ship, that lieth at anchor, and obſerving the mark it makes where it lights, which they find to be neer the * partners of the Maſt; but if the ſame bullet be let fall from the ſame place when the ſhip is under ſail, it ſhall light as far from the former place, as the ſhip hath run in the time of the leads deſcent; and this for no other reaſon, than becauſe the natural motion of the ball being at liberty is by a right line towards the centre of the Earth. They fortifie this argument with the experiment of a projection ſhot on high at a very great diſtance; as for example, a ball ſent out of a Cannon, erected perpendicular to the horizon, the which ſpendeth ſo much time in aſcending and falling, that in our parallel the Cannon and we both ſhould be carried by the Earth many miles towards the Eaſt, ſo that the ball in its return could never come neer the Peece, but would fall as far Weſt, as the Earth had run Eaſt. They againe adde a third, and very evident experiment, *ſcilicet*, that ſhooting a bullet point blank (or as Gunners ſay, neither above nor under metal) out of a Culverin towards the Eaſt, and afterwards another, with

Which is confirmed by the experiment of a body let fall from the round top of a Ship.

* That is, at the foot of the Maſt, upon the upper deck.

The ſecond argument taken from a Projection ſhot very high.

The third argument taken from the ſhots of a Cannon, towards the Eaſt, and towards the Weſt.

with the ſame charge, and at the ſame elevation or diſport towards the Weſt, the range towards the Weſt ſhould be very much greater then the other towards the Eaſt: for that whil'ſt the ball goeth Weſtward, and the Peece is carried along by the Earth Eaſtward, the ball will fall from the Peece as far diſtant as is the aggregate of the two motions, one made by it ſelf towards the Weſt; and the other by the Peece carried about by the Earth towards the Eaſt; and on the contrary, from the range of the ball ſhot Eaſtward you are to ſubſtract the ſpace the Peece moved, being carried after it. Now ſuppoſe, for example, that the range of the ball ſhot Weſt were five miles, and that the Earth in the ſame parallel and in the time of the Bals ranging ſhould remove three miles, the Ball in this caſe would fall eight miles diſtant from the Culverin, namely, its own five Weſtward, and the Culverins three miles Eaſtward: but the range of the ſhot towards the Eaſt would be but two miles long, for ſo much is the remainder, after you have ſubſtracted from the five miles of the range, the three miles which the Peece had moved towards the ſame part. But experience ſheweth the Ranges to be equal, therefore the Culverin, and conſequently the Earth are immoveable. And the ſtability of the Earth is no leſſe confirmed by two other ſhots made North and South; for they would never hit the mark, but the Ranges would be alwayes wide, or towards the Weſt, by meanes of the remove the mark would make, being carried along with the Earth towards the Eaſt, whil'ſt the ball is flying. And not onely ſhots made by the Meridians, but alſo thoſe aimed Eaſt or Weſt would prove uncertain; for thoſe aim'd Eaſt would be too high, and thoſe directed Weſt too low, although they were ſhot point blank, as I ſaid. For the Range of the Ball in both the ſhots being made by the Tangent, that is, by a line parallel to the Horizon, and being that in the diurnal motion, if it be of the Earth, the Horizon goeth continually deſcending towards the Eaſt, and riſing from the Weſt (therefore the Oriental Stars ſeem to riſe, and the Occidental to decline) ſo that the Oriental mark would deſcend below the aime, and thereupon the ſhot would fly too high, and the aſcending of the Weſtern mark would make the ſhot aimed that way range too low; ſo that the Peece would never carry true towards any point; and for that experience telleth us the contrary, it is requiſite to ſay, that the Earth is immoveable.

This argument is confirmed by two ſhots towards the South and towards the North.

And it is likewiſe confirmed by two ſhots towards the Eaſt, and towards the Weſt.

SIMPL. Theſe are ſolid reaſons, and ſuch as I believe no man can anſwer.

SALV. Perhaps they are new to you?

SIMPL. Really they are; and now I ſee with how many admirable experiments Nature is pleaſed to favour us, wherewith to aſſiſt us in the knowledge of the Truth. Oh! how exactly one truth

truth agreeth with another, and all conſpire to render each other inexpugnable!

SAGR. What pity it is that Guns were not uſed in *Ariſtotles* age, he would with help of them have eaſily battered down ignorance, and ſpoke without hæſitation of theſe mundane points.

SALV. I am very glad that theſe reaſons are new unto you, that ſo you may not reſt in the opinion of the *major* part of *Peripateticks*, who believe, that if any one forſakes the Doctrine of *Ariſtotle*, it is becauſe they did not underſtand or rightly apprehend his demonſtrations. But you may expect to hear of other Novelties, and you ſhall ſee the followers of this new Syſteme produce againſt themſelves obſervations, experiences, and reaſons of farre greater force than thoſe alledged by *Ariſtotle*, *Ptolomy*, and other oppoſers of the ſame concluſions, and by this means you ſhall come to aſcertain your ſelf that they were not induced through want of knowledge or experience to follow that opinion.

Copernicus his followers are not moved through ignorance of the arguments on the other part.

SAGR. It is requiſite that upon this occaſion I relate unto you ſome accidents that befell me, ſo ſoon as I firſt began to hear ſpeak of this new doctrine. Being very young, and having ſcarcely finiſhed my courſe of Philoſophy, which I left off, as being ſet upon other employments, there chanced to come into theſe parts a certain Foreigner of *Roſtock*, whoſe name, as I remember, was *Chriſtianus Vurſtitius*, a follower of *Copernicus*, who in an *Academy* made two or three Lectures upon this point, to whom many flock't as Auditors; but I thinking they went more for the novelty of the ſubject than otherwiſe, did not go to hear him: for I had concluded with my ſelf that that opinion could be no other than a ſolemn madneſſe. And queſtioning ſome of thoſe who had been there, I perceived they all made a jeſt thereof, except one, who told me that the buſineſſe was not altogether to be laugh't at, and becauſe this man was reputed by me to be very intelligent and wary, I repented that I was not there, and began from that time forward as oft as I met with any one of the *Copernican* perſwaſion, to demand of them, if they had been alwayes of the ſame judgment; and of as many as I examined, I found not ſo much as one, who told me not that he had been a long time of the contrary opinion, but to have changed it for this, as convinced by the ſtrength of the reaſons proving the ſame: and afterwards queſtioning them, one by one, to ſee whether they were well poſſeſt of the reaſons of the other ſide; I found them all to be very ready and perfect in them; ſo that I could not truly ſay, that they had took up this opinion out of ignorance, vanity, or to ſhew the acuteneſſe of their wits. On the contrary, of as many of the *Peripateticks* and *Ptolomeans* as I have asked (and out of curioſity I have talked with many) what pains they had taken in the Book of *Copernicus*, I found very few

Chriſtianus Vurſtitius *read certain Lectures touching the opinion of* Copernicus, *& what enſued thereupon.*

The followers of Copernicus *were all firſt againſt that opinion, but the Sectators of* Ariſtotle *&* Ptolomy, *were never of the other ſide.*

few that had ſo much as ſuperficially peruſed it; but of thoſe whom, I thought, had underſtood the ſame, not one; and moreover, I have enquired amongſt the followers of the *Peripatetick* Doctrine, if ever any of them had held the contrary opinion, and likewiſe found none that had. Whereupon conſidering that there was no man who followed the opinion of *Copernicus*, that had not been firſt on the contrary ſide, and that was not very well acquainted with the reaſons of *Ariſtotle* and *Ptolomy*; and, on the contrary, that there is not one of the followers of *Ptolomy* that had ever been of the judgment of *Copernicus*, and had left that, to imbrace this of *Ariſtotle*, conſidering, I ſay, theſe things, I began to think, that one, who leaveth an opinion imbued with his milk, and followed by very many, to take up another owned by very few, and denied by all the Schools, and that really ſeems a very great Paradox, muſt needs have been moved, not to ſay forced, by more powerful reaſons. For this cauſe, I am become very curious to dive, as they ſay, into the bottom of this buſineſſe, and account it my great good fortune that I have met you two, from whom I may without any trouble, hear all that hath been, and, haply, can be ſaid on this argument, aſſuring my ſelf that the ſtrength of your reaſons will reſolve all ſcruples, and bring me to a certainty in this ſubject.

SIMPL. But its poſſible your opinion and hopes may be diſappointed, and that you may find your ſelves more at a loſſe in the end than you was at firſt.

SAGR. I am very confident that this can in no wiſe befal me.

SIMPL. And why not? I have a manifeſt example in my ſelf, that the farther I go, the more I am confounded.

SAGR. This is a ſign that thoſe reaſons that hitherto ſeemed concluding unto you, and aſſured you in the truth of your opinion, begin to change countenance in your mind, and to let you by degrees, if not imbrace, at leaſt look towards the contrary tenent; but I, that have been hitherto indifferent, do greatly hope to acquire reſt and ſatisfaction by our future diſcourſes, and you will not deny but I may, if you pleaſe but to hear what perſwadeth me to this expectation.

SIMPL. I will gladly hearken to the ſame, and ſhould be no leſſe glad that the like effect might be wrought in me.

SAGR. Favour me therefore with anſwering to what I ſhall ask you. And firſt, tell me, *Simplicius*, is not the concluſion, which we ſeek the truth of, Whether we ought to hold with *Ariſtotle* and *Ptolomy*, that the Earth onely abiding without motion in the Centre of the Univerſe, the Cœleſtial bodies all move, or elſe, Whether the Starry Sphere and the Sun ſtanding ſtill in the Centre, the

the Earth is without the ſame, and owner of all thoſe motions that in our ſeeming belong to the Sun and fixed Stars?

SIMPL. Theſe are the concluſions which are in diſpute.

SAGR. And theſe two concluſions, are they not of ſuch a nature, that one of them muſt neceſſarily be true, and the other falſe?

SIMPL. They are ſo. We are in a *Dilemma*, one part of which muſt of neceſſity be true, and the other untrue; for between Motion and Reſt, which are contradictories, there cannot be inſtanced a third, ſo as that one cannot ſay the Earth moves not, nor ſtands ſtill; the Sun and Stars do not move, and yet ſtand not ſtill.

SAGR. The Earth, the Sun, and Stars, what things are they in nature? are they petite things not worth our notice, or grand and worthy of conſideration?

SIMPL. They are principal, noble, integral bodies of the Univerſe, moſt vaſt and conſiderable.

SAGR. And Motion, and Reſt, what accidents are they in Nature?

Motion and reſt principal accidents in nature.

SIMPL. So great and principal, that Nature her ſelf is defined by them.

SAGR. So that moving eternally, and the being wholly immoveable are two conditions very conſiderable in Nature, and indicate very great diverſity; and eſpecially when aſcribed to the principal bodies of the Univerſe, from which can enſue none but very different events.

SIMPL. Yea doubtleſſe.

SAGR. Now anſwer me to another point. Do you believe that in *Logick*, *Rhetorick*, the *Phyſicks*, *Metaphyſicks*, *Mathematicks*, and finally, in the univerſality of Diſputations there are arguments ſufficient to perſwade and demonſtrate to a perſon the fallacious, no leſſe then the true concluſions?

Untruths cannot be demonſtrated, as Truths are.

For proof of true concluſions, many ſolid arguments may be produced, but to prove a falſity, none.

SIMPL. No Sir; rather I am very confident and certain, that for the proving of a true and neceſſary concluſion, there are in nature not onely one, but many very powerfull demonſtrations: and that one may diſcuſſe and handle the ſame divers and ſundry wayes, without ever falling into any abſurdity; and that the more any Sophiſt would diſturb and muddy it, the more clear would its certainty appear: And that on the contrary to make a falſe poſition paſſe for true, and to perſwade the belief thereof, there cannot be any thing produced but fallacies, Sophiſms, Paralogiſmes, Equivocations, and Diſcourſes vain, inconſiſtant, and full of repugnances and contradictions.

SAGR. Now if eternal motion, and eternal reſt be ſo principal accidents of Nature, and ſo different, that there can depend on them only moſt different conſequences, and eſpecially when applied

applyed to the Sun, and to the Earth, ſo vaſt and famous bodies of the Univerſe; and it being, moreover, impoſſible, that one of two contradictory Propoſitions, ſhould not be true, and the other falſe; and that for proof of the falſe one, any thing can be produced but fallacies; but the true one being perſwadeable by all kind of concluding and demonſtrative arguments, why ſhould you think that he, of you two, who ſhall be ſo fortunate as to maintain the true Propoſition ought not to perſwade me? You muſt ſuppoſe me to be of a ſtupid wit, perverſe judgment, dull mind and intellect, and of a blind reaſon, that I ſhould not be able to diſtinguiſh light from darkneſſe, jewels from coals, or truth from falſhood.

SIMPL. I tell you now, and have told you upon other occaſions, that the beſt Maſter to teach us how to diſcern Sophiſmes, Paralogiſmes, and other fallacies, was *Ariſtotle*, who in this particular can never be deceived.

SAGR. You inſiſt upon *Ariſtotle*, who cannot ſpeak. Yet I tell you, that if *Ariſtotle* were here, he would either yield himſelf to be perſwaded by us, or refuting our arguments, convince us by better of his own. And you your ſelf, when you heard the experiments of the Suns related, did you not acknowledg and admire them, and confeſſe them more concludent than thoſe of *Ariſtotle*? Yet nevertheleſſe I cannot perceive that *Salviatus*, who hath produced them, examined them, and with exquiſite care ſcan'd them, doth confeſſe himſelf perſwaded by them; no nor by others of greater force, which he intimated that he was about to give us an account of. And I know not on what grounds you ſhould cenſure Nature, as one that for many Ages hath been lazie, and forgetful to produce ſpeculative *wits*; and that knoweth not how to make more ſuch, unleſſe they be ſuch kind of men as ſlaviſhly giving up their judgments to *Ariſtotle*, do underſtand with his brain, and reſent with his ſenſes. But let us hear the reſidue of thoſe reaſons which favour his opinion, that we may thereupon proceed to ſpeak to them; comparing and weighing them in the ballance of impartiality.

Ariſtotle would either refute his adverſaries arguments, or would alter his opinion.

SALV. Before I proceed any farther, I muſt tell *Sagredus*, that in theſe our Diſputations, I perſonate the *Copernican*, and imitate him, as if I were his *Zany*; but what hath been effected in my private thoughts by theſe arguments which I ſeem to alledg in his favour, I would not have you to judg by what I ſay, whil'ſt I am in the heat of acting my part in the Fable; but after I have laid by my diſguiſe, for you may chance to find me different from what you ſee me upon the Stage. Now let us go on.

Ptolomy and his followers produce another experiment like to that of the Projections, and it is of things that being ſeparated

An argument taken from the Clouds, and from Birds.

from the Earth, continue a good ſpace of time in the Air, ſuch as are the Clouds, Birds of flight; and as of them it cannot be ſaid that they are rapt or tranſparted by the Earth, having no adheſion thereto, it ſeems not poſſible, that they ſhould be able to keep pace with the velocity thereof; nay it ſhould rather ſeem to us, that they all ſwiftly move towards the Weſt: And if being carried about by the Earth, paſſe our parallel in twenty four hours, which yet is at leaſt ſixteen thouſand miles, how can Birds follow ſuch a courſe or revolution? Whereas on the contrary, we ſee them fly as well towards the Eaſt, as towards the Weſt, or any other part, without any ſenſible difference. Moreover, if when we run a Horſe at his ſpeed, we feel the air beat vehemently againſt our face, what an impetuous blaſt ought we perpetually to feel from the Eaſt, being carried with ſo rapid a courſe againſt the wind? and yet no ſuch effect is perceived. Take another very ingenious argument inferred from the following experiment. The circular motion hath a faculty to extrude and diſſipate from its Centre the parts of the moving body, whenſoever either the motion is not very ſlow, or thoſe parts are not very well faſtened together; and therefore, if *v. g.* we ſhould turn one of thoſe great wheels very faſt about, wherein one or more men walking, crane up very great weights, as the huge maſſie ſtone, uſed by the Callander for preſſing of Cloaths; or the fraighted Barks which being haled on ſhore, are hoiſted out of one river into another; in caſe the parts of that ſame Wheel ſo ſwiftly turn'd round, be not very well joyn'd and pin'd together, they would all be ſhattered to pieces; and though many ſtones or other ponderous ſubſtances, ſhould be very faſt bound to its outward Rimme, yet could they not reſiſt the impetuoſity, which with great violence would hurl them every way far from the Wheel, and conſequently from its Centre. So that if the Earth did move with ſuch and ſo much greater velocity, what gravity, what tenacity of lime or plaiſter would keep together Stones, Buildings, and whole Cities, that they ſhould not be toſt into the Air by ſo precipitous a motion? And both men and beaſts, which are not faſtened to the Earth, how could they reſiſt ſo great an *impetus*? Whereas, on the other ſide, we ſee both theſe, and far leſſe reſiſtances of pebles, ſands, leaves reſt quietly on the Earth, and to return to it in falling, though with a very ſlow motion. See here, *Simplicius*, the moſt potent arguments, taken, to ſo ſpeak, from things Terreſtrial; there remain thoſe of the other kind, namely, ſuch [illegible] have relation to the appearances of Heaven, which reaſons, to confeſſe the truth, tend more to prove the Earth to be in the centre of the Univerſe, and conſequently, to deprive it of the annual motion about the ſame, aſcribed unto it by

An argument taken from the air which we feel to beat upon us when we run a Horſe at full ſpeed.

An argument taken from the whirling of circular motion, which hath a faculty to extrude and diſſipate.

by *Copernicus*. Which arguments, as being of somewhat a different nature, may be produced, after we have examined the strength of these already propounded.

SAGR. What say you *Simplicius*? do you think that *Salviatus* is Master of, and knoweth how to unfold the *Ptolomean* and *Aristotelian* arguments? Or do you think that any *Peripatetick* is equally verst in the *Copernican* demonstrations?

SIMPL. Were it not for the high esteem, that the past discourses have begot in me of the learning of *Salviatus*, and of the acuteness of *Sagredus*, I would by their good leave have gone my way without staying for their answers; it seeming to me a thing impossible, that so palpable experiments should be contradicted; and would, without hearing them farther, confirm my self in my old perswasion; for though I should be made to see that it was erroneous, its being upheld by so many probable reasons, would render it excuseable. And if these are fallacies, what true demonstrations were ever so fair?

SAGR. Yet its good that we hear the responsions of *Salviatus*; which if they be true, must of necessity be more fair, and that by infinite degrees; and those must be deformed, yea most deformed, if the Metaphysical Axiome hold, That true and fair are one and the same thing; as also false and deformed. Therefore *Salviatus* let's no longer lose time.

True and fair are one and the same, as also false and deformed.

SALV. The first Argument alledged by *Simplicius*, if I well remember it, was this. The Earth cannot move circularly, because such motion would be violent to the same, and therefore not perpetual: that it is violent, the reason was: Because, that had it been natural, its parts would likewise naturally move round, which is impossible, for that it is natural for the parts thereof to move with a right motion downwards. To this my reply is, that I could gladly wish, that *Aristotle* had more cleerly expresst himself, where he said; That its parts would likewise move circularly; for this moving circularly is to be understood two wayes, one is, that every particle or atome separated from its *Whole* would move circularly about its particular centre, describing its small Circulets; the other is, that the whole Globe moving about its centre in twenty four hours, the parts also would turn about the same centre in four and twenty hours. The first would be no lesse an impertinency, than if one should say, that every part of the circumference of a Circle ought to be a Circle; or because that the Earth is Spherical, that therefore every part thereof be a Globe, for so doth the *Axiome* require: *Eadem est ratio totius, & partium.* But if he took it in the other sense, to wit, that the parts in imitation of the *Whole* should move naturally round the Centre of the whole Globe in twenty four hours, I say, that they do so; and it concerns you,

The answer to Aristotles first argument.

inſtead of *Ariſtotle*, to prove that they do not.

SIMPL. This is proved by *Ariſtotle* in the ſame place, when he ſaith, that the natural motion of the parts is the right motion downwards to the centre of the Univerſe; ſo that the circular motion cannot naturally agree therewith.

SALV. But do not you ſee, that thoſe very words carry in them a confutation of this ſolution?

SIMPL. How? and where?

SALV. Doth not he ſay that the circular motion of the Earth would be violent? and therefore not eternal? and that this is abſurd, for that the order of the World is eternal?

SIMPL. He ſaith ſo.

That which is violent, cannot be eternal, and that which cannot be eternal, cannot be natural.

SALV. But if that which is violent cannot be eternal, then by converſion, that which cannot be eternal, cannot be natural: but the motion of the Earth downwards cannot be otherwiſe eternal; therefore much leſſe can it be natural: nor can any other motion be natural to it, ſave onely that which is eternal. But if we make the Earth move with a circular motion, this may be eternal to it, and to its parts, and therefore natural.

SIMPL. The right motion is moſt natural to the parts of the Earth, and is to them eternal; nor ſhall it ever happen that they move not with a right motion; alwayes provided that the impediments be removed.

SALV. You equivocate *Simplicius*; and I will try to free you from the equivoke. Tell me, therefore, do you think that a Ship which ſhould ſail from the Strait of *Gibralter* towards *Paleſtina* can eternally move towards that Coaſt? keeping alwayes an equal courſe?

SIMPL. No doubtleſſe.

SALV. And why not?

SIMPL. Becauſe that Voyage is bounded and terminated between the *Herculean* Pillars, and the ſhore of the *Holy-land*; and the diſtance being limited, it is paſt in a finite time, unleſſe one by returning back ſhould with a contrary motion begin the ſame Voyage anew; but this would be an interrupted and no continued motion.

SALV. Very true. But the Navigation from the Strait of *Magalanes* by the *Pacifick* Ocean, the *Moluccha's*, the Cape *di buona Speranza*, and from thence by the ſame Strait, and then again by the *Pacifick* Ocean, &c. do you believe that it may be perpetuated?

SIMPL. It may; for this being a circumgyration, which returneth about its ſelf, with infinite replications, it may be perpetuated without any interruption.

SALV. A Ship then may in this Voyage continue ſailing eternally.

SIMPL.

SIMPL. It may, in caſe the Ship were incorruptible, but the Ship decaying, the Navigation muſt of neceſſity come to an end.

SALV. But in the Mediterrane, though the Veſſel were incorruptible, yet could ſhe not ſail perpetually towards *Paleſtina*; that Voyage being determined. Two things then are required, to the end a moveable may without intermiſſion move perpetually; the one is, that the motion may of its own nature be indeterminate and infinite; the other, that the moveable be likewiſe incorruptible and eternal.

Two things requiſite to the end a motion may perpetuate it ſelf; an unlimited ſpace, and an incorruptible moveable.

SIMPL. All this is neceſſary.

SALV. Therefore you may ſee how of your own accord you have confeſſed it impoſſible that any moveable ſhould move eternally in a right line, in regard that right motion, whether it be upwards, or downwards, is by you your ſelf bounded by the circumference and centre; ſo that if a Moveable, as ſuppoſe the Earth be eternal, yet foraſmuch as the right motion is not of its own nature eternall, but moſt * terminate, it cannot naturally ſuit with the Earth. Nay, as was ſaid * yeſterday, *Ariſtotle* himſelf is conſtrained to make the Terreſtrial Globe eternally immoveable. When again you ſay, that the parts of the Earth evermore move downwards, all impediments being removed, you egregiouſly equivocate; for then, on the other ſide they muſt be impeded, contraried, and forced, if you would have them move; for, when they are once fallen to the ground, they muſt be violently thrown upwards, that they may a ſecond time fall; and as to the impediments, theſe only hinder its arrival at the centre; but if there were a *Well*, that did paſſe thorow and beyond the centre, yet would not a clod of Earth paſſe beyond it, unleſſe inaſmuch as being tranſported by its *impetus*, it ſhould paſſe the ſame to return thither again, and in the end there to reſt. As therefore to the defending, that the motion by a right line doth or can agree naturally neither to the Earth, nor to any other moveable, whil'ſt the Univerſe retaineth its perfect order, I would have you take no further paines about it, but (unleſſe you will grant them the circular motion) your beſt way will be to defend and maintain their immobility.

Right motion cannot be eternal, and conſequently cannot be natural to the Earth.

* Terminatiſſimo.

* By this expreſſion he every where means the preceding Dialogue, or *Giornata*.

SIMPL. As to their immoveableneſſe, the arguments of *Ariſtotle*, and moreover thoſe alledged by your ſelf ſeem in my opinion neceſſarily to conclude the ſame, as yet; and I conceive it will be a hard matter to refute them.

SALV. Come we therefore to the ſecond Argument, which was, That thoſe bodies, which we are aſſured do move circularly, have more than one motion, unleſſe it be the *Primum Mobile*; and therefore, if the Earth did move circularly, it ought to have two motions; from which alterations would follow in the riſing and ſetting of the Fixed Stars: Which effect is not perceived to enſue. There-

The anſwer to the ſecond argument.

Therefore, &c. The moſt proper and genuine anſwer to this Allegation is contained in the Argument it ſelf; and even *Ariſtotle* puts it in our mouths, which it is impoſſible, *Simplicius*, that you ſhould not have ſeen.

SIMPL. I neither have ſeen it, nor do I yet apprehend it.

SALV. This cannot be, ſure, the thing is ſo very plain.

SIMPL. I will with your leave, caſt an eye upon the *Text.*

SAGR. We will command the *Text* to be brought forthwith.

SIMPL. I alwayes carry it about with me: See here it is, and I know the place perfectly well, which is in *lib.* 2. *De Cœlo, cap.* 16. Here it is, *Text* 97. *Preterea omnia, quæ feruntur latione circulari ſubdeficere videntur, ac moveri pluribus una latione, præter primam Sphæram; quare & Terram neceſſariam eſt, ſive circa medium, ſive in medio poſita feratur, duabus moveri lationibus. Si autem hoc acciderit, neceſſariam eſt fieri mutationes, ac converſiones fixorum aſtrorum. Hoc autem non videtur fieri, ſed ſemper eadem, apud eadem loca ipſius, & oriuntur, & occidunt.* [In Engliſh thus:] Furthermore all that are carried with circular motion, ſeem to * foreflow, and to move with more than one motion, except the firſt Sphere; wherefore it is neceſſary that the Earth move with two motions, whether it be carried about the * middle, or placed in the middle. But if it be ſo, there would of neceſſity be alterations and converſions made amongſt the fixed Stars. But no ſuch thing is ſeen to be done, but the ſame Star doth alwayes riſe and ſet in the ſame place. In all this I find not any falacy, and my thinks the argument is very forcible.

* Subdeficere.

* Or Centre.

SALV. And this new reading of the place hath confirmed me in the fallacy of the Sillogiſme, and moreover, diſcovered another falſity. Therefore obſerve. The Poſitions, or if you will, Concluſions, which *Ariſtotle* endeavours to oppoſe, are two; one is that of thoſe, who placing the Earth in the midſt of the World, do make it move in it ſelf about its own centre. The other is of thoſe, who conſtituting it far from the middle, do make it revolve with a circular motion about the middle of the Univerſe. And both theſe Poſitions he conjointly impugneth with one and the ſame argument. Now I affirm that he is out in both the one and the other impugnation; and that his error againſt the firſt Poſition is an Equivoke or Paralogiſme; and his miſtake touching the ſecond is a falſe conſequence. Let us begin with the firſt Aſſertion, which conſtituteth the Earth in the midſt of the World, and maketh it move in it ſelf about its own centre; and let us confront it with the objection of *Ariſtotle*; ſaying, All moveables, that move circularly, ſeem to * foreflow, and move with more than one Byas, except the firſt Sphere (that is *the primum*

Ariſtotles *argument againſt the Earths motion, is defective in two things.*

* The ſame word which a little above I rendred ſtay behind, as a bowle when it meets with ruts.

mum mobile) therefore the Earth moving about its own centre, being placed in the middle, muſt of neceſſity have two byaſſes, and foreflow. But if this were ſo, it would follow, that there ſhould be a variation in the riſing and ſetting of the fixed Stars, which we do not perceive to be done: Therefore the Earth doth not move, *&c.* Here is the Paralogiſme, and to diſcover it, I will argue with *Ariſtotle* in this manner. Thou ſaiſt, oh *Ariſtotle*, that the Earth placed in the middle of the World, cannot move in it ſelf (*i. e.* upon its own *axis*) for then it would be requiſite to allow it two byaſſes; ſo that, if it ſhould not be neceſſary to allow it more than one Byas onely, thou wouldeſt not then hold it impoſſible for it to move onely with that one; for thou would'ſt unneceſſarily have confined the impoſſibility to the plurality of byaſſes, if in caſe it had no more but one, yet it could not move with that. And becauſe that of all the moveables in the World, thou makeſt but one alone to move with one ſole byas; and all the reſt with more than one; and this ſame moveable thou affirmeſt to be the firſt Sphere, namely, that by which all the fixed and erratick Stars ſeem harmoniouſly to move from Eaſt to Weſt, if in caſe the Earth may be that firſt Sphere, that by moving with one byas onely, may make the Stars appear to move from Eaſt to Weſt, thou wilt not deny them it: But he that affirmeth, that the Earth being placed in the midſt of the World, moveth about its own Axis, aſcribes unto it no other motion, ſave that by which all the Stars appear to move from Eaſt to Weſt; and ſo it cometh to be that firſt Sphere, which thou thy ſelf acknowledgeſt to move with but one byas onely. It is therefore neceſſary, oh *Ariſtotle*, if thou wilt conclude any thing, that thou demonſtrate, that the Earth being placed in the midſt of the World, cannot move with ſo much as one byas onely; or elſe, that much leſſe can the firſt Sphere have one ſole motion; for otherwiſe thou doeſt in thy very Sillogiſme both commit the falacy, and detect it, denying, and at that very time proving the ſame thing. I come now to the ſecond Poſition, namely, of thoſe who placing the Earth far from the midſt of the Univerſe, make it moveable about the ſame; that is, make it a Planet and erratick Star; againſt which the argument is directed, and as to form is concludent, but faileth in matter. For it being granted, that the Earth doth in that manner move, and that with two byaſſes, yet doth it not neceſſarily follow that though it were ſo, it ſhould make alterations in the riſings and ſettings of the fixed Stars, as I ſhall in its proper place declare. And here I could gladly excuſe *Ariſtotle*; rather I could highly applaud him for having light upon the moſt ſubtil argument that could be produced againſt the *Copernican Hypotheſis*; and if the objection be ingenious,

nious, and to outward appearance moſt powerful, you may ſee how much more acute and ingenious the ſolution muſt be, and not to be found by a wit leſſe piercing than that of *Copernicus*; and again from the difficulty in underſtanding it, you may argue the ſo much greater difficulty in finding it. But let us for the preſent ſuſpend our anſwer, which you ſhall underſtand in due time and place, after we have repeated the objection of *Ariſtotle*, and that in his favour, much ſtrengthened. Now paſſe we to *Ariſtotles* third Argument, touching which we need give no farther reply, it having been ſufficiently anſwered betwixt the diſcourſes of yeſterday and to day: In as much as he urgeth, that the motion of grave bodies is naturally by a right line to the centre; and then enquireth, whether to the centre of the Earth, or to that of the Univerſe, and concludeth that they tend naturally to the centre of the Univerſe, but accidentally to that of the Earth. Therefore we may proceed to the fourth, upon which its requiſite that we ſtay ſome time, by reaſon it is founded upon that experiment, from whence the greater part of the remaining arguments derive all their ſtrength. *Ariſtotle* ſaith therefore, that it is a moſt convincing argument of the Earths immobility, to ſee that projections thrown or ſhot upright, return perpendicularly by the ſame line unto the ſame place from whence they were ſhot or thrown. And this holdeth true, although the motion be of a very great height; which could never come to paſſe, did the Earth move: for in the time that the projected body is moving upwards and downwards in a ſtate of ſeparation from the Earth, the place from whence the motion of the projection began, would be paſt, by means of the Earths revolution, a great way towards the Eaſt, and look how great that ſpace was, ſo far from that place would the projected body in its deſcent come to the ground. So that hither may be referred the argument taken from a bullet ſhot from a Canon directly upwards; as alſo that other uſed by *Ariſtotle* and *Ptolomy*, of the grave bodies that falling from on high, are obſerved to deſcend by a direct and perpendicular line to the ſurface of the Earth. Now that I may begin to untie theſe knots, I demand of *Simplicius* that in caſe one ſhould deny to *Ptolomy* and *Ariſtotle* that weights in falling freely from on high, deſcend by a right and perpendicular line, that is, directly to the centre, what means he would uſe to prove it?

The anſwer to the third argument.

The anſwer to the fourth argument.

SIMPL. The means of the ſenſes; the which aſſureth us, that that Tower or other altitude, is upright and perpendicular, and ſheweth us that that ſtone, or other grave body, doth ſlide along the Wall, without inclining a hairs breadth to one ſide or another, and light at the foot thereof juſt under the place from whence it was let fall.

SALV.

SALV. But if it ſhould happen that the Terreſtrial Globe did move round, and conſequently carry the Tower alſo along with it, and that the ſtone did then alſo grate and ſlide along the ſide of the Tower, what muſt its motion be then?

SIMPL. In this caſe we may rather ſay its motions: for it would have one wherewith to deſcend from the top of the Tower to the bottom, and ſhould neceſſarily have another to follow the courſe of the ſaid Tower.

SALV. So that its motion ſhould be compounded of two, to wit, of that wherewith it meaſureth the Tower, and of that other wherewith it followeth the ſame: From which compoſition would follow, that the ſtone would no longer deſcribe that ſimple right and perpendicular line, but one tranſverſe, and perhaps not ſtreight.

SIMPL. I can ſay nothing of its non-rectitude, but this I know very well, that it would of neceſſity be tranſverſe, and different from the other directly perpendicular, which it doth deſcribe, the Earth ſtanding ſtill.

SALV. You ſee then, that upon the meer obſerving the falling ſtone to glide along the Tower, you cannot certainly affirm that it deſcribeth a line which is ſtreight and perpendicular, unleſs you firſt ſuppoſe that the Earth ſtandeth ſtill.

SIMPL. True; for if the Earth ſhould move, the ſtones motion would be tranſverſe, and not perpendicular.

SALV. Behold then the Paralogiſm of *Ariſtotle* and *Ptolomey* to be evident and manifeſt, and diſcovered by you your ſelf, wherein that is ſuppoſed for known, which is intended to be demonſtrated.

The Paralogiſm of Ariſtotle *and* Ptolomey *in ſuppoſing that for known, which is in queſtion.*

SIMPL. How can that be? To me it appeareth that the Syllogiſm is rightly demonſtrated without *petitionem principii*.

SALV. You ſhall ſee how it is; anſwer me a little. Doth he not lay down the concluſion as unknown?

SIMPL. Unknown; why otherwiſe the demonſtrating it would be ſuperfluous.

SALV. But the middle term, ought not that to be known?

SIMPL. Its neceſſary that it ſhould; for otherwiſe it would be a proving *ignotum per æquè ignotum*.

SALV. Our concluſion which is to be proved, and which is unknown, is it not the ſtability of the Earth?

SIMPL. It is the ſame.

SALV. The middle term, which ought to be known, is it not the ſtreight and perpendicular deſcent of the ſtone?

SIMPL. It is ſo.

SALV. But was it not juſt now concluded, that we can have no certain knowledg whether that ſame ſhall be direct and perpen-

dicular, unleſs we firſt know that the Earth ſtands ſtill? Therefore in your Syllogiſm the certainty of the middle term is aſſumed from the uncertainty of the concluſion. You may ſee then, what and how great the Paralogiſm is.

SAGR. I would, in favour of *Simplicius*, defend *Ariſtotle* if it were poſſible, or at leaſt better ſatisfie my ſelf concerning the ſtrength of your illation. You ſay, that the ſeeing the ſtone rake along the Tower, is not ſufficient to aſſure us, that its motion is perpendicular (which is the middle term of the Syllogiſm) unleſs it be preſuppoſed, that the Earth ſtandeth ſtill, which is the concluſion to be proved: For that if the Tower did move together with the Earth, and the ſtone did ſlide along the ſame, the motion of the ſtone would be tranſverſe, and not perpendicular. But I ſhall anſwer, that ſhould the Tower move, it would be impoſſible that the ſtone ſhould fall gliding along the ſide of it; and therefore from its falling in that manner the ſtability of the Earth is inferred.

SIMPL. It is ſo; for if you would have the ſtone in deſcending to grate upon the Tower, though it were carried round by the Earth, you muſt allow the ſtone two natural motions, to wit, the ſtraight motion towards the Centre, and the circular about the Centre, the which is impoſſible.

SALV. *Ariſtotles* defenſe then conſiſteth in the impoſſibilitie, or at leaſt in his eſteeming it an impoſſibility, that the ſtone ſhould move with a motion mixt of right and circular: for if he did not hold it impoſſible that the ſtone could move to the Centre, and about the Centre at once, he muſt have underſtood, that it might come to paſs that the cadent ſtone might in its deſcent, race the Tower as well when it moved as when it ſtood ſtill; and conſequently he muſt have perceived, that from this grating nothing could be inferred touching the mobility or immobility of the Earth. But this doth not any way excuſe *Ariſtotle*; aſwell becauſe he ought to have expreſt it, if he had had ſuch a conceit, it being ſo material a part of his Argument; as alſo becauſe it can neither be ſaid that ſuch an effect is impoſſible, nor that *Ariſtotle* did eſteem it ſo. The firſt cannot be affirmed, for that by and by I ſhall ſhew that it is not onely poſſible, but neceſſary: nor much leſs can the ſecond be averred, for that *Ariſtotle* himſelf granteth fire to move naturally upwards in a right line, and to move about with the diurnal motion, imparted by Heaven to the whole Element of Fire, and the greater part of the Air: If therefore he held it not impoſſible to mix the right motion upwards, with the circular communicated to the Fire and Air from the concave of the Moon, much leſs ought he to account impoſſible the mixture of the right motion downwards of the ſtone, with the circular

Ariſtotle admitteth that the Fire moveth directly upwards by nature, and round about by participation.

circular which we presuppose natural to the whole Terrestrial Globe, of which the stone is a part.

SIMPL. I see no such thing: for if the element of Fire revolve round together with the Air, it is a very easie, yea a necessary thing, that a spark of fire which from the Earth mounts upwards, in passing thorow the moving air, should receive the same motion, being a body so thin, light, and easie to be moved: but that a very heavy stone, or a Canon bullet, that descendeth from on high, and that is at liberty to move whither it will, should suffer it self to be transported either by the air or any other thing, is altogether incredible. Besides that, we have the Experiment, which is so proper to our purpose, of the stone let fall from the round top of the Mast of a ship, which when the ship lyeth still, falleth at the Partners of the Mast; but when the ship saileth, falls so far distant from that place, by how far the ship in the time of the stones falling had run forward; which will not be a few fathoms, when the ships course is swift.

The disparity between the fall of a stone from the round top of a ship, and from the top of a tower.

SALV. There is a great disparity between the case of the Ship and that of the Earth, if the Terrestrial Globe be supposed to have a diurnal motion. For it is a thing very manifest, that the motion of the Ship, as it is not natural to it, so the motion of all those things that are in it is accidental, whence it is no wonder that the stone which was retained in the round top, being left at liberty, descendeth downwards without any obligation to follow the motion of the Ship. But the diurnal conversion is ascribed to the Terrestrial Globe for its proper and natural motion, and consequently, it is so to all the parts of the said Globe; and, as being impress'd by nature, is indelible in them; and therefore that stone that is on the top of the Tower hath an intrinsick inclination of revolving about the Centre of its *Whole* in twenty four hours, and this same natural instinct it exerciseth eternally, be it placed in any state whatsoever. And to be assured of the truth of this, you have no more to do but to alter an antiquated impression made in your mind; and to say, Like as in that I hitherto holding it to be the property of the Terrestrial Globe to rest immoveable about its Centre, did never doubt or question but that all whatsoever particles thereof do also naturally remain in the same state of rest: So it is reason, in case the Terrestrial Globe did move round by natural instinct in twenty four hours, that the intrinsick and natural inclination of all its parts should also be, not to stand still, but to follow the same revolution. And thus without running into any inconvenience, one may conclude, that in regard the motion conferred by the force of *Oars on the Ship, and by it on all the things that are contained within her, is not natural but forreign, it is very reasonable that that stone, it being separated from the ship,

*That you may not suspect my translation, or wonder what Oars have to do with a ship, you are to know that the Author intends the Gallies used in the Mediterrane.

The part of the Air inferiour to the higher mountains doth follow the motion of the Earth.

do reduce its ſelf to its natural diſpoſure, and return to exerciſe its pure ſimple inſtinct given it by nature. To this I add, that it's neceſſary, that at leaſt that part of the Air which is beneath the greater heights of mountains, ſhould be tranſported and carried round by the roughneſs of the Earths ſurface; or that, as being mixt with many Vapours, and terrene Exhalations, it do naturally follow the diurnal motion, which occurreth not in the Air about the ſhip rowed by Oars: So that your arguing from the ſhip to the Tower hath not the force of an illation; becauſe that ſtone which falls from the round top of the Maſt, entereth into a *medium*, which is unconcern'd in the motion of the ſhip: but that which departeth from the top of the Tower, finds a *medium* that hath a motion in common with the whole Terreſtrial Globe; ſo that without being hindred, rather being aſſiſted by the motion of the air, it may follow the univerſal courſe of the Earth.

The motion of the Air apt to carry with it light things but not heavy.

SIMPL. I cannot conceive that the air can imprint in a very great ſtone, or in a groſs Globe of Wood or Ball of Lead, as ſuppoſe of two hundred weight, the motion wherewith its ſelf is moved, and which it doth perhaps communicate to feathers, ſnow, and other very light things: nay, I ſee that a weight of that nature, being expoſed to any the moſt impetuous wind, is not thereby removed an inch from its place; now conſider with your ſelf whether the air will carry it along therewith.

SALV. There is great difference between your experiment and our caſe. You introduce the wind blowing againſt that ſtone, ſuppoſed in a ſtate of reſt, and we expoſe to the air, which already moveth, the ſtone which doth alſo move with the ſame velocity; ſo that the air is not to conferr a new motion upon it, but onely to maintain, or to ſpeak better, not to hinder the motion already acquired: you would drive the ſtone with a ſtrange and preternatural motion, and we deſire to conſerve it in its natural. If you would produce a more pertinent experiment, you ſhould ſay, that it is obſerved, if not with the eye of the forehead, yet with that of the mind, what would evene, if an eagle that is carried by the courſe of the wind, ſhould let a ſtone fall from its talons; which, in regard that at its being let go, it went along with the wind, and after it was let fall it entered into a *medium* that moved with equal velocity, I am very confident that it would not be ſeen to deſcend in its fall perpendicularly, but that following the courſe of the wind, and adding thereto that of its particular gravity, it would move with a tranſverſe motion.

SIMPL. But it would firſt be known how ſuch an experiment may be made; and then one might judg according to the event. In the mean time the effect of the ſhip doth hitherto incline to favour our opinion.

SALV.

SALV. Well ſaid you *hitherto*, for perhaps it may anon change countenance. And that I may no longer hold you in ſuſpenſe, tell me, *Simplicius*, do you really believe, that the Experiment of the ſhip ſquares ſo very well with our purpoſe, as that it ought to be believed, that that which we ſee happen in it, ought alſo to evene in the Terreſtrial Globe?

SIMPL. As yet I am of that opinion; and though you have alledged ſome ſmall diſparities, I do not think them of ſo great moment, as that they ſhould make me change my judgment.

SALV. I rather deſire that you would continue therein, and hold for certain, that the effect of the Earth would exactly anſwer that of the ſhip: provided, that when it ſhall appear prejudicial to your cauſe, you would not be humorous and alter your thoughts. You may haply ſay, Foraſmuch as when the ſhip ſtands ſtill, the ſtone falls at the foot of the Maſt, and when ſhe is under ſail, it lights far from thence, that therefore by converſion, from the ſtones falling at the foot is argued the ſhips ſtanding ſtill, and from its falling far from thence is argued her moving; and becauſe that which occurreth to the ſhip, ought likewiſe to befall the Earth: that therefore from the falling of the ſtone at the foot of the Tower is neceſſarily inferred the immobility of the Terreſtrial Globe. Is not this your argumentation?

SIMPL. It is; and reduced into that conciſeneſs, as that it is become moſt eaſie to be apprehended.

SALV. Now tell me; if the ſtone let fall from the Round-top, when the ſhip is in a ſwift courſe, ſhould fall exactly in the ſame place of the ſhip, in which it falleth when the ſhip is at anchor, what ſervice would theſe experiments do you, in order to the aſcertaining whether the veſſel doth ſtand ſtill or move?

SIMPL. Juſt none: Like as, for exemple, from the beating of the pulſe one cannot know whether a perſon be aſleep or awake, ſeeing that the pulſe beateth after the ſame manner in ſleeping as in waking.

SALV. Very well. Have you ever tryed the experiment of the Ship?

SIMPL. I have not; but yet I believe that thoſe Authors which alledg the ſame, have accurately obſerved it; beſides that the cauſe of the diſparity is ſo manifeſtly known, that it admits of no queſtion.

SALV. That it is poſſible that thoſe Authors inſtance in it, without having made tryal of it, you your ſelf are a good teſtimony, that without having examined it, alledg it as certain, and in a credulous way remit it to their authority; as it is now not onely poſſible, but very probable that they likewiſe did; I mean, did remit the ſame to their Predeceſſors, without ever arriving at one

that

that had made the experiment: for whoever ſhall examine the ſame, ſhall find the event ſucceed quite contrary to what hath been written of it: that is, he ſhall ſee the ſtone fall at all times in the ſame place of the Ship, whether it ſtand ſtill, or move with any whatſoever velocity. So that the ſame holding true in the Earth, as in the Ship, one cannot from the ſtones falling perpendicularly at the foot of the Tower, conclude any thing touching the motion or reſt of the Earth.

The ſtone falling from the Maſt of a ſhip lights in the ſame place, whether the ſhip doth move or ly ſtill.

SIMPL. If you ſhould refer me to any other means than to experience, I verily believe our Diſputations would not come to an end in haſte; for this ſeemeth to me a thing ſo remote from all humane reaſon, as that it leaveth not the leaſt place for credulity or probability.

SALV. And yet it hath left place in me for both.

SIMPL. How is this? You have not made an hundred, no nor one proof thereof, and do you ſo confidently affirm it for true? I for my part will return to my incredulity, and to the confidence I had that the Experiment hath been tried by the principal Authors who made uſe thereof, and that the event ſucceeded as they affirm.

SALV. I am aſſured that the effect will enſue as I tell you; for ſo it is neceſſary that it ſhould: and I farther add, that you know your ſelf that it cannot fall out otherwiſe, however you feign or ſeem to feign that you know it not. Yet I am ſo good at taming of wits, that I will make you confeſs the ſame whether you will or no. But *Sagredus* ſtands very mute, and yet, if I miſtake not, I ſaw him make an offer to ſpeak ſomewhat.

SAGR. I had an intent to ſay ſomething, but to tell you true, I know not what it was; for the curioſity that you have moved in me, by promiſing that you would force *Simplicius* to diſcover the knowledg which he would conceal from us, hath made me to depoſe all other thoughts: therefore I pray you to make good your vaunt.

SALV. Provided that *Simplicius* do conſent to reply to what I ſhall ask him, I will not fail to do it.

SIMPL. I will anſwer what I know, aſſured that I ſhall not be much put to it, for that of thoſe things which I hold to be falſe, I think nothing can be known, in regard that Science reſpecteth truths and not falſhoods.

SALV. I deſire not that you ſhould ſay or reply, that you know any thing, ſave that which you moſt aſſuredly know. Therefore tell me; If you had here a flat ſuperficies as polite as a Looking-glaſs, and of a ſubſtance as hard as ſteel, and that it were not parallel to the Horizon, but ſomewhat inclining, and that upon it you did put a Ball perfectly ſpherical, and of a ſubſtance grave and hard,

hard, as ſuppoſe of braſs; what think you it would do being let go? do not you believe (as for my part I do) that it would lie ſtill?

SIMPL. If that ſuperficies were inclining?

SALV. Yes; for ſo I have already ſuppoſed.

SIMPL. I cannot conceive how it ſhould lie ſtill: nay, I am confident that it would move towards the declivity with much propenſneſs.

SALV. Take good heed what you ſay, *Simplicius*, for I am confident that it would lie ſtill in what ever place you ſhould lay it.

SIMPL. So long as you make uſe of ſuch ſuppoſitions, *Salviatus*, I ſhall ceaſe to wonder if you infer moſt abſurd concluſions.

SALV. Are you aſſured, then, that it would freely move towards the declivity?

SIMPL. Who doubts it?

SALV. And this you verily believe, not becauſe I told you ſo, (for I endeavoured to perſwade you to think the contrary) but of your ſelf, and upon your natural judgment.

SIMPL. Now I ſee what you would be at; you ſpoke not this as really believing the ſame; but to try me, and to wreſt matter out of my own mouth wherewith to condemn me.

SALV. You are in the right. And how long would that Ball move, and with what velocity? But take notice that I inſtanced in a Ball exactly round, and a plain exquiſitely poliſhed, that all external and accidental impediments might be taken away. And ſo would I have you remove all obſtructions cauſed by the Airs reſiſtance to diviſion, and all other caſual obſtacles, if any other there can be.

SIMPL. I very well underſtand your meaning, and as to your demand, I anſwer, that the Ball would continue to move *in infinitum*, if the inclination of the plain ſhould ſo long laſt, and continually with an accelerating motion; for ſuch is the nature of ponderous moveables, that *vires acquirant eundo*: and the greater the declivity was, the greater the velocity would be.

SALV. But if one ſhould require that that Ball ſhould move upwards on that ſame ſuperficies, do you believe that it would ſo do?

SIMPL. Not ſpontaneouſly; but being drawn, or violently thrown, it may.

SALV. And in caſe it were thruſt forward by the impreſſion of ſome violent *impetus* from without, what and how great would its motion be?

SIMPL. The motion would go continually decreaſing and retarding,

tarding, as being contrary to nature; and would be longer or ſhorter, according to the greater or leſs impulſe, and according to the greater or leſs acclivity.

SALV. It ſeems, then, that hitherto you have explained to me the accidents of a moveable upon two different Planes; and that in the inclining plane, the grave moveable doth ſpontaneouſly deſcend, and goeth continually accelerating, and that to retain it in reſt, force muſt be uſed therein: but that on the aſcending plane, there is required a force to thruſt it forward, and alſo to ſtay it in reſt, and that the motion impreſſed goeth continually diminiſhing, till that in the end it cometh to nothing. You ſay yet farther, that in both the one and the other caſe, there do ariſe differences from the planes having a greater or leſs declivity or acclivity; ſo that the greater inclination is attended with the greater velocity; and contrariwiſe, upon the aſcending plane, the ſame moveable thrown with the ſame force, moveth a greater diſtance, by how much the elevation is leſs. Now tell me, what would befall the ſame moveable upon a ſuperficies that had neither acclivity nor declivity?

SIMPL. Here you muſt give me a little time to conſider of an anſwer. There being no declivity, there can be no natural inclination to motion: and there being no acclivity, there can be no reſiſtance to being moved; ſo that there would ariſe an indifference between propenſion and reſiſtance of motion; therefore, methinks it ought naturally to ſtand ſtill. But I had forgot my ſelf; it was but even now that *Sagredus* gave me to underſtand that it would ſo do.

SALV. So I think, provided one did lay it down gently: but if it had an *impetus* given it towards any part, what would follow?

SIMP. There would follow, that it ſhould move towards that part.

SALV. But with what kind of motion? with the continually accelerated, as in declining planes; or with the ſucceſſively retarded, as in thoſe aſcending.

SIMP. I cannot tell how to diſcover any cauſe of acceleration, or retardation, there being no declivity or acclivity.

SALV. Well: but if there be no cauſe of retardation, much leſs ought there to be any cauſe of reſt. How long therefore would you have the moveable to move?

SIMP. As long as that ſuperficies, neither inclined nor declined ſhall laſt.

SALV. Therefore if ſuch a ſpace were interminate, the motion upon the ſame would likewiſe have no termination, that is, would be perpetual.

SIMP. I think ſo, if ſo be the moveable be of a matter durable.

SALV. That hath been already ſuppoſed, when it was ſaid, that all external and accidental impediments were removed, and the brittleneſſe of the moveable in this our caſe, is one of thoſe impediments accidental. Tell me now, what do you think is the cauſe that that ſame Ball moveth ſpontaneouſly upon the inclining plane, and not without violence upon the erected?

SIMP. Becauſe the inclination of grave bodies is to move towards the centre of the Earth, and onely by violence upwards towards the circumference; and the inclining ſuperficies is that which acquireth vicinity to the centre, and the aſcending one, remoteneſſe.

SALV. Therefore a ſuperficies, which ſhould be neither declining nor aſcending, ought in all its parts to be equally diſtant from the centre. But is there any ſuch ſuperficies in the World?

SIMP. There is no want thereof: Such is our Terreſtrial Globe, if it were more even, and not as it is rough and montainous; but you have that of the Water, at ſuch time as it is calm and ſtill.

SALV. Then a ſhip which moveth in a calm at Sea, is one of thoſe moveables, which run along one of thoſe ſuperficies that are neither declining nor aſcending, and therefore diſpoſed, in caſe all obſtacles external and accidental were removed, to move with the impulſe once imparted inceſſantly and uniformly.

SIMPL. It ſhould ſeem to be ſo.

SALV. And that ſtone which is on the round top, doth not it move, as being together with the ſhip carried about by the circumference of a Circle about the Centre; and therefore conſequently by a motion in it indelible, if all extern obſtacles be removed? And is not this motion as ſwift as that of the ſhip.

SIMPL. Hitherto all is well. But what followeth?

SALV. Then in good time recant, I pray you, that your laſt concluſion, if you are ſatisfied with the truth of all the premiſes.

SIMPL. By my laſt concluſion, you mean, That that ſame ſtone moving with a motion indelibly impreſſed upon it, is not to leave, nay rather is to follow the ſhip, and in the end to light in the ſelf ſame place, where it falleth when the ſhip lyeth ſtill; and ſo I alſo grant it would do, in caſe there were no outward impediments that might diſturb the ſtones motion, after its being let go, the which impediments are two, the one is the moveables inability to break through the air with its meer *impetus* onely, it being deprived of that of the ſtrength of Oars, of which it had

been partaker, as part of the ſhip, at the time that it was upon the Maſt; the other is the new motion of deſcent, which alſo muſt needs be an hinderance of that other progreſſive motion.

SALV. As to the impediment of the Air, I do not deny it you; and if the thing falling were a light matter, as a feather, or a lock of wool, the retardation would be very great, but in an heavy ſtone is very exceeding ſmall. And you your ſelf but even now did ſay, that the force of the moſt impetuous wind ſufficeth not to ſtir a great ſtone from its place; now do but conſider what the calmer air is able to do, being encountred by a ſtone no more ſwift than the whole ſhip. Nevertheleſſe, as I ſaid before, I do allow you this ſmall effect, that may depend upon ſuch an impediment; like as I know, that you will grant to me, that if the air ſhould move with the ſame velocity that the ſhip and ſtone hath, then the impediment would be nothing at all. As to the other of the additional motion downwards; in the firſt place it is manifeſt, that theſe two, I mean the circular, about the centre, and the ſtreight, towards the centre, are not contraries, or deſtructive to one another, or incompatible. Becauſe that as to the moveable, it hath no repugnance at all to ſuch motions, for you your ſelf have already confeſt the repugnance to be againſt the motion which removeth from the centre, and the inclination to be towards the motion which approacheth to the centre. Whence it doth of neceſſity follow, that the moveable hath neither repugnance, nor propenſion to the motion which neither approacheth, nor goeth from the centre, nor conſequently is there any cauſe for the diminiſhing in it the faculty impreſſed. And forasmuch as the moving cauſe is not one alone, which it hath attained by the new operation of retardation; but that they are two, diſtinct from each other, of which, the gravity attends only to the drawing of the moveable towards the centre, and the vertue impreſs't to the conducting it about the centre, there remaineth no occaſion of impediment.

The projett according to Ariſtotle, *is not moved by vertue impreſſed, but by the* medium.

SIMPL. Your argumentation, to give you your due, is very probable; but in reality it is invelloped with certain intricacies, that are not eaſie to be extricated. You have all along built upon a ſuppoſition, which the *Peripatetick* Schools will not eaſily grant you, as being directly contrary to *Ariſtotle*, and it is to take for known and manifeſt, That the project ſeparated from the projicient, continueth the motion by *vertue impreſſed* on it by the ſaid projicient, which *vertue impreſſed* is a thing as much deteſted in *Peripatetick* Philoſophy, as the paſſage of any accident from one ſubject into another. Which doctrine doth hold, as I believe it is well known unto you, that the project is carried by the *medium*, which in our caſe happeneth to be the Air. And

there-

therefore if that ſtone let fall from the round top, ought to follow the motion of the ſhip, that effect ſhould be aſcribed to the Air, and not to the vertue impreſſed. But you preſuppoſe that the Air doth not follow the motion of the ſhip, but is tranquil. Moreover, he that letteth it fall, is not to throw it, or to give it *impetus* with his arm, but ought barely to open his hand and let it go; and by this means, the ſtone, neither through the vertue impreſſed by the projicient, nor through the help of the Air, ſhall be able to follow the ſhips motion, and therefore ſhall be left behind.

SALV. I think then that you would ſay, that if the ſtone be not thrown by the arm of that perſon, it is no longer a projection.

SIMPL. It cannot be properly called a motion of projection.

SALV. So then that which *Ariſtotle* ſpeaks of the motion, the moveable, and the mover of the projects, hath nothing to do with the buſineſſe in hand; and if it concern not our purpoſe, why do you alledg the ſame?

SIMP. I produce it on the occaſion of that impreſſed vertue, named and introduced by you, which having no being in the World, can be of no force; for *non-entium nullæ ſunt operationes*; and therefore not onely of projected, but of all other preternatural motions, the moving cauſe ought to be aſcribed to the *medium*, of which there hath been no due conſideration had; and therefore all that hath been ſaid hitherto is to no purpoſe.

SALV. Go to now, in good time. But tell me, ſeeing that your inſtance is wholly grounded upon the nullity of the vertue impreſſed, if I ſhall demonſtrate to you, that the *medium* hath nothing to do in the continuation of projects, after they are ſepatated from the projicient, will you admit of the impreſſed vertue, or will you make another attempt to overthrow it?

SIMP. The operation of the *medium* being removed, I ſee not how one can have recourſe to any thing elſe ſave the faculty impreſſed by the mover.

SALV. It would be well, for the removing, as much as is poſſible, the occaſions of multiplying contentions, that you would explain with as much diſtinctneſſe as may be, what is that operation of the *medium* in continuing the motion of the project.

Operation of the medium *incontinuing the motion of the project.*

SIMP. The projicient hath the ſtone in his hand, and with force and violence throws his arm, with which jactation the ſtone doth not move ſo much as the circumambient Air; ſo that when the ſtone at its being forſaken by the hand, findeth it ſelf in the Air, which at the ſame time moveth with impetouſity, it is thereby born away; for, if the air did not operate, the ſtone would fall at the foot of the projicient or thrower.

Many experiments, and reaſons againſt the cauſe of the motion of projects, aſſigned by Ariſtotle.

SALV. And was you ſo credulous, as to ſuffer your ſelf to be perſwaded to believe theſe fopperies, ſo long as you had your ſenſes about you to confute them, and to underſtand the truth thereof? Therefore tell me, that great ſtone, and that Canon bullet, which but onely laid upon a table, did continue immoveable againſt the moſt impetuous winds, according as you a little before did affirm, if it had been a ball of cork or other light ſtuffe, think you that the wind would have removed it from its place?

SIMP. Yes, and I am aſſured that it would have blown it quite away, and with ſo much more velocity, by how much the matter was lighter, for upon this reaſon we ſee the clouds to be tranſported with a velocity equal to that of the wind that drives them.

SALV. And what is the Wind?

SIMP. The Wind is defined to be nothing elſe but air moved.

SALV. Then the moved air doth carry light things more ſwiftly, and to a greater diſtance, then it doth heavy.

SIMP. Yes certainly.

SALV. But if you were to throw with your arm a ſtone, and a lock of cotton wool, which would move ſwifteſt and fartheſt?

SIMP. The ſtone by much; nay the wool would fall at my feet.

SALV. But, if that which moveth the projected ſubſtance, after it is delivered from the hand, be no other than the air moved by the arm, and the moved air do more eaſily bear away light than grave matters, how cometh it that the project of wool flieth not farther, and ſwifter than that of ſtone? Certainly it argueth that the ſtone hath ſome other impulſe beſides the motion of the air. Furthermore, if two ſtrings of equal length did hang at yonder beam, and at the end of one there was faſtened a bullet of lead, and a ball of cotton wool at the other, and both were carried to an equal diſtance from the perpendicular, and then let go; it is not to be doubted, but that both the one and the other would move towards the perpendicular, and that being carried by their own *impetus*, they would go a certain ſpace beyond it, and afterwards return thither again. But which of theſe two pendent Globes do you think, would continue longeſt in motion, before that it would come to reſt in its perpendicularity?

SIMP. The ball of lead would ſwing to and again many times, and that of wool but two or three at the moſt.

SALV. So that that *impetus* and that *mobility* whatſoever is the cauſe thereof, would conſerve its ſelf longer in grave ſubſtances, than light; I proceed now to another particular, and demand of you, why the air doth not carry away that Lemon which is upon that ſame Table?

SIMP.

SIMP. Becauſe that the air it ſelf is not moved

SALV. It is requiſite then, that the projicient do confer motion on the Air, with which it afterward moveth the project. But if ſuch a motion cannot be impreſſed [*i. e. imparted*] it being impoſſible to make an accident paſſe out of one ſubject into another, how can it paſſe from the arm into the Air? Will you ſay that the Air is not a ſubject different from the arm?

SIMP. To this it is anſwered that the Air, in regard it is neither heavy nor light in its own Region, is diſpoſed with facility to receive every impulſe, and alſo to retain the ſame.

SALV. But if thoſe *penduli* even now named, did prove unto us, that the moveable, the leſſe it had of gravity, the leſſe apt it was to conſerve its motion, how can it be that the Air which in the Air hath no gravity at all, doth of it ſelf alone retain the motion acquired? I believe, and know that you by this time are of the ſame opinion, that the arm doth not ſooner return to reſt, than doth the circumambient Air. Let's go into the Chamber, and with a towel let us agitate the Air as much as we can, and then holding the cloth ſtill, let a little candle be brought, that was lighted in the next room, or in the ſame place let a leaf of beaten Gold be left at liberty to flie any way, and you ſhall by the calm vagation of them be aſſured that the Air is immediately reduced to tranquilty. I could alledg many other experiments to the ſame purpoſe, but if one of theſe ſhould not ſuffice, I ſhould think your folly altogether incurable.

SAGR. When an arrow is ſhot againſt the Wind, how incredible a thing is it, that that ſame ſmall filament of air, impelled by the bow-ſtring, ſhould in deſpite of fate go along with the arrow? But I would willingly know another particular of *Ariſtotle*, to which I intreat *Simplicius* would vouchſafe me an anſwer. Suppoſing that with the ſame Bow there were ſhot two arrows, one juſt after the uſual manner, and the other ſide-wayes, placing it long-wayes upon the Bow-ſtring, and then letting it flie, I would know which of them would go fartheſt. Favour me, I pray you with an anſwer, though the queſtion may ſeem to you rather ridiculous than otherwiſe; and excuſe me, for that I, who am, as you ſee, rather blockiſh, than not, can reach no higher with my ſpeculative faculty.

SIMPL. I have never ſeen an arrow ſhot in that manner, yet nevertheleſſe I believe, that it would not flie ſide-long, the twentieth part of the ſpace that it goeth end-wayes.

SAGR. And for that I am of the ſame opinion, hence it is, that I have a doubt riſen in me, whether *Ariſtotle* doth not contradict experience. For as to experience, if I lay two arrows upon this Table, in a time vvhen a ſtrong Wind blovveth, one tovvards the

the courſe of the wind, and the other ſidelong, the wind will quickly carry away this later, and leave the other where it was; and the ſame to my ſeeming, ought to happen, if the Doctrine of *Ariſtotle* were true, of thoſe two ſhot out of a Bow: foraſmuch as the arrow ſhot ſideways is driven by a great quantity of Air, moved by the bowſtring, to wit by as much as the ſaid ſtring is long, whereas the other arrow receiveth no greater a quantity of air, than the ſmall circle of the ſtrings thickneſs. And I cannot imagine what may be the reaſon of ſuch a difference, but would fain know the ſame.

SIMP. The cauſe ſeemeth to me ſufficiently manifeſt; and it is, becauſe the arrow ſhot endways, hath but a little quantity of air to penetrate, and the other is to make its way through a quantity as great as its whole length.

SALV. Then it ſeems the arrows ſhot, are to penetrate the air? but if the air goeth along with them, yea, is that which carrieth them, what penetration can they make therein? Do you not ſee that, in this caſe, the arrow would of neceſſity move with greater velocity than the air? and this greater velocity, what doth confer it on the arrow? Will you ſay the air giveth them a velocity greater than its own? Know then, *Simplicius*, that the buſineſs proceeds quite contrary to that which *Ariſtotle* ſaith, and that the *medium* conferreth the motion on the project, is as falſe, as it is true, that it is the onely thing which procureth its obſtruction; and having known this, you ſhall underſtand without finding any thing whereof to make queſtion, that if the air be really moved, it doth much better carry the dart along with it longways, than endways, for that the air which impelleth it in that poſture, is much, and in this very little. But ſhooting with the Bow, foraſmuch as the air ſtands ſtill, the tranſverſe arrow, being to force its paſſage through much air, comes to be much impeded, and the other that was nock't eaſily overcometh the obſtruction of the ſmall quantity of air, which oppoſeth it ſelf thereto.

The medium *doth impede and not confer the motion of projects.*

SALV. How many Propoſitions have I obſerved in *Ariſtotle*, (meaning ſtill in Natural Philoſophy) that are not onely falſe, but falſe in ſuch ſort, that its diametrical contrary is true, as it happens in this caſe. But purſuing the point in hand, I think that *Simplicius* is perſwaded, that, from ſeeing the ſtone always to fall in the ſame place, he cannot conjecture either the motion or ſtability of the Ship: and if what hath been hitherto ſpoken, ſhould not ſuffice, there is the Experiment of the *medium* which may thorowly aſſure us thereof; in which experiment, the moſt that could be ſeen would be, that the cadent moveable might be left behind, if it were light, and that the air did not follow the motion of the ſhip: but in caſe the air ſhould move with equal velocity,

velocity, no imaginable diverſity could be found either in this, or any other experiment whatſoever, as I am anon to tell you. Now if in this caſe there appeareth no difference at all, what can be pretended to be ſeen in the ſtone falling from the top of the Tower, where the motion in gyration is not adventitious, and accidental, but natural and eternal; and where the air exactly followeth the motion of the Tower, and the Tower that of the Terreſtrial Globe? have you any thing elſe to ſay, *Simplicius*, upon this particular?

SIMP. No more but this, that I ſee not the mobility of the Earth as yet proved.

SALV. Nor have I any intention at this time, but onely to ſhew, that nothing can be concluded from the experiments alledged by our adverſaries for convincing Arguments: as I think I ſhall prove the others to be.

SAGR. I beſeech you, *Salviatus*, before you proceed any farther, to permit me to ſtart certain queſtions, which have been rouling in my fancy all the while that you with ſo much patience and equanimity, was minutely explaining to *Simplicius* the experiment of the Ship.

SALV. We are here met with a purpoſe to diſpute, and it's fit that every one ſhould move the difficulties that he meets withall; for this is the way to come to the knowledg of the truth. Therefore ſpeak freely.

SAGR. If it be true, that the *impetus* wherewith the ſhip moves, doth remain indelibly impreſſ'd in the ſtone, after it is let fall from the Maſt; and if it be farther true, that this motion brings no impediment or retardment to the motion directly downwards, natural to the ſtone: it's neceſſary, that there do an effect enſue of a very wonderful nature. Let a Ship be ſuppoſed to ſtand ſtill, and let the time of the falling of a ſtone from the Maſts Round-top to the ground, be two beats of the pulſe; let the Ship afterwards be under ſail, and let the ſame ſtone depart from the ſame place, and it, according to what hath been premiſed, ſhall ſtill take up the time of two pulſes in its fall, in which time the ſhip will have run, ſuppoſe, twenty yards; ſo that the true motion of the ſtone will be a tranſverſe line, conſiderably longer than the firſt ſtraight and perpendicular line, which is the length of the *Maſt, and yet nevertheleſs the *ſtone will have paſt it in the ſame time. Let it be farther ſuppoſed, that the Ships motion is much more accelerated, ſo that the ſtone in falling ſhall be to paſs a tranſverſe line much longer than the other; and in ſum, increaſing the Ships velocity as much as you will, the falling ſtone ſhall deſcribe its tranſverſe lines ſtill longer and longer, and yet ſhall paſs them all in thoſe ſelf ſame two pulſes. And in this faſhion, if a Canon were level'd

An admirable accident in the motion of projects.

*By the length of the maſt he means the diſtance between the upper-deck and Round-top.

*La palla.

level'd on the top of a Tower, and ſhots were made therewith point blank, that is, paralel to the Horizon, let the Piece have a greater or leſs charge, ſo as that the ball may fall ſometimes a thouſand yards diſtant, ſometimes four thouſand, ſometimes ſix, ſometimes ten, *&c.* and all theſe ſhots ſhall curry or finiſh their ranges in times equal to each other, and every one equal to the time which the ball would take to paſs from the mouth of the Piece to the ground, being left, without other impulſe, to fall ſimply downwards in a perpendicular line. Now it ſeems a very admirable thing, that in the ſame ſhort time of its falling perpendicularly down to the ground, from the height of, ſuppoſe, an hundred yards, the ſame ball, being thruſt violently out of the Piece by the Fire, ſhould be able to paſs one while four hundred, another while a thouſand, another while four, another while ten thouſand yards, ſo as that the ſaid ball in all ſhots made point blank, always continueth an equal time in the air.

SALV. The conſideration for its novelty is very pretty, and if the effect be true, very admirable: and of the truth thereof, I make no queſtion: and were it not for the accidental impediment of the air, I verily believe, that, if at the time of the balls going out of the Piece, another were let fall from the ſame height directly downwards, they would both come to the ground at the ſame inſtant, though that ſhould have curried ten thouſand miles in its range, and this but an hundred onely: preſuppoſing the ſurface of the Earth to be equal, which to be aſſured of, the experiment may be made upon ſome lake. As for the impediment which might come from the air, it would conſiſt in retarding the extreme ſwift motion of the ſhot. Now, if you think fit, we will proceed to the ſolution of the other Objections, ſeeing that *Simplicius* (as far as I can ſee) is convinc'd of the nullity of this firſt, taken from things falling from on high downwards.

SIMP. I find not all my ſcruples removed, but it may be the fault is my own, as not being of ſo eaſie and quick an apprehenſion as *Sagredus*. And it ſeems to me, that if this motion, of which the ſtone did partake whilſt it was on the Round-top of the Ships Maſt, be, as you ſay, to conſerve it ſelf indelibly in the ſaid ſtone, even after it is ſeparated from the Ship, it would follow, that likewiſe in caſe any one, riding a horſe that was upon his ſpeed, ſhould let a bowl drop out of his hand, that bowl being fallen to the ground would continue its motion and follow the horſes ſteps, without tarrying behind him: the which effect, I believe, is not to be ſeen, unleſs when he that is upon the horſe ſhould throw it with violence that way towards which he runneth; but otherwiſe, I believe it will ſtay on the ground in the ſame place where it fell.

SALV.

SALV. I believe that you very much deceive your ſelf, and am certain, that experience will ſhew you the contrary, and that the ball being once arrived at the ground, will run together with the horſe, not ſtaying behind him, unleſs ſo far as the aſperity and unevenneſs of the Earth ſhall hinder it. And the reaſon ſeems to me very manifeſt: for if you, ſtanding ſtill, throw the ſaid ball along the ground, do you think it would not continue its motion even after you had delivered it out of your hand? and that for ſo much a greater ſpace, by how much the ſuperficies were more ſmooth, ſo that *v. g.* upon ice it would run a great way?

SIMP. There is no doubt of it, if I give it *impetus* with my arm; but in the other caſe it is ſuppoſed, that he who is upon the horſe, onely drops it out of his hand.

SALV. So I deſire that it ſhould be: but when you throw it with your arm, what other remaineth to the ball being once gone out of your hand, than the motion received from your arm, which motion being conſerved in the boul, it doth continue to carry it forward? Now, what doth it import, that that *impetus* be conferred on the ball rather from the arm than from the horſe? Whilſt you were on horſeback, did not your hand, and conſequently the ball run as faſt as the horſe it ſelf? Doubtleſs it did: therefore in onely opening of the hand, the ball departs with the motion already conceived, not from your arm, by your particular motion, but from the motion dependant on the ſaid horſe, which cometh to be communicated to you, to your arm, to your hand, and laſtly to the ball. Nay, I will tell you farther, that if the rider upon his ſpeed fling the ball with his arm to the part contrary to the courſe, it ſhall, after it is fallen to the ground, ſometimes (albeit thrown to the contrary part) follow the courſe of the horſe, and ſometimes lie ſtill on the ground; and ſhall onely move contrary to the ſaid courſe, when the motion received from the arm, ſhall exceed that of the carrier in velocity. And it is a vanity, that of ſome, who ſay that a horſeman is able to caſt a javelin thorow the air, that way which the horſe runs, and with the horſe to follow and overtake the ſame; and laſtly, to catch it again. It is, I ſay, a vanity, for that to make the project return into the hand, it is requiſite to caſt it upwards, in the ſame manner as if you ſtood ſtill. For, let the carrier be never ſo ſwift, provided it be uniform, and the project not over-light, it ſhall always fall back again into the hand of the projicient, though never ſo high thrown.

Sundry curious Problems, touching the motions of projects.

SAGR. By this Doctrine I come to know ſome Problems very curious upon this ſubject of projections; the firſt of which muſt ſeem very ſtrange to *Simplicius*. And the Problem is this; I affirm it to be poſſible, that the ball being barely dropt or let fall, by one that any way runneth very ſwiftly, being arrived at the

Earth, doth not onely follow the courſe of that perſon, but doth much out go him. Which Problem is connexed with this, that the moveable being thrown by the projicient above the plane of the Horizon, may acquire new velocity, greater by far than that confer'd upon it by the projicient. The which effect I have with admiration obſerved, in looking upon thoſe who uſe the ſport of tops, which, ſo ſoon as they are ſet out of the hand, are ſeen to move in the air with a certain velocity, the which they afterwards much encreaſe at their coming to the ground; and if whipping them, they rub at any uneven place that makes them skip on high, they are ſeen to move very ſlowly through the air, and falling again to the Earth, they ſtill come to move with a greater velocity: But that which is yet more ſtrange, I have farther obſerved, that they not onely turn always more ſwiftly on the ground, than in the air, but of two ſpaces both upon the Earth, ſometimes a motion in the ſecond ſpace is more ſwift than in the firſt. Now what would *Simplicius* ſay to this?

SIMP. He would ſay in the firſt place, that he had never made ſuch an obſervation. Secondly, he would ſay, that he did not believe the ſame. He would ſay again, in the third place, that if you could aſſure him thereof, and demonſtratively convince him of the ſame, he would account you a great Dæmon.

SAGR. I hope then that it is one of the Socratick, not infernal ones. But that I may make you underſtand this particular, you muſt know, that if a perſon apprehend not a truth of himſelf, it is impoſſible that others ſhould make him underſtand it: I may indeed inſtruct you in thoſe things which are neither true nor falſe; but the true, that is, the neceſſary, namely, ſuch as it is impoſſible ſhould be otherwiſe, every common capacity either comprehendeth them of himſelf, or elſe it is impoſſible he ſhould ever know them. And of this opinion I am confident is *Salviatus* alſo: and therefore I tell you, that the reaſons of the preſent Problems are known by you, but it may be, not apprehended.

SIMP. Let us, for the preſent, paſs by that controverſie, and permit me to plead ignorance of theſe things you ſpeak of, and try whether you can make me capable of underſtanding theſe Problems.

SAGR. This firſt dependeth upon another, which is, Whence cometh it, that ſetting a top with the laſh, it runneth farther, and conſequently with greater force, than when its ſet with the fingers?

SIMP. *Ariſtotle* alſo makes certain Problems about theſe kinds of projects.

SALV. He doth ſo; and very ingenious they are: particularly, That, Whence it cometh to paſs that round tops run better than the ſquare?

SAGR.

SAGR. And cannot you, *Simplicius*, give a reaſon for this, without others prompting you?

SIMP. Very good, I can ſo; but leave your jeering.

SAGR. In like manner you do know the reaſon of this other alſo. Tell me therefore; know you that a thing which moveth, being impeded ſtands ſtill?

SIMP. I know it doth, if the impediment be ſo great as to ſuffice.

SAGR. Do you know, that moving upon the Earth is a greater impediment to the moveable, than moving in the air, the Earth being rough and hard, and the air ſoft and yielding?

SIMP. And knowing this, I know that the top will turn faſter in the air, than on the ground, ſo that my knowledg is quite contrary to what you think it.

SAGR. Fair and ſoftly, *Simplicius*. You know that in the parts of a moveable, that turneth about its centre, there are found motions towards all ſides; ſo that ſome aſcend, others deſcend; ſome go forwards, others backwards?

SIMP. I know it, and *Ariſtotle* taught me the ſame.

SAGR. And with what demonſtration, I pray you?

SIMP. With that of ſenſe.

SAGR. *Ariſtotle*, then, hath made you ſee that which without him you would not have ſeen? Did he ever lend you his eyes? You would ſay, that *Ariſtotle* hath told, advertiſed, remembered you of the ſame; and not taught you it. When then a top, without changing place, turns round, (or in the childrens phraſe, ſleepeth) not paralel, but erect to the Horizon, ſome of its parts aſcend, and the oppoſite deſcend; the ſuperiour go one way, the inferiour another. Fancie now to your ſelf, a top, that without changing place, ſwiftly turns round in that manner, and ſtands ſuſpended in the air, and that in that manner turning, it be let fall to the Earth perpendicularly, do you believe, that when it is arrived at the ground, it will continue to turn round in the ſame manner, without changing place, as before?

SIMP. No, Sir.

SAGR. What will it do then?

SIMP. It will run along the ground very faſt.

SAGR. And towards what part?

SIMP. Towards that, whither its *reeling carrieth it. * Vertigine.

SAGR. In its reeling there are parts, that is the uppermoſt, which do move contrary to the inferiour; therefore you muſt inſtance which it ſhall obey: for as to the parts aſcending and deſcending, the one kind will not yield to the other; nor will they all go downwards, being hindered by the Earth, nor upwards as being heavy.

SIMP. The top will run reeling along the floor towards that part whither its upper parts encline it.

SAGR. And why not whither the contrary parts tend, namely, thoſe which touch the ground?

SIMP. Becauſe thoſe upon the ground happen to be impeded by the roughneſs of the touch, that is, by the floors unevenneſs; but the ſuperiour, which are in the tenuous and flexible air, are hindred very little, if at all; and therefore the top will obey their inclination.

SAGR. So that that taction, if I may ſo ſay, of the neither parts on the floor, is the cauſe that they ſtay, and onely the upper parts ſpring the top forward.

SALV. And therefore, if the top ſhould fall upon the ice, or other very ſmooth ſuperficies, it would not ſo well run forward, but might peradventure continue to revolve in it ſelf, (or ſleep) without acquiring any progreſſive motion.

SAGR. It is an eaſie thing for it ſo to do; but yet nevertheleſs, it would not ſo ſpeedily come to ſleep, as when it falleth on a ſuperficies ſomewhat rugged. But tell me, *Simplicius*, when the top turning round about it ſelf, in that manner, is let fall, why doth it not move forwards in the air, as it doth afterwards when it is upon the ground?

SIMP. Becauſe having air above it, and beneath, neither thoſe parts, nor theſe have any where to touch, and not having more occaſion to go forward than backward, it falls perpendicularly.

SAGR. So then the onely reeling about its ſelf, without other *impetus*, can drive the top forward, being arrived at the ground, very nimbly. Now proceed we to what remains. That laſh, which the driver tyeth to his Top-ſtick, and with which, winding it about the top, he ſets it (*i. e.* makes it go) what effect hath it on the ſaid top?

SIMP. It conſtrains it to turn round upon its toe, that ſo it may free it ſelf from the Top-laſh.

SAGR. So then, when the top arriveth at the ground, it cometh all the way turning about its ſelf, by means of the laſh. Hath it not reaſon then to move in it ſelf more ſwiftly upon the ground, than it did whilſt it was in the air?

SIMP. Yes doubtleſs; for in the air it had no other impulſe than that of the arm of the projicient; and if it had alſo the reeling, this (as hath been ſaid) in the air drives it not forward at all: but arriving at the floor, to the motion of the arm is added the progreſſion of the reeling, whereby the velocity is redoubled. And I know already very well, that the top skipping from the ground, its velocity will deminiſh, becauſe the help of its circulation is wanting; and returning to the Earth will get it again, and by that means

means move again faſter, than in the air. It onely reſts for me to underſtand, whether in this ſecond motion on the Earth it move more ſwiftly, than in the firſt; for then it would move *in infinitum*, alwayes accelerating.

SAGR. I did not abſolutely affirm, that this ſecond motion is more ſwift than the firſt; but that it may happen ſo to be ſometimes.

SIMP. This is that, which I apprehend not, and which I deſire to know.

SAGR. And this alſo you know of your ſelf. Therefore tell me: When you let the top fall out of your hand, without making it turn round (*i. e.* ſetting it) what will it do at its coming to the ground?

SIMP. Nothing, but there lie ſtill.

SAGR. May it not chance, that in its fall to the ground it may acquire a motion? Think better on it.

SIMP. Unleſſe we let it fall upon ſome inclining ſtone, as children do playing at * *Chioſa*, and that falling ſide-wayes upon the ſame, it do acquire the motion of turning round upon its toe, wherewith it afterwards continueth to move progreſſively on the floor, I know not in what other manner it can do any thing but lie ſtill where it falleth.

* A Game in *Italy*, which is, to glide bullets down an inclining ſtone, *&c.*

SAGR. You ſee then that in ſome caſe it may acquire a new revolution. When then the top jerked up from the ground, falleth down again, why may it not caſually hit upon the declivity of ſome ſtone fixed in the floor, and that hath an inclination that way towards which it moveth, and acquiring by that ſlip a new whirle over and above that conferred by the laſh, why may it not redouble its motion, and make it ſwifter than it was at its firſt lighting upon the ground?

SIMP. Now I ſee that the ſame may eaſily happen. And I am thinking that if the top ſhould turn the contrary way, in arriving at the ground, it would work a contrary effect, that is, the motion of the accidental whirl would retard that of the projicient.

SAGR. And it would ſometimes wholly retard and ſtop it, in caſe the revolution of the top were very ſwift. And from hence ariſeth the reſolution of that ſlight, which the more skilful Tennis Players uſe to their advantage; that is, to gull their adverſary by cutting (for ſo is their Phraſe) the Ball; which is, to return it with a ſide Rachet, in ſuch a manner, that it doth thereby acquire a motion by it ſelf contrary to the projected motion, and ſo by that means, at its coming to the ground, the rebound, which if the ball did not turn in that manner, would be towards the adverſary, giving him the uſual time to toſſe it back again, doth fail,

fail, and the ball runs tripping along the ground, or rebounds leſſe than uſual, and breaketh the time of the return. Hence it is that you ſee, thoſe who play at *Stool-ball, when they play in a ſtony way, or a place full of holes and rubs that make the ball trip an hundred ſeveral wayes, never ſuffering it to come neer the mark, to avoid them all, they do not trundle the ball upon the ground, but throw it, as if they were to pitch a quait. But becauſe in throwing the ball, it iſſueth out of the hand with ſome roling conferred by the fingers, when ever the hand is under the ball, as it is moſt commonly held; whereupon the ball in its lighting on the ground neer to the mark, between the motion of the projicient and that of the roling, would run a great way from the ſame: To make the ball ſtay, they hold it artificially, with their hand uppermoſt, and it undermoſt, which in its delivery hath a contrary twirl or roling conferred upon it by the fingers, by means whereof in its coming to the ground neer the mark it ſtays there, or runs very very little forwards. But to return to our principal problem which gave occaſion for ſtarting theſe others; I ſay it is poſſible that a perſon carried very ſwiftly, may let a ball drop out of his hand, that being come to the Earth, ſhall not onely follow his motion, but alſo out-go it, moving with a greater velocity. And to ſee ſuch an effect, I deſire that the courſe may be that of a Chariot, to which on the out-ſide let a declining board be faſtened; ſo as that the neither part may be towards the horſes, and the upper towards the hind Wheel. Now, if in the Chariots full career, a man within it, let a ball fall gliding along the declivity of that board, it ſhall in roling downward acquire a particular *vertigo* or turning, the which added to the motion impreſſed by the Chariot, will carrie the ball along the ground much faſter than the Chariot. And if one accommodate another declining board over againſt it, the motion of the Chariot may be qualified ſo, that the ball, gliding downwards along the board, in its coming to the ground ſhall reſt immoveable, and alſo ſhall ſometimes run the contrary way to the Chariot. But we are ſtrayed too far from the purpoſe, therefore if *Simplicius* be ſatisfied with the reſolution of the firſt argument againſt the Earths mobility, taken from things falling perpendicularly, we may paſſe to the reſt.

*A Game in *Italy*, wherein they ſtrive who ſhall trundle or throw a wooden bowle neereſt to an aſſigned mark.

SALV. The digreſſions made hitherto, are not ſo alienated from the matter in hand, as that one can ſay they are wholly ſtrangers to it. Beſides theſe argumentations depend on thoſe things that ſtart up in the fancy not of one perſon, but of three, that we are: And moreover we diſcourſe for our pleaſure, nor are we obliged to that ſtrictneſſe of one who *ex profeſſo* treateth methodically of an argument, with an intent to publiſh the ſame.

I

I will not conſent that our Poem ſhould be ſo confined to that unity, as not to leave us fields open for Epſody's, which every ſmalll connection ſhould ſuffice to introduce; but with almoſt as much liberty as if we were met to tell ſtories, it ſhall be lawful for me to ſpeak, what ever your diſcourſe brings into mymind.

SAGR. I like this motion very well; and ſince we are at this liberty, let me take leave, before we paſſe any farther to ask of you *Salviatus*, whether you did ever conſider what that line may be that is deſcribed by the grave moveable naturally falling down from the top of a Tower; and if you have reflected on it, be pleaſed to tell me what you think thereof.

SALV. I have ſometimes conſidered of it, and make no queſtion, that if one could be certain of the nature of that motion wherewith the grave body deſcendeth to approach the centre of the Terreſtrial Globe, mixing it ſelf afterwards with the common circular motion of the diurnal converſion; it might be exactly found what kind of line that is, that the centre of gravity of the moveable deſcribeth in thoſe two motions.

SAGR. Touching the ſimple motion towards the centre dependent on the gravity, I think that one may confidently, without error, believe that it is by a right line, as it would be, were the Earth immoveable.

SALV. As to this particular, we may not onely believe it, but experience rendereth us certain of the ſame.

SAGR. But how doth experience aſſure us thereof, if we never ſee any motions but ſuch as are compoſed of the two, circular and deſcending.

SALV. Nay rather *Sagredus* we onely ſee the ſimple motion of deſcent; ſince that other circular one common to the Earth, the Tower and our ſelves remains imperceptible, and as if it never were, and there remaineth perceptible to us that of the ſtone, onely not participated by us, and for this, ſenſe demonſtrateth that it is by a right line, ever parallel to the ſaid Tower, which is built upright and perpendicular upon the Terreſtrial ſurface.

SAGR. You are in the right; and this was but too plainly demonſtrated to me even now, ſeeing that I could not remember ſo eaſie a thing; but this being ſo manifeſt, what more is it that you ſay you deſire, for underſtanding the nature of this motion downwards?

SALV. It ſufficeth not to know that it is ſtreight, but its requiſite to know whether it be uniform, or irregular; that is, whether it maintain alwayes one and the ſame velocity, or elſe goeth retarding or accelerating.

SAGR. It is already clear, that it goeth continually accelleratting.

SALV.

SALV. Neither doth this ſuffice, but its requiſite to know according to what proportion ſuch accelleration is made; a Problem, that I believe was never hitherto underſtood by any Philoſopher or Mathematician; although Philoſophers, and particularly the *Peripateticks*, have writ great and entire Volumes, touching motion.

SIMP. Philoſophers principally buſie themſelves about univerſals; they find the definitions and more common ſymptomes, omitting certain ſubtilties and niceties, which are rather curioſities to the Mathematicians. And *Ariſtotle* did content himſelf to define excellently what motion was in general; and of the local, to ſhew the principal qualities, to wit, that one is natural, another violent; one is ſimple, another compound; one is equal, another accellerate; and concerning the accelerate, contents himſelf to give the reaſon of acceleration, remitting the finding out of the proportion of ſuch acceleration, and other particular accidents to the Mechanitian, or other inferiour Artiſt.

SAGR. Very well *Simplicius*. But you *Salviatus*, when you deſcend ſometimes from the Throne of *Peripatetick* Majeſty, have you ever thrown away any of your hours in ſtudying to find this proportion of the acceleration of the motion of deſcending grave bodies?

SALV. There was no need that I ſhould ſtudy for it, in regard that the Academick our common friend, heretofore ſhewed me a Treatiſe of his * *De Motu*, where this, and many other accidents were demonſtrated. But it would be too great a digreſſion, if for this particular, we ſhould interrupt our preſent diſcourſe, (which yet it ſelf is alſo no better than a digreſſion) and make as the Saying is, a Comedy within a Comedy.

* This is that excellent tract which we give the firſt place in our ſecond Volume.

SAGR. I am content to excuſe you from this narration for the preſent, provided that this may be one of the Propoſitions reſerved to be examined amongſt the reſt in another particular meeting, for that the knowledg thereof is by me very much deſired; and in the mean time let us return to the line deſcribed by the grave body in its fall from the top of the Tower to its baſe.

SALV. If the right motion towards the centre of the Earth was uniforme, the circular towards the Eaſt being alſo uniforme, you would ſee compoſed of them both a motion by a ſpiral line, of that kind with thoſe defined by *Archimedes* in his Book *De Spiralibus*; which are, when a point moveth uniformly upon a right line, whileſt that line in the mean time turneth uniformly about one of its extreme points fixed, as the centre of his gyration. But becauſe the right motion of grave bodies falling, is continually accelerated, it is neceſſary, that the line reſulting of the com-

compoſition of the two motions do go alwayes receding with greater and greater proportion from the circumference of that circle, which the centre of the ſtones gravity would have deſigned, if it had alwayes ſtaid upon the Tower; it followeth of neceſſity that this receſſion at the firſt be but little, yea very ſmall, yea, more, as ſmall as can be imagined, ſeeing that the deſcending grave body departing from reſt, that is; from the privation of motion, towards the bottom and entring into the right motion downwards, it muſt needs paſſe through all the degrees of tardity, that are betwixt reſt, and any aſſigned velocity; the which degrees are infinite; as already hath been at large diſcourſed and proved.

It being ſuppoſed therefore, that the progreſſe of the acceleration being after this manner, and it being moreover true, that the deſcending grave body goeth to terminate in the centre of the Earth, it is neceſſary that the line of its mixt motion be ſuch, that it go continually receding with greater and greater proportion from the top of the Tower, or to ſpeak more properly, from the circumference of the circle deſcribed by the top of the Tower, by means of the Earths converſion; but that ſuch receſſions be leſſer and leſſer *in infinitum*; by how much the moveable finds it ſelf to be leſſe and leſſe removed from the firſt term where it reſted. Moreover it is neceſſary, that this line of the compounded motion do go to terminate in the centre of the Earth. Now having preſuppoſed theſe two things, I come to deſcribe about the centre A [*in Fig.* 1. *of this ſecond Dialogue*;] with the ſemidiameter A B, the circle B I, repreſenting to me the Terreſtrial Globe, and prolonging the ſemidiameter A B to C, I have deſcribed the height of the Tower B C; the which being carried about by the Earth along the circumference B I, deſcribeth with its top the arch C D: Dividing, in the next place, the line C A in the middle at E; upon the centre E, at the diſtance E C, I deſcribe the ſemicircle C I A: In which, I now affirm, that it is very probable that a ſtone falling from the top of the Tower C, doth move, with a motion mixt of the circular, which is in common, and of its peculiar right motion. If therefore in the circumference C D, certain equal parts C F, F G, G H, H L, be marked, and from the points F, G, H, L, right lines be drawn towards the centre A, the parts of them intercepted between the two circumferences C D and B I, ſhall repreſent unto us the ſame Tower C B, tranſported by the Terreſtrial Globe towards D I; in which lines the points where they come to be interſected by the arch of the ſemicircle C I, are the places by which from time to time the falling ſtone doth paſſe; which points go continually with greater and greater proportion receding from the top of the

The line deſcribed by a moveable in its natural deſcent, the motion of the Earth about its own centre being preſuppoſed, would probably be the circumference of a circle.

Tower. And this is the cause why the right motion made along the side of the Tower appeareth to us more and more accelerate. It appeareth also, how by reason of the infinite acuteness of the contact of those two circles D C, C I, the recession of the cadent moveable from the circumference C F D; namely, from the top of the Tower, is towards the beginning extream small, which is as much as if one said its motion downwards is very slow, and more and more slow *in infinitum*, according to its vicinity to the term C, that is to the state of rest. And lastly it is seen how in the end this same motion goeth to terminate in the centre of the Earth A.

SAGR. I understand all this very well, nor can I perswade my self that the falling moveable doth describe with the centre of its gravity any other line, but such an one as this.

SALV. But stay a little *Sagredus*, for I am to acquaint you also with three Observations of mine, that its possible will not displease you. The first of which is, that if we do well consider, the moveable moveth not really with any more than onely one motion simply circular, as when being placed upon the Tower, it moved with one single and circular motion. The second is yet more pleasant; for, it moveth neither more nor lesse then if it had staid continually upon the Tower, being that to the arches C F, F G, G H, &c. that it would have passed continuing always upon the Tower, the arches of the circumference C I are exactly equal, answering under the same C F, F G, G H, &c. Whence followeth the third wonder, That the true and real motion of the stone is never accelerated, but always even and uniforme, since that all the equal arches noted in the circumference C D, and their respondent ones marked in the circumference C I, are past in equal times; so that we are left at liberty to seek new causes of acceleration, or of other motions, seeing that the moveable, as well standing upon the Tower, as descending thence, always moveth in the same fashion, that is, circularly, with the same velocity, and with the same uniformity. Now tell me what you think of this my fantastical conjecture.

A moveable falling from the top of the Tower, moveth in the circumference of a circle.

It moveth neither more nor lesse, than if it had staid always there.

It moveth with an uniform, not an accelerate motion.

SAGR. I must tell you, that I cannot with words sufficiently expresse how admirable it seemeth to me; and for what at present offereth it self to my understanding, I cannot think that the business happeneth otherwise; and would to God that all the demonstrations of Philosophers were but half so probable as this. However for my perfect satisfaction I would gladly hear how you prove those arches to be equal.

SALV. The demonstration is most easie. Suppose to your self a line drawn from I to E. And the Semidiameter of the circle C D, that is, the line C A, being double the Semidiameter C E of the cir-

circle C I, the circumference ſhall be double to the circumference, and every arch of the greater circle double to every like arch of the leſſer; and conſequently, the half of the arch of the greater circle, equal to the whole arch of the leſſe. And becauſe the angle C E I made in the centre E of the leſſer circle, and which inſiſteth upon the arch C I, is double the angle C A D, made in the centre A of the greater circle, to which the arch C D ſubtendeth; therefore the arch C D is half of the arch of the greater circle like to the arch C I, and therefore the two arches C D and C I are equal; and in the ſame manner we may demonſtrate of all their parts. But that the buſineſs, as to the motion of deſcending grave bodies, proceedeth exactly thus, I will not at this time affirm; but this I will ſay, that if the line deſcribed by the cadent moveable be not exactly the ſame with this, it doth extream neerly reſemble the ſame..

SAGR. But I, *Salviatus*, am juſt now conſidering another particular very admirable; and this it is; That admitting theſe conſiderations, the right motion doth go wholly * mounting, and that Nature never makes uſe thereof, ſince that, even that that uſe, which was from the beginning granted to it, which was of reducing the parts of integral bodies to their place, when they were ſeparated from their whole, and therefore conſtituted in a depraved diſpoſition, is taken from it, and aſſigned to the circular motion.

Right motion ſeemeth wholly excluded in nature.

*Vadia del tutto a monte, *rendered in the Latine* omnino peſſum eat.

SALV. This would neceſſarily follow, if it were concluded that the Terreſtrial Globe moveth circularly; a thing, which I pretend not to be done, but have onely hitherto attempted, as I ſhall ſtill, to examine the ſtrength of thoſe reaſons, which have been alledged by Philoſophers to prove the immobility of the Earth, of which this firſt taken from things falling perpendicularly, hath begat the doubts, that have been mentioned; which I know not of what force they may have ſeemed to *Simplicius*; and therefore before I paſſe to the examination of the remaining arguments, it would be convenient that he produce what he hath to reply to the contrary.

SIMP. As to this firſt, I confeſſe indeed that I have heard ſundry pretty notions, which I never thought upon before, and in regard they are new unto me, I cannot have anſwers ſo ready for them, but this argument taken from things falling perpendicularly, I eſteem it not one of the ſtrongeſt proofs of the mobility of the Earth; and I know not what may happen touching the ſhots of great Guns, eſpecially thoſe aimed contrary to the diurnal motion.

SAGR. The flying of the birds as much puzzleth me as the objection of the Gun-ſhot, and all the other experiments above al-

alledged. For theſe birds which at their pleaſure flie forwards and backwards, and wind to and again in a thouſand faſhions, and, which more importeth, lie whole hours upon the wing, theſe I ſay do not a little poſe me, nor do I ſee how amongſt ſo many circumgyrations, they ſhould not loſe the motion of the Earth, and how they ſhould be able to keep pace with ſo great a velocity as that which they ſo far exceed with their flight.

SALV. To ſpeak the truth, your ſcruple is not without reaſon, and its poſſible *Copernicus* himſelf could not find an anſwer for it, that was to himſelf entirely ſatisfactory; and therefore haply paſt it over in ſilence; albeit he was, indeed, very brief in examining the other allegations of his adverſaries, I believe through his height of wit, placed on greater aud ſublimer contemplations, like as Lions are not much moved at the barking of little Dogs. We will therefore reſerve the inſtance of birds to the laſt place, and for the preſent, ſee if we can give *Simplicius* ſatisfaction in the others, by ſhewing him in our wonted manner, that he himſelf hath their anſwers at hand, though upon firſt thoughts he doth not diſcover them. And to begin with the ſhots made at randome, with the ſelf ſame piece, powder, and ball, the one towards Eaſt, the other towards the Weſt (if the diurnal converſion belonged to the Earth) ought to be much longer than that towards Eaſt.

The reaſon why a Gun ſhould ſeem to carry farther towards the Weſt than towards the Eaſt.

SIMP. I am moved ſo to think; becauſe in the ſhot made towards the Eaſt, the ball whil'ſt it is out of the piece, is followed by the ſaid piece, the which being carried round by the Earth, runneth alſo with much velocity towards the ſame part, whereupon the fall of the ball to the ground, cometh to be but little diſtant from the piece. On the contrary in the ſhot towards the Weſt, before that the ball falleth to the ground, the piece is retired very far towards the Eaſt, by which means the ſpace between the ball and the piece, that is Range, will appear longer than the other, by how much the piece, that is the Earth, had run in the time that both the bals were in the air.

SALV. I could wiſh, that we did know ſome way to make an experiment correſponding to the motion of theſe projects, as that of the ſhip doth to the motion of things perpendicularly falling from on high; and I am thinking how it may be done.

The experiment of a running chariot to find out the difference of Ranges.

*Baleſtrone da bolzoni.

SAGR. I believe, that it would be a very oppoſite proof, to take an open Chariot, and to accomodate therein a * Stock-bow at half elevation, to the end the flight may prove the greateſt that my be, and whil'ſt the horſes ſhall run, to ſhoot firſt towards the part whither you drive, and then another backwards towards the contrary part, cauſing ſome one to mark diligently where the Chariot was in that moment ſ time when the ſhaft came to the

the ground, as well in the one ſhot as in the other: for thus you may ſee exactly how much one ſhaft flew farther than the other.

SIMP. In my thoughts this experiment is very proper: and I do not doubt but that the flight, that is, the ſpace between the ſhaft and the place where the chariot was at the ſhafts fall, will be leſs by much when one ſhooteth towards the chariots courſe, than when one ſhooteth the contrary way. For an example; let the flight of it ſelf be three hundred yards, and the courſe of the chariot in the time, whilſt the ſhaft ſtayeth in the air, an hundred yards, therefore ſhooting towards the courſe of the three hundred yards of the flight, the chariot will have gone one hundred; ſo then at the ſhafts coming to the ground, the ſpace between it and the chariot ſhall be but two hundred yards onely; but on the contrary, in the other ſhoot, the chariot running contrary to the ſhaft, when the ſhaft ſhall have paſſed its three hundred yards, and the chariot its other hundred the contrary way, the diſtance interpoſing ſhall be found to be four hundred yards.

SALV. Is there any way to ſhoot ſo that theſe flights may be equal?

SIMP. I know no other way, unleſs by making the chariot to ſtand ſtill.

SALV. This we know; but I mean when the chariot runneth in full carreer.

SIMP. In that caſe you are to draw the Bow higher in ſhooting forwards, and to ſlack it in ſhooting the contrary way.

SALV. Then you ſee that there is one way more. But how much is the bow to be drawn, and how much ſlackened?

SIMP. In our caſe, where we have ſuppoſed that the bow carried three hundred yards, it would be requiſite to draw it ſo, as that it might carry four hundred, and in the other to ſlacken it ſo, as that it might carry no more than two hundred. For ſo each of the flights would be but three hundred in relation to the chariot, the which, with its courſe of an hundred yards which it ſubſtracts from the ſhoot of four hundred, and addeth to that of two hundred, would reduce them both to three hundred.

SALV. But what effect hath the greater or leſs intenſneſs of the bow upon the ſhaft?

SIMP. The ſtiffer bow carrieth it with greater velocity, and the weaker with leſs; and the ſame ſhaft flieth ſo much farther at one time than another, with how much greater velocity it goeth out of the tiller at one time, than another.

SALV. So that to make the ſhaft ſhot either way, to flie at equal diſtance from the running chariot, it is requiſite, that if in the firſt ſhoot of the precedent example, it goeth out of the tiller with *v. g.* four degrees of velocity, that then in the other ſhoot it depart

part but with two onely : but if the ſame bow be uſed, it always receiveth thence three degrees.

SIMP. It doth ſo; and for this reaſon, ſhooting with the ſame bow in the chariots courſe, the ſhoots cannot be equal.

SALV. I had forgot to ask, with what velocity it is ſuppoſed in this particular experiment, that the chariot runneth.

SIMP. The velocity of the chariot muſt be ſuppoſed to be one degree in compariſon to that of the bow, which is three,

SALV. Very right, for ſo computation gives it. But tell me, when the chariot moveth, doth not all things in the ſame move with the ſame velocity ?

SIMP. Yes doubtleſs.

SALV. Then ſo doth the ſhaft alſo, and the bow, and the ſtring, upon which the ſhaft is nock't.

SIMP. They do ſo.

SALV. Why then, in diſcharging the ſhaft towards the courſe of the chariot, the bow impreſſeth its three degrees of velocity on a ſhaft that had one degree of velocity before, by means of the chariot which tranſported it ſo faſt towards that part; ſo that in its going off it hath four degrees of velocity. On the contrary, in the other ſhoot, the ſame bow conferreth its ſame three degrees of velocity on a ſhaft that moveth the contrary way, with one degree; ſo that in its departing from the bow-ſtring, it hath no more left but onely two degrees of velocity. But you your ſelf have already ſaid, that the way to make the ſhoots equal, is to cauſe that the ſhaft be let flie the firſt time with four degrees of velocity, and the ſecond time with two. Therefore without changing the bow, the very courſe of the chariot is that which adjuſteth the flights, and the experiment doth ſo repreſent them to any one who is not either wilfully or naturally incapable of reaſon. Now apply this diſcourſe to Gunnery, and you ſhall find, that whether the Earth move or ſtand ſtill, the ſhots made with the ſame force, will always curry equal ranges, to what part ſoever aimed. The error of *Ariſtotle*, *Ptolomey*, *Tycho*, your ſelf, and all the reſt, is grounded upon that fixed and ſtrong perſuaſion, that the Earth ſtandeth ſtill, which you have not judgment nor power to depoſe, no not when you have a deſire to argue of that which would enſue, preſuppoſing the Earth to move. And thus, in the other argument, not conſidering that whil'ſt the ſtone is upon the Tower, it doth, as to moving or not moving, the ſame that the Terreſtrial Globe doth, becauſe you have concluded with your ſelf, that the Earth ſtands ſtill, you always diſcourſe touching the fall of the ſtone, as if it were to depart from reſt : whereas it behooveth to ſay, that if the Earth ſtandeth ſtill, the ſtone departeth from reſt, and deſcendeth perpendicularly; but if the Earth do move, the ſtone likewiſe

The ſolution of the argument taken from great-Guns ſhot towards the Eaſt & Weſt.

likewiſe moveth with like velocity, nor doth it depart from reſt, but from a motion equal to that of the Earth, wherewith it intermixeth the ſupervenient motion of deſcent, and of thoſe two compoſeth a third which is tranſverſal or ſide-ways.

SIMP. But for Gods ſake, if it move tranſverſly, how is it that I behold it to move directly and perpendicularly? This is no better than the denial of manifeſt ſenſe; and if we may not believe ſenſe, at what other door ſhall we enter into diſquiſitions of Philoſophy?

SALV. In reſpect to the Earth, to the Tower, and to our ſelves, which all as one piece move with the diurnal motion together with the ſtone, the diurnal motion is as if it never had been, and becometh inſenſible, imperceptible, and without any action at all; and the onely motion which we can perceive, is that of which we partake not, that is the deſcent gliding along the ſide of the Tower: You are not the firſt that hath felt great repugnance in apprehending this non-operating of motion upon things to which it is common.

A notable caſe of Sagredus, *to ſhew the non-operating of common motion.*

SAGR. Now I do remember a certain conceipt, that came one day into my fancy, whilſt I ſailed in my voyage to *Aleppo*, whither I went Conſul for our Country, and poſſibly it may be of ſome uſe, for explaining this nullity of operation of common motion, and being as if it never were to all the partakers thereof. And if it ſtand with the good liking of *Simplicius*, I will reaſon with him upon that which then I thought of by my ſelf alone.

SIMP. The novelty of the things which I hear, makes me not ſo much a patient, as a greedy and curious auditor: therefore go on.

SAGR. If the neb of a writing pen, that I carried along with me in the ſhip through all my navigation from *Venice* to *Scanderoon** had had a faculty of leaving viſible marks of its whole voyage, what ſigns, what lines would it have left?

* Aleſſandretta.

SIMP. It would have left a line diſtended from *Venice* thither, not perfectly ſtreight, or to ſay better, diſtended in a perfect arch of a circle, but in ſome places more, in ſome leſs curved, according as the veſſel had gone more or leſs fluctuating; but this its inflecting in ſome places a fathom or two to the right hand or to the left, upwards or downwards, in a length of many hundred miles, would have brought but little alteration to the entire tract of the line, ſo that it would have been hardly ſenſible; and without any conſiderable error, might have been called the part of a perfect arch.

SAGR. So that the true and moſt exact motion of the neb of my pen would have alſo been an arch of a perfect circle, if the veſſels motion, the fluctuation of the billows ceaſing, had been

calm

calm and tranquill. And if I had continually held that pen in my hand, and had onely moved it ſometimes an inch or two this way or that way, what alteration ſhould I have made in that its principal, and very long tract or ſtroke?

SIMP. Leſs than that which the declining in ſeveral places from abſolute rectitude, but the quantity of a flea's eye makes in a right line of a thouſand yards long.

SAGR. If a Painter, then, at our launching from the Port, had began to deſign upon a paper with that pen, and continued his work till he came to *Scanderon*, he would have been able to have taken by its motion a perfect draught of all thoſe figures perfectly interwoven and ſhadowed on ſeveral ſides with countreys, buildings, living creatures, and other things; albeit all the true, real, and eſſential motion traced out by the neb of that pen, would have been no other than a very long, but ſimple line: and as to the proper operation of the Painter, he would have delineated the ſame to an hair, if the ſhip had ſtood ſtill. That therefore of the huge long motion of the pen there doth remain no other marks, than thoſe tracks drawn upon the paper, the reaſon thereof is becauſe the grand motion from *Venice* to *Scanderon*, was common to the paper, the pen, and all that which was in the ſhip: but the petty motions forwards and backwards, to the right, to the left, communicated by the fingers of the Painter unto the pen, and not to the paper, as being peculiar thereunto, might leave marks of it ſelf upon the paper, which did not move with that motion. Thus it is likewiſe true, that the Earth moving, the motion of the ſtone in deſcending downwards, was really a long tract of many hundreds and thouſands of yards, and if it could have been able to have delineated in a calm air, or other ſuperficies, the track of its courſe, it would have left behind an huge long tranſverſe line. But that part of all this motion which is common to the ſtone, the Tower, and our ſelves, is imperceptible to us, and as if it had never been, and that part onely remaineth obſervable, of which neither the Tower nor we are partakers, which is in fine, that wherewith the ſtone falling meaſureth the Tower.

SALV. A moſt witty conceipt to clear up this point, which was not a little difficult to many capacities. Now if *Simplicius* will make no farther reply, we may paſs to the other experiments, the unfolding of which will receive no ſmall facility from the things already declared.

SIMP. I have nothing more to ſay: and I was well-nigh tranſported with that delineation, and with thinking how thoſe ſtrokes drawn ſo many ways, hither, thither, upwards, downwards, forwards, backwards, and interwoven with thouſands of turnings, are not eſſentially or really other, than ſmall pieces of one ſole line drawn

drawn all one way, and the ſame without any other alteration ſave the declining the direct rectitude, ſometimes a very inſenſible matter towards one ſide or another, and the pens moving its neb one while ſofter, another while ſlower, but with very ſmall inequality. And I think that it would in the ſame manner write a letter, and that thoſe frollike penmen, who to ſhew their command of hand, without taking their pen from the paper in one ſole ſtroke, with infinite turnings draw a pleaſant knot, if they were in a boat that did tide it along ſwiftly they would convert the whole motion of the pen, which in reality is but one ſole line, drawn all towards one and the ſame part, and very little curved, or declining from perfect rectitude, into a knot or flouriſh. And I am much pleaſed that *Sagredus* hath helped me to this conceit: therefore let us go on, for the hope of meeting with more of them, will make me the ſtricter in my attention.

SAGR. If you have a curioſity to hear ſuch like ſubtilties, which occurr not thus to every one, you will find no want of them, eſpecially in this particular of Navigation; and do you not think that a witty conceit which I met with likewiſe in the ſame voyage, when I obſerved that the maſt of the ſhip, without either breaking or bending, had made a greater voyage with its round-top, that is with its top-gallant, than with its foot; for the round top being more diſtant from the centre of the Earth than the foot is, it had deſcribed the arch of a circle bigger than the circle by which the foot had paſſed.

Subtilties ſufficiently inſipid, ironically, ſpoken and taken from a certain Encyclopædia.

SIMP. And thus when a man walketh he goeth farther with his head than with his feet.

SAGR. You have found out the matter your ſelf by help of your own mother-vvit: But let us not interrupt *Salviatus*.

SALV. It pleaſeth me to ſee *Simplicius* hovv he ſootheth up himſelf in this conceit, if happly it be his ovvn, and that he hath not borrovved it from a certain little pamphlet of concluſions, vvhere there are a great many more ſuch fancies no leſs pleaſant & vvitty. It followveth that vve ſpeak of the peice of Ordinance mounted perpendicular to the Horizon, that is, of a ſhot tovvards our vertical point, and to conclude, of the return of the ball by the ſame line unto the ſame peice, though that in the long time vvhich it is ſeparated from the peice, the earth hath tranſported it many miles tovvards the Eaſt; novv it ſeemeth, that the ball ought to fall a like diſtance from the peice tovvards the Weſt; the vvhich doth not happen: therefore the peice vvithout having been moved did ſtay expecting the ſame. The anſvver is the ſame vvith that of the ſtone falling from the Tovver; and all the fallacy, and equivocation conſiſteth in ſuppoſing ſtill for true, that vvhich is in queſtion; for the Opponent hath it ſtill fixed in his conceit that the ball departs from its reſt, being diſcharged by the fire

An inſtance againſt the diurnal motion of the earth, taken from the ſhot of a Peece of Ordinance perpendicularly.

The anſwer to the objection, ſhewing the equivoke.

from the piece; and the departing from the ſtate of reſt, cannot be, unleſſe the immobility of the Terreſtrial Globe be preſuppoſed, which is the concluſion of that was in diſpute; Therefore, I reply, that thoſe who make the Earth moveable, anſwer, that the piece, and the ball that is in it, partake of the ſame motion with the Earth; nay that they have this together with her from nature; and that therefore the ball departs in no other manner from its quieſcence, but conjoyned with its motion about the centre, the which by its projection upwards, is neither taken away, nor hindered; and in this manner following, the univerſal motion of the Earth towards the Eaſt, it alwayes keepeth perpendicular over the ſaid piece, as well in its riſe as in its return. And the ſame you ſee to enſue, in making the experiment in a ſhip with a bullet ſhot upwards perpendicularly with a Croſſe-bow, which returneth to the ſame place whether the ſhip doth move, or ſtand ſtill.

Another anſwer to the ſame objection.

SAGR. This ſatisfieth very well to all; but becauſe that I have ſeen that *Simplicius* taketh pleaſure with certain ſubtilties to puzzle his companions, I will demand of him whether, ſuppoſing for this time that the Earth ſtandeth ſtill, and the piece erected upon it perpendicularly, directed to our Zenith, he do at all queſtion that to be the true perpendicular ſhot, and that the ball in departing, and in its return is to go by the ſame right line, ſtill ſuppoſing all external and accidental impediments to be removed?

SIMP. I underſtand that the matter ought to ſucceed exactly in that manner.

SAGR. But if the piece were placed, not perpendicularly, but inclining towards ſome place, what would the motion of the ball be? Would it go haply, as in the other ſhot, by the perpendicular line, and return again by the ſame?

SIMP. It would not ſo do; but iſſuing out of the piece, it would purſue its motion by a right line which prolongeth the erect perpendicularity of the concave cylinder of the piece, unleſſe ſo far as its own vveight vvould make it decline from that erection towards the Earth.

SAGR. So that the mounture of the cylinder is the regulator of the motion of the ball, nor doth it, or would it move out of that line, if its own gravity did not make it decline downwards. And therefore placing the cylinder perpendicularly, and ſhooting the ball upwards, it returneth by the ſame right line downvvards; becauſe the motion of the ball dependent on its gravity is downward, by the ſame perpendicular. The journey therefore of the ball out of the piece, continueth or prolongeth the rectitude or perpendicularity of that ſmall part of the ſaid journey, vvhich it made vvithin the ſaid piece; is it not ſo?

Projects continue their motion by the right line that followeth the direction of the motion, made together with the projicient, whil'ſt they were conjoin'd therewith.

SIMP.

SIMP. So it is, in my opinion.

SAGR. Now imagine the cylinder to be erected, and that the Earth doth revolve about vvith a diurnal motion, carrying the piece along vvith it, tell me vvhat ſhall be the motion of the ball vvithin the cylinder, having given fire?

SIMP. It ſhall be a ſtreight and perpendicular motion, the cylinder being erected perpendicularly.

SAGR. Conſider vvell vvhat you ſay: for I believe that it vvill not be perpendicular. It vvould indeed be perpendicular, if the Earth ſtood ſtill, for ſo the ball vvould have no other motion but that proceeding from the fire. But in caſe the Earth turns round, the ball that is in the piece, hath likewiſe a diurnal motion; ſo that there being added to the ſame the impulſe of the fire; it moveth from the breech of the piece to the muzzle with two motions, from the compoſition whereof it cometh to paſſe that the motion made by the centre of the balls gravity is an inclining line. And for your clearer underſtanding the ſame, let the piece A C [*in Fig.* 2.] be erected, and in it the ball B; it is manifeſt, that the piece ſtanding immoveable, and fire being given to it, the ball will make its way out by the mouth A, and with its centre, paſſing thorow the the piece, ſhall have deſcribed the perpendicular line B A, and it ſhall purſue that rectitude when it is out of the piece, moving toward the Zenith. But in caſe the Earth ſhould move round, and conſequently carry the piece along with it, in the time that the ball driven out of the piece ſhall move along the cylinder, the piece being carried by the Earth, ſhall paſſe into the ſituation D E, and the ball B, in going off, would be at the corniſh D, and the motion of the bals centre, would have been according to the line B D, no longer perpendicular, but inclining towards the Eaſt; and the ball (as hath been concluded) being to continue its motion through the air, according to the direction of the motion made in the piece, the ſaid motion ſhall continue on according to the inclination of the line B D, and ſo ſhall no longer be perpendicular, but inclined towards the Eaſt, to which part the piece doth alſo move; whereupon the ball may follow the motion of the Earth, and of the piece. Now *Simplicius*; you ſee it demonſtrated, that the Range which you took to be perpendicular, is not ſo.

The revolution of the Earth ſuppoſed, the ball in the piece erected perpendicularly, doth not move by a perpendicular, but an inclined line.

SIMP. I do not very well underſtand this buſineſs; do you, *Salviatus*?

SALV. I apprehend it in part; but I have a certain kind of ſcruple, which I wiſh I knew how to expreſs. It ſeems to me, that according to what hath been ſaid, if the Piece be erected perpendicular, and the Earth do move, the ball would not be to fall, as *Ariſtotle* and *Tycho* will have it, far from the Piece towards the

Weſt, nor as you would have it, upon the Piece, but rather far diſtant towards the Eaſt. For according to your explanation, it would have two motions, the which would with one conſent carry it thitherward, to wit, the common motion of the Earth, which carrieth the Piece and the ball from C A towards E D; and the fire which carrieth it by the inclined line B D, both motions towards the Eaſt, and therefore they are ſuperiour to the motion of the Earth.

SAGR. Not ſo, Sir. The motion which carrieth the ball towards the Eaſt, cometh all from the Earth, and the fire hath no part at all therein: the motion which mounteth the ball upwards, is wholly of fire, wherewith the Earth hath nothing to do. And that it is ſo, if you give not fire, the ball will never go out of the Piece, nor yet riſe upwards a hairs breadth; as alſo if you make the Earth immoveable, and give fire, the ball without any inclination ſhall go perpendicularly upwards. The ball therefore having two motions, one upwards, and the other in gyration, of both which the tranſverſe line B D is compounded, the impulſe upward is wholly of fire, the circular cometh wholly from the Earth, and is equal to the Earths motion: and being equal to it, the ball maintaineth it ſelf all the way directly over the mouth of the Piece, and at laſt falleth back into the ſame: and becauſe it always obſerveth the erection of the Piece, it appeareth alſo continually over the head of him that is near the Piece, and therefore it appeareth to mount exactly perpendicular towards our Zenith, or vertical point.

SIMP. I have yet one doubt more remaining, and it is, that in regard the motion of the ball is very ſwift in the Piece, it ſeems not poſſible, that in that moment of time the tranſpoſition of the Piece from C A to A D ſhould confer ſuch an inclination upon the tranſverſe line C D, that by means thereof, the ball when it cometh afterwards into the air ſhould be able to follow the courſe of the Earth.

SAGR. You err upon many accounts; and firſt, the inclination of the tranſverſe line C D, I believe it is much greater than you take it to be, for I verily think that the velocity of the Earths motion, not onely under the Equinoctial, but in our parallel alſo, is greater than that of the ball whilſt it moveth in the Piece; ſo that the interval C E would be abſolutely much bigger than the whole length of the Piece, and the inclination of the tranſverſe line conſequently bigger than half a right angle: but be the velocity of the Earth more, or be it leſs, in compariſon of the velocity of the fire, this imports nothing; for if the velocity of the Earth be ſmall, and conſequently the inclination of the tranſverſe line be little alſo; there is then alſo need but of little inclination to make the ball

ball ſuſpend it ſelf in its range directly over the Piece. And in a word, if you do but attentively conſider, you will comprehend, that the motion of the Earth in transferring the Piece along with it from C A to E D, conferreth upon the tranſverſe line C D, ſo much of little or great inclination, as is required to adjuſt the range to its perpendicularity. But you err, ſecondly, in that you referr the faculty of carrying the ball along with the Earth to the impulſe of the fire, and you run into the ſame error, into which *Salviatus*, but even now ſeemed to have fallen; for the faculty of following the motion of the Earth, is the primary and perpetual motion, indelibly and inſeparably imparted to the ſaid ball, as to a thing terreſtrial, and that of its own nature doth and ever ſhall poſſeſs the ſame.

The manner how Fowlers ſhoot birds flying.

SALV. Let us yield, *Simplicius*, for the buſineſs is juſt as he ſaith. And now from this diſcourſe let us come to underſtand the reaſon of a Venatorian Problem, of thoſe Fowlers who with their guns ſhoot a bird flying; and becauſe I did imagine, that in regard the bird flieth a great pace, therefore they ſhould aim their ſhot far from the bird, anticipating its flight for a certain ſpace, and more or leſs according to its velocity and the diſtance of the bird, that ſo the bullet haſting directly to the mark aimed at, it might come to arrive at the ſelf ſame time in the ſame point with its motion, and the bird with its flight, and by that means one to encounter the other: and asking one of them, if their practiſe was not ſo to do; He told me, no; but that the ſlight was very eaſie and certain, and that they took aim juſt in the ſame manner as if they had ſhot at a bird that did ſit ſtill; that is, they made the flying bird their mark, and by moving their fowling-piece they followed her, keeping their aim ſtill full upon her, till ſuch time as they let fly, and in this manner ſhot her as they did others ſitting ſtill. It is neceſſary therefore that that motion, though ſlow, which the fowling-piece maketh in turning and following after the flight of the bird do communicate it ſelf to the bullet alſo, and that it be joyned with that of the fire; ſo that the ball hath from the fire the motion directly upwards, and from the concave Cylinder of the barrel the declination according to the flight of the Bird, juſt as was ſaid before of the ſhot of a Canon; where the ball receiveth from the fire a virtue of mounting upwards towards the Zenith, and from the motion of the Earth its winding towards the Eaſt, and of both maketh a compound motion that followeth the courſe of the Earth, and that to the beholder ſeemeth onely to go directly upwards, and return again downwards by the ſame line. The holding therefore of the gun continually directed towards the mark, maketh the ſhoot hit right, and that you may keep your gun directed to the mark, in caſe the mark ſtands ſtill, you muſt alſo hold

your gun ſtill; and if the mark ſhall move, the gun muſt be kept upon the mark by moving. And upon this dependeth the proper anſwer to the other argument taken from the ſhot of a Canon, at the mark placed towards the South or North: wherein is alledged, that if the Earth ſhould move, the ſhots would all range Weſtward of the mark, becauſe that in the time whilſt the ball, being forc'd out of the Piece, goeth through the air to the mark, the ſaid mark being carried toward the Eaſt, would leave the ball to the Weſtward. I anſwer therefore, demanding whether if the Canon be aimed true at the mark, and permitted ſo to continue, it will conſtantly hit the ſaid mark, whether the Earth move or ſtand ſtill? It muſt be replied, that the aim altereth not at all, for if the mark doth ſtand ſtill, the Piece alſo doth ſtand ſtill, and if it, being tranſported by the Earths motion, doth move, the Piece doth alſo move at the ſame rate, and, the aim maintained, the ſhot proveth always true, as by what hath been ſaid above, is manifeſt.

The anſwer to the objection taken from the ſhots of great Guns made towards the North and South.

SAGR. Stay a little, I entreat you, *Salviatus*, till I have propounded a certain conceit touching theſe ſhooters of birds flying, whoſe proceeding I believe to be the ſame which you relate, and believe the effect of hitting the bird doth likewiſe follow: but yet I cannot think that act altogether conformable to this of ſhooting in great Guns, which ought to hit as well when the piece and mark moveth, as when they both ſtand ſtill; and theſe, in my opinion, are the particulars in which they diſagree. In ſhooting with a great Gun both it and the mark move with equal velocity, being both tranſported by the motion of the Terreſtrial Globe: and albeit ſometimes the piece being planted more towards the Pole, than the mark, and conſequently its motion being ſomewhat ſlower than the motion of the mark, as being made in a leſſer circle, ſuch a difference is inſenſible, at that little diſtance of the piece from the mark: but in the ſhot of the Fowler the motion of the Fowling-piece wherewith it goeth following the bird, is very ſlow in compariſon of the flight of the ſaid bird; whence me thinks it ſhould follow, that that ſmall motion which the turning of the Birding-piece confereth on the bullet that is within it, cannot, when it is once gone forth of it, multiply it ſelf in the air, untill it come to equal the velocity of the birds flight, ſo as that the ſaid bullet ſhould always keep direct upon it: nay, me thinketh the bird would anticipate it and leave it behind. Let me add, that in this act, the air through which the bullet is to paſs, partaketh not of the motion of the bird; whereas in the caſe of the Canon, both it, the mark, and the intermediate air, do equally partake of the common diurnal motion. So that the true cauſe of the Marks-man his hitting the mark, as it ſhould ſeem, moreover and beſides the following

following the birds flight with the piece, is his ſomewhat anticipating it, taking his aim before it; as alſo his ſhooting (as I believe) not with one bullet, but with many ſmall balls (called ſhot) the which ſcattering in the air poſſeſs a great ſpace; and alſo the extreme velocity wherewith theſe ſhot, being diſcharged from the Gun, go towards the bird.

SALV. See how far the winged wit of *Sagredus* anticipateth, and out-goeth the dulneſs of mine; which perhaps would have light upon theſe diſparities, but not without long ſtudie. Now turning to the matter in hand, there do remain to be conſidered by us the ſhots at point blank, towards the Eaſt and towards the Weſt; the firſt of which, if the Earth did move, would always happen to be too high above the mark, and the ſecond too low; foraſmuch as the parts of the Earth Eaſtward, by reaſon of the diurnal motion, do continually deſcend beneath the tangent paralel to the Horizon, whereupon the Eaſtern ſtars to us appear to aſcend; and on the contrary, the parts Weſtward do more and more aſcend, whereupon the Weſtern ſtars do in our ſeeming deſcend: and therefore the ranges which are leveled according to the ſaid tangent at the Oriental mark, (which whilſt the ball paſſeth along by the tangent deſcendeth) ſhould prove too high, and the Occidental too low by means of the elevation of the mark; whilſt the ball paſſeth along the tangent. The anſwer is like to the reſt: for as the Eaſtern mark goeth continually deſcending, by reaſon of the Earths motion, under a tangent that continueth immoveable; ſo likewiſe the piece for the ſame reaſon goeth continually inclining, and with its mounture purſuing the ſaid mark: by which means the ſhot proveth true.

The anſwer to the Argument taken from the ſhots at point blanck towards the Eaſt & Weſt.

But here I think it a convenient opportunity to give notice of certain conceſſions, which are granted perhaps over liberally by the followers of *Copernicus* unto their Adverſaries: I mean of yielding to them certain experiments for ſure and certain, which yet the Adverſaries themſelves had never made tryal of: as for example, that of things falling from the round-top of a ſhip whilſt it is in motion, and many others; amongſt which I verily believe, that this of experimenting whether the ſhot made by a Canon towards the Eaſt proveth too high, and the Weſtern ſhot too low, is one: and becauſe I believe that they have never made tryal thereof, I deſire that they would tell me what difference they think ought to happen between the ſaid ſhots, ſuppoſing the Earth moveable, or ſuppoſing it moveable; and let *Simplicius* for this time anſwer for them.

The followers of Copernicus *too freely admit certain propoſitions for true, which are very doubtfull.*

SIMP. I will not undertake to anſwer ſo confidently as another more intelligent perhaps might do; but ſhall ſpeak what thus upon the ſudden I think they would reply; which is in effect the ſame with

with that which hath been ſaid already, namely, that in caſe the Earth ſhould move, the ſhots made Eaſtward would prove too high, &c. the ball, as it is probable, being to move along the tangent.

SALV. But if I ſhould ſay, that ſo it falleth out upon triall, how would you cenſure me?

SIMP. It is neceſſary to proceed to experiments for the proving of it.

SALV. But do you think, that there is to be found a Gunner ſo skilful, as to hit the mark at every ſhoot, in a diſtance of *v.g.* five hundred paces?

SIMP. No Sir; nay I believe that there is no one, how good a marks-man ſoever that would promiſe to come within a pace of the mark,

SALV. How can we then, with ſhots ſo uncertain, aſſure our ſelves of that which is in diſpute?

SIMP. We may be aſſured thereof two wayes; one, by making many ſhots; the other, becauſe in reſpect of the great velocity of the Earths motion, the deviation from the mark would in my opinion be very great.

SALV. Very great, that is more than one pace; in regard that the varying ſo much, yea and more, is granted to happen ordinarily even in the Earths mobility.

SIMP. I verily believe the variation from the mark would be more than ſo.

A Computation how much the ranges of great ſhot ought to vary from the marke, the Earths motion being granted.

SALV. Now I deſire that for our ſatisfaction we do make thus in groſſe a ſlight calculation, if you conſent thereto, which will ſtand us in ſtead likewiſe (if the computation ſucceed as I expect) for a warning how we do in other occurrences ſuffer our ſelves, as the ſaying is, to be taken with the enemies ſhouts, and ſurrender up our belief to what ever firſt preſents it ſelf to our fancy. And now to give all advantages to the *Peripateticks* and *Tychonicks*, let us ſuppoſe our ſelves to be under the Equinoctial, there to ſhoot a piece of Ordinance point blank Eaſtwards at a mark five hundred paces off. Firſt, let us ſee thus (as I ſaid) in a level, what time the ſhot after it is gone out of the Piece taketh to arrive at the mark; which we know to be very little, and is certainly no more than that wherein a travailer walketh two ſteps, which alſo is leſs than the ſecond of a minute of an hour; for ſuppoſing that the travailer walketh three miles in an hour, which are nine thouſand paces, being that an hour containes three thouſand, ſix hundred ſecond minutes, the travailer walketh two ſteps and an half in a ſecond, a ſecond therefore is more than the time of the balls motion. And for that the diurnal revolution is twenty four hours, the Weſtern horizon riſeth fifteen degrees in an hour, that is,

is, fifteen firſt minutes of a degree, in one firſt minute of an hour; that is, fifteen ſeconds of a degree, in one ſecond of an hour; and becauſe one ſecond is the time of the ſhot, therefore in this time the Weſtern horizon riſeth fifteen ſeconds of a degree, and ſo much likewiſe the mark; and therefore fifteen ſeconds of that circle, whoſe ſemidiameter is five hundred paces (for ſo much the diſtance of the mark from the Piece was ſuppoſed.) Now let us look in the table of Arches and Chords (ſee here is *Copernicus* his book) what part is the chord of fifteen ſeconds of the ſemidiameter, that is, five hundred paces. Here you ſee the chord (or ſubtenſe) of a firſt minute to be leſs than thirty of thoſe parts, of which the ſemidiameter is an hundred thouſand. Therefore the chord of a ſecond minute ſhall be leſs then half of one of thoſe parts, that is leſs than one of thoſe parts, of which the ſemidiameter is two hundred thouſand; and therefore the chord of fifteen conds ſhall be leſs than fifteen of thoſe ſame two hundred thouſand parts; but that which is leſs than (*a*) fifteen parts of two hundred thouſand, is alſo more than that which is four centeſimes of five hundred; therefore the aſcent of the mark in the time of the balls motion is leſſe than four centeſmes, that is, than one twenty fifth part of a pace; it ſhall be therefore (*b*) about two inches: And ſo much conſequently ſhall be the variation of each Weſtern ſhot, the Earth being ſuppoſed to have a diurnal motion. Now if I ſhall tell you, that this variation (I mean of falling two inches ſhort of what they would do in caſe the Earth did not move) upon triall doth happen in all ſhots, how will you convince me *Simplicius*, ſhewing me by an experiment that it is not ſo? Do you not ſee that it is impoſſible to confute me, unleſs you firſt find out a way to ſhoot at a mark with ſo much exactneſſe, as never to miſſe an hairs bredth? For whilſt the ranges of great ſhot conſiſt of different numbers of paces, as *de facto* they do, I will affirm that in each of thoſe variations there is contained that of two inches cauſed by the motion of the Earth.

(*a*) That is, in plainer termes the fraction $\frac{15}{2000}$, is more than the fraction $\frac{3}{1000}$, for dividing the denominators by their nominators, and the firſt produceth 133333$\frac{1}{3}$, the other but 12500.

(*b*) It ſhall be neer 2$\frac{1}{2}$ inches, accounting the pace to be Geometrical, containing 5 foot.

SAGR. Pardon me, *Salviatus*, you are too liberal. For I would tell the *Peripateticks*, that though every ſhot ſhould hit the very centre of the mark, that ſhould not in the leaſt diſprove the motion of the Earth. For the Gunners are ſo conſtantly imployed in levelling the ſight and gun to the mark, as that they can hit the ſame, notwithſtanding the motion of the Earth. And I ſay, that if the Earth ſhould ſtand ſtill, the ſhots would not prove true; but the Occidental would be too low, and the Oriental too high: now let *Simplicius* diſprove me if he can.

It is demonſtrated with great ſubtilty, that the Earths motion ſuppoſed, Canon ſhot ought not to vary more than in reſt.

SALV. This is a ſubtilty worthy of *Sagredus*: But whether this variation be to be obſerved in the motion, or in the reſt of the Earth, it muſt needs be very ſmall, it muſt needs be ſwallowed up

It is requiſite to be very cautious in admitting experiments for true, to thoſe who never tried them.

in thoſe very great ones which ſundry accidents continually produce. And all this hath been ſpoken and granted on good grounds to *Simplicius*, and only with an intent to advertiſe him how much it importeth to be cautious in granting many experiments for true to thoſe who never had tried them, but only eagerly alledged them juſt as they ought to be for the ſerving their purpoſe: This is ſpoken, I ſay, by way of ſurpluſſage and Corollary to *Simplicius*, for the real truth is, that as concerning theſe ſhots, the ſame ought exactly to befall aſwell in the motion as in the reſt of the Terreſtrial Globe; as likewiſe it will happen in all the other experiments that either have been or can be produced, which have at firſt bluſh ſo much ſemblance of truth, as the antiquated opinion of the Earths motion hath of equivocation.

Experiments and arguments againſt the Earths motion ſeem ſo far concluding, as they lie hid under equivokes.

SAGR. As for my part I am fully ſatisfied, and very well underſtand that who ſo ſhall imprint in his fancy this general community of the diurnal converſion amongſt all things Terreſtrial, to all which it naturally agreeth, aſwell as in the old conceit of its reſt about the centre, ſhall doubtleſſe diſcern the fallacy and equivoke which made the arguments produced ſeem concluding. There yet remains in me ſome hæſitancy (as I have hinted before) touching the flight of birds; the which having as it were an animate faculty of moving at their pleaſure with a thouſand motions, and to ſtay long in the Air ſeparated from the Earth, and therein with moſt irregular windings to go fluttering to and again, I cannot conceive how amongſt ſo great a confuſion of motions, they ſhould be able to retain the firſt commune motion; and in what manner, having once made any ſtay behind, they can get it up again, and overtake the ſame with flying, and keep pace with the Towers and trees which hurry with ſo precipitant a courſe towards the Eaſt; I ſay ſo precipitant, for in the great circle of the Globe it is little leſſe than a thouſand miles an hour, whereof the flight of the ſwallow I believe makes not fifty.

SALV. If the birds were to keep pace with the courſe of the trees by help of their wings, they would of neceſſity flie very faſt; and if they were deprived of the univerſal converſion, they would lag as far behind; and their flight would ſeem as furious towards the Weſt, and to him that could diſcern the ſame, it would much exceed the flight of an arrow; but I think we could not be able to perceive it, no more than we ſee a Canon bullet, whil'ſt driven by the fury of the fire, it flieth through the Air: But the truth is that the proper motion of birds, I mean of their flight, hath nothing to do with the univerſal motion, to which it is neither an help, nor an hinderance; and that which maintaineth the ſaid motion unaltered in the birds, is the Air it ſelf, thorough which they flie, which naturally followving the *Vertigo* of the Earth

Earth, like as it carrieth the clouds along with it, ſo it tranſporteth birds and every thing elſe which is pendent in the ſame; in ſo much that as to the buſineſſe of keeping pace vvith the Earth, the birds need take no care thereof, but for that work might ſleep perpetually.

SAGR. That the Air can carry the clouds along with it, as being matters eaſie for their lightneſſe to be moved and deprived of all other contrary inclination, yea more, as being matters that partake alſo of the conditions and properties of the Earth; I comprehend without any difficulty; but that birds, which as having life, may move with a motion quite contrary to the diurnal, once having ſurceaſed the ſaid motion, the Air ſhould reſtore them to it, ſeems to me a little ſtrange, and the rather for that they are ſolid and weighty bodies; and withal, we ſee; as hath been ſaid, ſtones and other grave bodies to lie unmoved againſt the *impetus* of the air; and when they ſuffer themſelves to be overcome thereby, they never acquire ſo much velocity as the wind which carrieth them.

SALV. We aſcribe not ſo little force, *Sagredus*, to the moved Air, which is able to move and bear before it ſhips full fraught, to tear up trees by the roots, and overthrow Towers when it moveth ſwiftly; and yet we cannot ſay that the motion of the Air in theſe violent operations is neer ſo violent, as that of the diurnal revolution.

SIMP. You ſee then that the moved Air may alſo cotinue the motion of projects, according to the Doctrine of *Ariſtotle*; and it ſeemed to me very ſtrange that he ſhould have erred in this particular.

SALV. It may without doubt, in caſe it could continue it ſelf, but like as when the wind ceaſing neither ſhips go on, nor trees are blown down, ſo the motion in the Air not continuing after the ſtone is gone out of the hand, and the Air ceaſing to move, it followeth that it muſt be ſomething elſe beſides the Air that maketh the projects to move.

SIMP. But how upon the winds being laid, doth the ſhip ceaſe to move?" Nay you may ſee that when the wind is down, and the ſails furl'd, the veſſel continueth to run whole miles.

SALV. But this maketh againſt your ſelf *Simplicius*, for that the wind being laid that filling the ſails drove on the ſhip, yet nevertheleſſe doth it without help of the *medium* continue its courſe.

SIMP. It might be ſaid that the water was the *medium* which carried forward the ſhip, and maintain'd it in motion.

SALV. It might indeed be ſo affirmed, if you would ſpeak quite contrary to truth; for the truth is, that the water, by rea-

ſon of its great reſiſtance to the diviſion made by the hull of the ſhip, doth with great noiſe reſiſt the ſame; nor doth it permit it of a great while to acquire that velocity which the wind would confer upon it, were the obſtacle of the water removed. Perhaps *Simplicius* you have never conſidered with what fury the water beſets a bark, whil'ſt it forceth its way through a ſtanding water by help of Oars or Sails: for if you had ever minded that effect, you would not now have produced ſuch an abſurdity. And I am thinking that you have hitherto been one of thoſe who to find out how ſuch things ſucceed, and to come to the knowledg of natural effects, do not betake themſelves to a Ship, a Croſſe-bow, or a piece of Ordinance, but retire into their ſtudies, and turn over Indexes and Tables to ſee whether *Ariſtotle* hath ſpoken any thing thereof; and being aſſured of the true ſenſe of the Text, neither deſire nor care for knowing any more.

The great felicity for which they are much to be envied who perſwade themſelves that they know every thing.

SAGR. This is a great felicity, and they are to be much envied for it. For if knowledg be deſired by all, and if to be wiſe, be to think ones ſelf ſo, they enjoy a very great happineſſe, for that they may perſwade themſelves that they know and underſtand all things, in ſcorn of thoſe who knowing, that they underſtand not what theſe think they underſtand, and conſequently ſeeking that they know not the very leaſt particle of what is knowable, kill themſelves with waking and ſtudying, and conſume their days in experiments and obſervations. But pray you let us return to our birds; touching which you have ſaid, that the Air being moved with great velocity, might reſtore unto them that part of the diurnal motion which amongſt the windings of their flight they might have loſt; to which I reply, that the agitated Air ſeemeth unable to confer on a ſolid and grave body, ſo great a velocity as its own: And becauſe that of the Air is as great as that of the Earth, I cannot think that the Air is able to make good the loſſe of the birds retardation in flight.

SALV. Your diſcourſe hath in it much of probability, and to ſtick at trivial doubts is not for an acute wit; yet nevertheleſſe the probability being removed, I believed that it hath not a jot more force than the others already conſidered and reſolved.

SAGR. It is moſt certain that if it be not neceſſarily concludent, its efficacy muſt needs be juſt nothing at all, for it is onely when the concluſion is neceſſary that the opponent hath nothing to alledg on the contrary.

SALV. Your making a greater ſcruple of this than of the other inſtances dependeth, if I miſtake not, upon the birds being animated, and thereby enabled to uſe their ſtrength at pleaſure againſt the primary motion in-bred in terrene bodies: like as for example,

example, we ſee them whil'ſt they are alive to fly upwards, a thing altogether impoſſible for them to do as they are grave bodies; whereas being dead they can onely fall downwards; and therefore you hold that the reaſons that are of force in all the kinds of projects above named, cannot take place in birds: Now this is very true; and becauſe it is ſo, *Sagredus*, that doth not appear to be done in thoſe projects, which we ſee the birds to do. For if from the top of a Tower you let fall a dead bird and a live one, the dead bird ſhall do the ſame that a ſtone doth, that is, it ſhall firſt follow the general motion diurnal, and then the motion of deſcent, as grave; but if the bird let fall, be a live, what ſhall hinder it, (there ever remaining in it the diurnal motion) from ſoaring by help of its wings to what place of the Horizon it ſhall pleaſe? and this new motion, as being peculiar to the bird, and not participated by us, muſt of neceſſity be viſible to us; and if it be moved by help of its wings towards the Weſt, what ſhall hinder it from returning with a like help of its wings unto the Tower. And, becauſe, in the laſt place, the bird ſwending its flight towards the Weſt was no other than a withdrawing from the diurnal motion, (which hath, ſuppoſe ten degrees of velocity) one degree onely, there did thereupon remain to the bird, whil'ſt it was in its flight nine degrees of velocity, and ſo ſoon as it did alight upon the the Earth, the ten common degrees returned to it, to which, by flying towards the Eaſt it might adde one, and with thoſe eleven overtake the Tower. And in ſhort, if we well conſider, and more narrowly examine the effects of the flight of birds, they differ from the projects ſhot or thrown to any part of the World in nothing, ſave onely that the projects are moved by an external projicient, and the birds by an internal principle. And here for a final proof of the nullity of all the experiments before alledged, I conceive it now a time and place convenient to demonſtrate a way how to make an exact trial of them all. Shut your ſelf up with ſome friend in the grand Cabbin between the decks of ſome large Ship, and there procure gnats, flies, and ſuch other ſmall winged creatures: get alſo a great tub (or other veſſel) full of water, and within it put certain fiſhes; let alſo a certain bottle be hung up, which drop by drop letteth forth its water into another bottle placed underneath, having a narrow neck: and, the Ship lying ſtill, obſerve diligently how thoſe ſmall winged animals fly with like velocity towards all parts of the Cabin; how the fiſhes ſwim indifferently towards all ſides; and how the diſtilling drops all fall into the bottle placed underneath. And caſting any thing towards your friend, you need not throw it with more force one way then another, provided the diſtances be equal: and leaping, as the ſaying is, with your feet cloſed, you will reach

The anſwer to the argument taken from the flight of birds contrary to the motion of the Earth.

An experiment with which alone is ſhewn the nullity of all the objections produced againſt the motion of the Earth.

as far one way as another. Having obſerved all theſe particulars, though no man doubteth that ſo long as the veſſel ſtands ſtill, they ought to ſucceed in this manner; make the Ship to move with what velocity you pleaſe; for (ſo long as the motion is uniforme, and not fluctuating this way and that way) you ſhall not diſcern any the leaſt alteration in all the forenamed effects; nor can you gather by any of them whether the Ship doth move or ſtand ſtill. In leaping you ſhall reach as far upon the floor, as before; nor for that the Ship moveth ſhall you make a greater leap towards the poop than towards the prow; howbeit in the time that you ſtaid in the Air, the floor under your feet ſhall have run the contrary way to that of your jump; and throwing any thing to your companion you ſhall not need to caſt it with more ſtrength that it may reach him, if he ſhall be towards the prow, and you towards the poop, then if you ſtood in a contrary ſituation; the drops ſhall all diſtill as before into the inferiour bottle, and not ſo much as one ſhall fall towards the poop, albeit whil'ſt the drop is in the Air, the Ship ſhall have run many feet; the Fiſhes in their water ſhall not ſwim with more trouble towards the fore-part, than towards the hinder part of the tub; but ſhall with equal velocity make to the bait placed on any ſide of the tub; and laſtly, the flies and gnats ſhall continue their flight indifferently towards all parts; nor ſhall they ever happen to be driven together towards the ſide of the Cabbin next the prow, as if they were wearied with following the ſwift courſe of the Ship, from which through their ſuſpenſion in the Air, they had been long ſeparated; and if burning a few graines of incenſe you make a little ſmoke, you ſhall ſee it aſcend on high, and there in manner of a cloud ſuſpend it ſelf, and move indifferently, not inclining more to one ſide than another: and of this correſpondence of effects the cauſe is for that the Ships motion is common to all the things contained in it, and to the Air alſo; I mean if thoſe things be ſhut up in the Cabbin: but in caſe thoſe things were above deck in the open Air, and not obliged to follow the courſe of the Ship, differences more or leſſe notable would be obſerved in ſome of the fore-named effects, and there is no doubt but that the ſmoke would ſtay behind as much as the Air it ſelf; the flies alſo, and the gnats being hindered by the Air would not be able to follow the motion of the Ship, if they were ſeparated at any diſtance from it. But keeping neer thereto, becauſe the Ship it ſelf as being an unfractuous Fabrick, carrieth along with it part of its neereſt Air, they would follow the ſaid Ship without any pains or difficulty. And for the like reaſon we ſee ſometimes in riding poſt, that the troubleſome flies and * hornets do follow the horſes flying ſometimes to one, ſometimes to another part of the body, but in the falling drops

* *Tavani, horſe-flies*

the

the difference would be very ſmall; and in the ſalts, and projections of grave bodies altogether imperceptible.

SAGR. Though it came not into my thoughts to make triall of theſe obſervations, when I was at Sea, yet am I confident that they will ſucceed in the ſame manner, as you have related; in confirmation of which I remember that being in my Cabbin I have asked an hundred times whether the Ship moved or ſtood ſtill; and ſometimes I have imagined that it moved one way, when it ſteered quite another way. I am therefore as hitherto ſatisfied and convinced of the nullity of all thoſe experiments that have been produced in proof of the negative part. There now remains the objection founded upon that which experience ſhews us, namely, that a ſwift *Vertigo* or whirling about hath a faculty to extrude and diſperſe the matters adherent to the machine that turns round; whereupon many were of opinion, and *Ptolomy* amongſt the reſt, that if the Earth ſhould turn round with ſo great velocity, the ſtones and creatures upon it ſhould be toſt into the Skie, and that there could not be a morter ſtrong enough to faſten buildings ſo to their foundations, but that they would likewiſe ſuffer a like extruſion.

SALV. Before I come to anſwer this objection, I cannot but take notice of that which I have an hundred times obſerved, and not without laughter, to come into the minds of moſt men ſo ſoon as ever they hear mention made of this motion of the Earth, which is believed by them ſo fixt and immoveable, that they not only never doubted of that reſt, but have ever ſtrongly believed that all other men aſwell as they, have held it to be created immoveable, and ſo to have continued through all ſucceeding ages: and being ſetled in this perſwaſion, they ſtand amazed to hear that any one ſhould grant it motion, as if, after that he had held it to be immoveable, he had fondly thought it to commence its motion then (and not till then) when *Pythagoras* (or whoever elſe was the firſt hinter of its mobility) ſaid that it did move. Now that ſuch a fooliſh conceit (I mean of thinking that thoſe who admit the motion of the Earth, have firſt thought it to ſtand ſtill from its creation, untill the time of *Pythagoras*, and have onely made it moveable after that *Pythagoras* eſteemed it ſo) findeth a place in the mindes of the vulgar, and men of ſhallow capacities, I do not much wonder; but that ſuch perſons as *Ariſtotle* and *Ptolomy* ſhould alſo run into this childiſh miſtake, is to my thinking a more admirable and unpardonable folly.

The ſtupidity of ſome that think the Earth to have begun to move, when Pythagoras *began to affirme that it did ſo.*

SAGR. You believe then, *Salviatus*, that *Ptolomy* thought, that in his Diſputation he was to maintain the ſtability of the Earth againſt ſuch perſons, as granting it to have been immoveable, untill the time of *Pythagoras*, did affirm it to have been but then made

made moveable, when the ſaid *Pythagoras* aſcribed unto it motion.

Ariſtotle and Ptolomy ſeem to confute the mobility of the Earth againſt thoſe who thought that it having a long time ſtood ſtill, did begin to move in the time of Pythagoras

SALV. We can think no other, if we do but conſider the way he taketh to confute their aſſertion; the confutation of which conſiſts in the demolition of buildings, and the toſſing of ſtones, living creatures and men themſelves up into the Air. And becauſe ſuch overthrows and extruſions cannot be made upon buildings and men, which were not before on the Earth, nor can men be placed, nor buildings erected upon the Earth, unleſſe when it ſtandeth ſtill; hence therefore it is cleer, that *Ptolomy* argueth againſt thoſe, who having granted the ſtability of the Earth for ſome time, that is, ſo long as living creatures, ſtones, and Maſons were able to abide there, and to build Palaces and Cities, make it afterwards precipitately moveable to the overthrow and deſtruction of Edifices, and living creatures, &c. For if he had undertook to diſpute againſt ſuch as had aſcribed that revolution to the Earth from its firſt creation, he would have confuted them by ſaying, that if the Earth had alwayes moved, there could never have been placed upon it either men or ſtones; much leſs could buildings have been erected, or Cities founded, &c.

SIMP. I do not well conceive theſe *Ariſtotelick* and *Ptolomaick* inconveniences.

SALV. *Ptolomey* either argueth againſt thoſe who have eſteemed the Earth always moveable; or againſt ſuch as have held that it ſtood for ſome time ſtill, and hath ſince been ſet on moving. If againſt the firſt, he ought to ſay, that the Earth did not always move, for that then there would never have been men, animals, or edifices on the Earth, its *vertigo* not permitting them to ſtay thereon. But in that he arguing, ſaith that the Earth doth not move, becauſe that beaſts, men, and houſes before plac'd on the Earth would precipitate, he ſuppoſeth the Earth to have been once in ſuch a ſtate, as that it did admit men and beaſts to ſtay, and build thereon; the which draweth on the conſequence, that it did for ſome time ſtand ſtill, to wit, was apt for the abode of animals and erection of buildings. Do you now conceive what I would ſay?

SIMP. I do, and I do not: but this little importeth to the merit of the cauſe; nor can a ſmall miſtake of *Ptolomey*, committed through inadvertencie be ſufficient to move the Earth, when it is immoveable. But omitting cavils, let us come to the ſubſtance of the argument, which to me ſeems unanſwerable.

SALV. And I, *Simplicius*, will drive it home, and re-inforce it, by ſhewing yet more ſenſibly, that it is true that grave bodies turn'd with velocity about a ſettled centre, do acquire an *impetus* of moving, and receding to a diſtance from that centre, ever

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then when they are in a ſtate of having a propenſion of moving naturally to the ſame. Tie a bottle that hath water in it, to the end of a cord, and holding the other end faſt in your hand, and making the cord and your arm the ſemi-diameter, and the knitting of the ſhoulder the centre, ſwing the bottle very faſt about, ſo as that it may deſcribe the circumference of a circle, which, whether it be parallel to the Horizon, or perpendicular to it, or any way inclined, it ſhall in all caſes follow, that the water will not fall out of the bottle: nay, he that ſhall ſwing it, ſhall find the cord always draw, and ſtrive to go farther from the ſhoulder. And if you bore a hole in the bottom of the bottle, you ſhall ſee the water ſpout forth no leſs upwards into the skie, than laterally, and downwards to the Earth; and if inſtead of water, you ſhall put little pebble ſtones into the bottle, and ſwing it in the ſame manner, you ſhall find that they will ſtrive in the like manner againſt the cord. And laſtly, we ſee boys throw ſtones a great way, by ſwinging round a piece of a ſtick, at the end of which the ſtone is let into a ſlit (*which ſtick is called by them a ſling*;) all which are arguments of the truth of the concluſion, to wit, that the *vertigo* or ſwing conferreth upon the moveable, a motion towards the circumference, in caſe the motion be ſwift: and therefore if the Earth revolve about its own centre, the motion of the ſuperficies, and eſpecially towards the great circle, as being incomparably more ſwift than thoſe before named, ought to extrude all things up into the air.

SIMP. The Argument ſeemeth to me very well proved and inforced; and I believe it would be an hard matter to anſwer and overthrow it.

SALV. Its ſolution dependeth upon certain notions no leſs known and believed by you, than by my ſelf: but becauſe they come not into your mind, therefore it is that you perceive not the anſwer; wherefore, without telling you it (for that you know the ſame already) I ſhall with onely aſſiſting your memory, make you to refute this argument.

SIMP. I have often thought of your way of arguing, which hath made me almoſt think that you lean to that opinion of *Plato*, *Quòd noſtrum ſcire ſit quoddam reminiſci*; therefore I intreat you to free me from this doubt, by letting me know your judgment.

Our knowledg is a kind of reminiſcence according to Plato.

SALV. What I think of the opinion of *Plato*, you may gather from my words and actions. I have already in the precedent conferences expreſly declared my ſelf more than once; I will purſue the ſame ſtyle in the preſent caſe, which may hereafter ſerve you for an example, thereby the more eaſily to gather what my opinion is touching the attainment of knowledg, when a time ſhall

offer upon ſome other day: but I would not have *Sagredus* offended at this digreſſion.

SAGR. I am rather very much pleaſed with it, for that I remember that when I ſtudied Logick, I could never comprehend that ſo much cry'd up and moſt potent demonſtration of *Ariſtotle*.

SALV. Let us go on therefore; and let *Simplicius*, tell me what that motion is which the ſtone maketh that is held faſt in the ſlit of the ſling, when the boy ſwings it about to throw it a great way?

SIMP. The motion of the ſtone, ſo long as it is in the ſlit, is circular, that is, moveth by the arch of a circle, whoſe ſtedfaſt centre is the knitting of the ſhoulder, and its ſemi-diameter the arm and ſtick.

SALV. And when the ſtone leaveth the ſling, what is its motion? Doth it continue to follow its former circle, or doth it go by another line?

SIMP. It will continue no longer to ſwing round, for then it would not go farther from the arm of the projicient, whereas we ſee it go a great way off.

SALV. With what motion doth it move then?

SIMP. Give me a little time to think thereof; For I have never conſidered it before.

SALV. Hark hither, *Sagredus*; this is the *Quoddam reminiſci* in a ſubject well underſtood. You have pauſed a great while, *Simplicius*.

SIMP. As far as I can ſee, the motion received in going out of the ſling, can be no other than by a right line; nay, it muſt neceſſarily be ſo, if we ſpeak of the pure adventitious *impetus*. I was a little puzled to ſee it make an arch, but becauſe that arch bended all the way upwards, and no other way, I conceive that that incurvation cometh from the gravity of the ſtone, vvhich naturally dravveth it dovvnvvards. The impreſſed *impetus*, I ſay, vvithout reſpecting the natural, is by a right line.

The motion impreſſed by the projicient is onely by a right line.

SALV. But by what right line? Becauſe infinite, and towards every ſide may be produced from the ſlit of the ſling, and from the point of the ſtones ſeparation from the ſling.

SIMP. It moveth by that line which goeth directly from the motion which the ſtone made in the ſling.

SALV. The motion of the ſtone whilſt it was in the ſlit, you have affirmed already to be circular; now circularity oppoſeth directneſs, there not being in the circular line any part that is direct or ſtreight.

SIMP. I mean not that the projected motion is direct in reſpect of the whole circle, but in reference to that ultimate point, where the circular motion determineth. I know what I would ſay,

ſay, but do not well know how to expreſs my ſelf.

SALV. And I alſo perceive that you underſtand the buſineſs, but that you have not the proper terms, wherewith to expreſs the ſame. Now theſe I can eaſily teach you; teach you, that is, as to the words, but not as to the truths, which are things. And that you may plainly ſee that you know the thing I ask you, and onely want language to expreſs it, tell me, when you ſhoot a bullet out of a gun, towards what part is it, that its acquired *impetus* carrieth it?

SIMP. Its acquired *impetus* carrieth it in a right line, which continueth the rectitude of the barrel, that is, which inclineth neither to the right hand nor to the left, nor upwards nor downwards.

SALV. Which in ſhort is aſmuch as to ſay, it maketh no angle with the line of ſtreight motion made by the ſling.

SIMP. So I would have ſaid.

SALV. If then the line of the projects motion be to continue without making an angle upon the circular line deſcribed by it, whilſt it was with the projicient; and if from this circular motion it ought to paſs to the right motion, what ought this right line to be?

SIMP. It muſt needs be that which toucheth the circle in the point of ſeparation, for that all others, in my opinion, being prolonged would interſect the circumference, and by that means make ſome angle therewith.

SALV. You have argued very well, and ſhewn your ſelf half a Geometrician. Keep in mind therefore, that your true opinion is expreſt in theſe words, namely, That the project acquireth an *impetus* of moving by the Tangent, the arch deſcribed by the motion of the projicient, in the point of the ſaid projects ſeparation from the projicient.

SIMP. I underſtand you very well, and this is that which I would ſay.

SALV. Of a right line which toucheth a circle, which of its points is the neareſt to the centre of that circle?

SIMP. That of the contact without doubt: for that is in the circumference of a circle, and the reſt without: and the points of the circumference are all equidiſtant from the centre.

SALV. Therefore a moveable departing from the contact, and moving by the ſtreight Tangent, goeth continually farther and farther from the contact, and alſo from the centre of the circle.

SIMP. It doth ſo doubtleſs.

SALV. Now if you have kept in mind the propoſitions, which you have told me, lay them together, and tell me what you gather from them.

SIMP. I think I am not ſo forgetful, but that I do remember

The project moveth by the Tangent of the circle of the motion precedent in the point of ſeparation.

them. From the things premiſed I gather that the project ſwiftly ſwinged round by the projicient, in its ſeparating from it, doth retain an *impetus* of continuing its motion by the right line, which toucheth the circle deſcribed by the motion of the projicient in the point of ſeparation, by which motion the project goeth continually receding from the centre of the circle deſcribed by the motion of the projicient.

SALV. You know then by this time the reaſon why grave bodies ſticking to the rim of a wheele, ſwiftly moved, are extruded and thrown beyond the circumference to yet a farther diſtance from the centre.

SIMP. I think I underſtand this very well; but this new knowledg rather increaſeth than leſſeneth my incredulity that the Earth can turn round with ſo great velocity, without extruding up into the sky, ſtones, animals, *&c.*

SALV. In the ſame manner that you have underſtood all this, you ſhall, nay you do underſtand the reſt: and with recollecting your ſelf, you may remember the ſame without the help of others: but that we may loſe no time, I will help your memory therein. You do already know of your ſelf, that the circular motion of the projicient impreſſeth on the project an *impetus* of moving (when they come to ſeparate) by the right Tangent, the circle of the motion in the point of ſeparation, and continuing along by the ſame the motion ever goeth receding farther and farther from the projicient: and you have ſaid, that the project would continue to move along by that right line, if there were not by its proper weight an inclination of deſcent added unto it; from which the incurvation of the line of motion is derived. It ſeems moreover that you knew of your ſelf, that this incurvation always bended towards the centre of the Earth, for thither do all grave bodies tend. Now I proceed a little farther, and ask you, whether the moveable after its ſeparation, in continuing the right motion goeth always equally receding from the centre, or if you will, from the circumference of that circle, of which the precedent motion was a part; which is as much as to ſay, Whether a moveable, that forſaking the point of a Tangent, and moving along by the ſaid Tangent, doth equally recede from the point of contact, and from the circumference of the circle?

SIMP. No, Sir: for the Tangent near to the point of contact, recedeth very little from the circumference, wherewith it keepeth a very narrow angle, but in its going farther and farther off, the diſtance always encreaſeth with a greater proportion; ſo that in a circle that ſhould have *v. g.* ten yards of diameter, a point of the Tangent that was diſtant from the contact but two palms, would be three or four times as far diſtant from the circumference

of

of the circle, as a point that was distant from the contaction one palm, and the point that was distant half a palm, I likewise believe would scarse recede the fourth part of the distance of the second: so that within an inch or two of the contact, the separation of the Tangent from the circumference is scarse discernable.

SALV. So that the recession of the project from the circumference of the precedent circular motion is very small in the beginning?

SIMP. Almost insensible.

SALV. Now tell me a little; the project, which from the motion of the projicient receiveth an *impetus* of moving along the Tangent in a right line, and that would keep unto the same, did not its own weight depress it downwards, how long is it after the separation, ere it begin to decline downwards.

SIMP. I believe that it beginneth presently; for it not having any thing to uphold it, its proper gravity cannot but operate.

A grave project, as soon as it is separated from the projicient begineth to decline.

SALV. So that, if that same stone, which being extruded from that wheel turn'd about very fast, had as great a natural propension of moving towards the centre of the said wheel, as it hath to move towards the centre of the Earth, it would be an easie matter for it to return unto the wheel, or rather not to depart from it; in regard that upon the begining of the separation, the recession being so small, by reason of the infinite acutenels of the angle of contact, every very little of inclination that draweth it back towards the centre of the wheel, would be sufficient to retain it upon the rim or circumference.

SIMP. I question not, but that if one suppose that which neither is, nor can be, to wit, that the inclination of those grave bodies was to go towards the centre of the wheel, they would never come to be extruded or shaken off.

SALV. But I neither do, nor need to suppose that which is not; for I will not deny but that the stones are extruded. Yet I speak this by way of supposition, to the end that you might grant me the rest. Now fancy to your self, that the Earth is that great wheel, which moved with so great velocity is to extrude the stones. You could tell me very well even now, that the motion of projection ought to be by that right line which toucheth the Earth in the point of separation: and this Tangent, how doth it notably recede from the superficies of the Terrestrial Globe?

SIMP. I believe, that in a thousand yards, it will not recede from the Earth an inch.

SALV. And did you not say, that the project being drawn by its own weight, declineth from the Tangent towards the centre of the Earth?

SIMP. I ſaid ſo, and alſo confeſſe the reſt: and do now plainly underſtand that the ſtone will not ſeparate from the Earth, for that its receſſion in the beginning would be ſuch, and ſo ſmall, that it is a thouſand times exceeded by the inclination which the ſtone hath to move towards the centre of the Earth, which centre in this caſe is alſo the centre of the wheel. And indeed it muſt be confeſſed that the ſtones, the living creatures, and the other grave bodies cannot be extruded; but here again the lighter things beget in me a new doubt, they having but a very weak propenſion of deſcent towards the centre; ſo that there being wanting in them that faculty of withdrawing from the ſuperficies, I ſee not, but that they may be extruded; and you know the rule, that *ad deſtruendum ſufficit unum.*

SALV. We will alſo give you ſatisfaction in this. Tell me therefore in the firſt place, what you underſtand by light matters, that is, whether you thereby mean things really ſo light, as that they go upwards, or elſe not abſolutely light, but of ſo ſmall gravity, that though they deſcend downwards, it is but very ſlowly; for if you mean the abſolutely light, I will be readier than your ſelf to admit their extruſion.

SIMP. I ſpeak of the other ſort, ſuch as are feathers, wool, cotton, and the like; to lift up which every ſmall force ſufficeth: yet nevertheleſſe we ſee they reſt on the Earth very quietly.

SALV. This pen, as it hath a natural propenſion to deſcend towards the ſuperficies of the Earth, though it be very ſmall, yet I muſt tell you that it ſufficeth to keep it from mounting upwards: and this again is not unknown to you your ſelf; therefore tell me if the pen were extruded by the *Vertigo* of the Earth, by what line would it move?

SIMP. By the tangent in the point of ſeparation.

SALV. And when it ſhould be to return, and re-unite it ſelf to the Earth, by what line would it then move?

SIMP. By that which goeth from it to the centre of the Earth.

SALV. So then here falls under our conſideration two motions; one the motion of projection, which beginneth from the point of contact, and proceedeth along the tangent; and the other the motion of inclination downwards, which beginneth from the project it ſelf, and goeth by the ſecant towards the centre; and if you deſire that the projection follow, it is neceſſary that the *impetus* by the tangent overcome the inclination by the ſecant: is it not ſo?

SIMP. So it ſeemeth to me.

SALV. But what is it that you think neceſſary in the motion of the projicient, to make that it may prevail over that inclination,

tion, from which enſueth the ſeparation and elongation of the pen from the Earth ?

SIMP. I cannot tell.

SALV. How, do you not know that? The moveable is here the ſame, that is, the ſame pen ; now how can the ſame moveable ſuperate and exceed it ſelf in motion ?

SIMP. I do not ſee how it can overcome or yield to it ſelf in motion, unleſſe by moving one while faſter, and another while ſlower.

SALV. You ſee then, that you do know it. If therefore the projection of the pen ought to follow, and its motion by the tangent be to overcome its motion by the ſecant, what is it requiſite that their velocities ſhould be ?

SIMP. It is requiſite that the motion by the tangent be greater than that other by the ſecant. But wretch that I am ! Is it not only many thouſand times greater than the deſcending motion of the pen, but than that of the ſtone ? And yet like a ſimple fellow I had ſuffered my ſelf to be perſwaded, that ſtones could not be extruded by the revolution of the Earth. I do therefore revoke my former ſentence, and ſay, that if the Earth ſhould move, ſtones, Elephants, Towers, and whole Cities would of neceſſity be toſt up into the Air ; and becauſe that that doth not evene, I conclude that the Earth doth not move.

SALV. Softly *Simplicius*, you go on ſo faſt, that I begin to be more afraid for you, than for the pen. Reſt a little, and obſerve what I am going to ſpeak. If for the reteining of the ſtone or pen annexed to the Earths ſurface it were neceſſary that its motion of deſcent were greater, or as much as the motion made by the tangent ; you would have had reaſon to ſay, that it ought of neceſſity to move as faſt, or faſter by the ſecant downwards, than by the tangent Eaſtwards : But did not you tell me even now, that a thouſand yards of diſtance by the tangent from the contact, do remove hardly an inch from the circumference ? It is not ſufficient therefore that the motion by the tangent, which is the ſame with that of the diurnall *Vertigo*, (or haſty revolution) be ſimply more ſwift than the motion by the ſecant, which is the ſame with that of the pen in deſcending ; but it is requiſite that the ſame be ſo much more ſwift as that the time which ſufficeth for the pen to move *v.g.* a thouſand yards by the tangent, be inſufficient for it to move one ſole inch by the ſecant. The which I tell you ſhall never be, though you ſhould make that motion never ſo ſwift, and this never ſo ſlow.

SIMP. And why might not that by the tangent be ſo ſwift, as not to give the pen time to return to the ſurface of the Earth ?

SALV. Try whether you can ſtate the caſe in proper termes, and

and I will give you an anſwer. Tell me therefore, how much do you think ſufficeth to make that motion ſwifter than this?

SIMP. I will ſay for example, that if that motion by the tangent were a million of times ſwifter than this by the ſecant, the pen, yea, and the ſtone alſo would come to be extruded.

SALV. You ſay ſo, and ſay that which is falſe, onely for want, not of Logick, Phyſicks, or Metaphyſicks, but of Geometry; for if you did but underſtand its firſt elements, you would know, that from the centre of a circle a right line may be drawn to meet the tangent, which interſecteth it in ſuch a manner, that the part of the tangent between the contact and the ſecant, may be one, two, or three millions of times greater than that part of the ſecant which lieth between the tangent and the circumference, and that the neerer and neerer the ſecant ſhall be to the contact, this proportion ſhall grow greater and greater *in infinitum*; ſo that it need not be feared, though the *vertigo* be ſwift, and the motion downwards ſlow, that the pen or other lighter matter can begin to riſe upwards, for that the inclination downwards always exceedeth the velocity of the projection.

SAGR. I do not perfectly apprehend this buſineſſe.

A geometrical demonſtration to prove the impoſſibility of extruſion by means of the terreſtrial vertigo.

SALV. I will give you a moſt univerſal yet very eaſie demonſtration thereof. Let a proportion be given between B A [*in Fig.* 3.] and C: And let B A be greater than C at pleaſure. And let there be deſcribed a circle, whoſe centre is D. From which it is required to draw a ſecant, in ſuch manner, that the tangent may be in proportion to the ſaid ſecant, as B A to C. Let A I be ſuppoſed a third proportional to B A and C. And as B I is to I A, ſo let the diameter F E be to E G; and from the point G, let there be drawn the tangent G H. I ſay that all this is done as was required; and as B A is to C, ſo is H G to G E. And in regard that as B I is to I A, ſo is F E to E G; therefore by compoſition, as B A is to A I; ſo ſhall F G be to G E. And becauſe C is the middle proportion between B A and A I; and G H is a middle term between F G and G E; therefore, as B A is to C, ſo ſhall F G be to G H; that is H G to G E, which was to be demonſtrated.

SAGR. I apprehend this demonſtration; yet nevertheleſſe, I am not left wholly without hæſitation; for I find certain confuſed ſcruples role to and again in my mind, which like thick and dark clouds, permit me not to diſcern the cleerneſſe and neceſſity of the concluſion with that perſpicuity, which is uſual in Mathematical Demonſtrations. And that which I ſtick at is this. It is true that the ſpaces between the tangent and the circumference do gradually diminiſh *in infinitum* towards the contact; but it is alſo true on the contrary, that the propenſion of the moveable to de-

deſcending groweth leſs & leſs in it, the nearer it is to the firſt term of its deſcent; that is, to the ſtate of reſt; as is manifeſt from that which you declare unto us, demonſtrating that the deſcending grave body departing from reſt, ought to paſſe thorow all the degrees of tardity comprehended between the ſaid reſt, & any aſſigned degree of velocity, the which grow leſs and leſs *in infinitum*. To which may be added, that the ſaid velocity and propenſion to motion, doth for another reaſon diminiſh to infinity; and it is becauſe the gravity of the ſaid moveable may infinitely diminiſh. So that the cauſes which diminiſh the propenſion of aſcending, and conſequently favour the projection, are two; that is, the levity of the moveable, and its vicinity to the ſtate of reſt; both which are augmentable *in infinit.* and theſe two on the contrary being to contract but with one ſole cauſe of making the projection; I cannot conceive how it alone, although it alſo do admit of infinite augmentation, ſhould be able to remain invincible againſt the union & confederacy of the others, wch are two, and are in like manner capable of infinite augmentation.

SALV. This is a doubt worthy of *Sagredus*; and to explain it ſo as that we may more cleerly apprehend it, for that you ſay that you your ſelf have but a confuſed *Idea* of it, we will diſtinguiſh of the ſame by reducing it into figure; which may alſo perhaps afford us ſome eaſe in reſolving the ſame. Let us therefore [*in Fig.* 4.] draw a perpendicular line towards the centre, and let it be AC, and to it at right angles let there be drawn the Horizontal line A *B*, upon which the motion of the projection ought to be made; now the project would continue to move along the ſame with an even motion, if ſo be its gravity did not incline it downwards. Let us ſuppoſe from the point A a right line to be drawn, that may make any angle at pleaſure with the line A B; which let be A E, and upon A*B* let us mark ſome equal ſpaces AF, FH, HK, and from them let us let fall the perpendiculars FG, HI, K L, as far as AE. And becauſe, as already hath been ſaid, the deſcending grave body departing from reſt, goeth from time to time acquiring a greater degree of velocity, according as the ſaid time doth ſucceſſively encreaſe; we may conceive the ſpaces AF, FH, HK, to repreſent unto us equal times; and the perpendiculars FG, HI, KL, degrees of velocity acquired in the ſaid times; ſo that the degree of velocity acquired in the whole time AK, is as the line K L, in reſpect to the degree H I, acquired in the time AH, and the degree FG in the time AF; the which degrees KL, HI, FG, are (as is manifeſt) the ſame in proportion, as the times KA, HA, F A, and if other perpendiculars were drawn from the points marked at pleaſure in the line F A, one might ſucceſſively find degrees leſſe and leſſe *in infinitum*, proceeding towards the point A, repreſenting the firſt inſtant of time, and the firſt ſtate of reſt. And this retreat towards A; repreſenteth the firſt propenſion to the

motion of deſcent, diminiſhed *in infinitum* by the approach of the moveable to the firſt ſtate of reſt, which approximation is augmentable *in infinitum*. Now let us find the other diminution of velocity, which likewiſe may proceed to infinity, by the diminution of the gravity of the moveable, and this ſhall be repreſented by drawing other lines from the point A, which contein angles leſſe than the angle B A E, which would be this line A D, the which interſecting the parallels K L, H I, F G, in the points M, N, and O, repreſent unto us the degrees F O, H N, K M, acquired in the times A F, A H, A K, leſſe than the other degrees F G, H I, K L, acquired in the ſame times; but theſe latter by a moveable more ponderous, and thoſe other by a moveable more light. And it is manifeſt, that by the retreat of the line E A towards A B, contracting the angle E A B (the which may be done *in infinitum*, like as the gravity may *in infinitum* be diminiſhed) the velocity of the cadent moveable may in like manner be diminiſhed *in infinitum*, and ſo conſequently the cauſe that impeded the projection; and therefore my thinks that the union of theſe two reaſons againſt the projection, diminiſhed to infinity, cannot be any impediment to the ſaid projection. And couching the whole argument in its ſhorteſt terms, we will ſay, that by contracting the angle E A B, the degrees of velocity L K, I H, G F, are diminiſhed; and moreover by the retreat of the parallels K L, H I, F G, towards the angle A, the ſame degrees are again diminiſhed; and both theſe diminutions extend to infinity: Therefore the velocity of the motion of deſcent may very well diminiſh ſo much, (it admitting of a twofold diminution *in infinitum*) as that it may not ſuffice to reſtore the moveable to the circumference of the wheel, and thereupon may occaſion the projection to be hindered and wholly obviated.

Again on the contrary, to impede the projection, it is neceſſary that the ſpaces by which the project is to deſcend for the reuniting it ſelf to the Wheel, be made ſo ſhort and cloſe together, that though the deſcent of the moveable be retarded, yea more, diminiſhed *in infinitum*, yet it ſufficeth to reconduct it thither: and therefore it would be requiſite, that you find out a diminution of the ſaid ſpaces, not only produced to infinity, but to ſuch an infinity, as that it may ſuperate the double infinity that is made in the diminution of the velocity of the deſcending moveable. But how can a magnitude be diminiſhed more than another, which hath a twofold diminution *in infinitum*? Now let *Simplicius* obſerve how hard it is to philoſophate well in nature, without *Geometry*. The degrees of velocity diminiſhed *in infinitum*, as well by the diminution of the gravity of the moveable, as by the approxination to the firſt term of the motion, that is, to the ſtate of

of reſt, are alwayes determinate, and anſwer in proportion to the parallels comprehended between two right lines that concur in an angle, like to the angle B A E, or B A D, or any other infinitely more acute, alwayes provided it be rectilineall. But the diminution of the ſpaces thorow which the moveable is to be conducted along the circumference of the wheel, is proportionate to another kind of diminution, comprehended between lines that contain an angle infinitely more narrow and acute, than any rectilineal angle, how acute ſoever, which is that in our preſent caſe. Let any point be taken in the perpendicular A C, and making it the centre, deſcribe at the diſtance C A, an arch A M P, the which ſhall interſect the parallels that determine the degrees of velocity, though they be very minute, and comprehended within a moſt acute rectilineal angle; of which parallels the parts that lie between the arch and the tangent A B, are the quantities of the ſpaces, and of the returns upon the wheel, alwayes leſſer (and with greater proportion leſſer, by how much neerer they approach to the contact) than the ſaid parallels of which they are parts. The parallels comprehended between the right lines in retiring towards the angle diminiſh alwayes at the ſame rate, as *v.g.* A H being divided in two equal parts in F, the parallel H I ſhall be double to F G, and ſub-dividing F A, in two equal parts, the parallel produced from the point of the diviſion ſhall be the half of F G; and continuing the ſub-diviſion *in infinitum*, the ſubſequent parallels ſhall be alwayes half of the next preceding; but it doth not ſo fall out in the lines intercepted between the tangent and the circumference of the circle: For if the ſame ſub-diviſion be made in F A; and ſuppoſing for example, that the parallel which cometh from the point H, were double unto that which commeth from F, this ſhall be more then double to the next following, and continually the neerer we come towards the contact A, we ſhall find the precedent lines, contein the next following three, four, ten, an hundred, a thouſand, an hundred thouſand, an hundred millions of times, and more *in infinitum*. The brevity therefore of ſuch lines is ſo reduced, that it far exceeds what is requiſite to make the project, though never ſo light, return, nay more, continue unremoveable upon the circumference.

SAGR. I very well comprehend the whole diſcourſe, and upon what it layeth all its ſtreſſe, yet nevertheleſſe methinks that he that would take pains to purſue it, might yet ſtart ſome further queſtions; by ſaying, that of thoſe two cauſes which render the deſcent of the moveable ſlower and ſlower *in infinitum*, it is manifeſt, that that which dependeth on the vicinity to the firſt term of the deſcent, increaſeth alwayes in the ſame proportion, like as the parallels alwayes retain the ſame proportion to each other, &c.

but that the diminution of the ſame velocity, dependent on the diminution of the gravity of the moveable (which vvas the ſecond cauſe) doth alſo obſerve the ſame proportion, doth not ſo plainly appear, And vvho ſhall aſſure us that it doth not proceed according to the proportion of the lines intercepted between the ſecant, and the circumference; or vvhether vvith a greater proportion?

SALV. I have aſſumed for a truth, that the velocities of moveables deſcending naturally, vvill followv the proportion of their gravities, with the favour of *Simplicius*, and of *Ariſtotle*, who doth in many places affirm the ſame, as a propoſition manifeſt: You, in favour of my adverſary, bring the ſame into queſtion, and ſay that its poſſible that the velocity increaſeth with greater proportion, yea and greater *in infinitum* than that of the gravity; ſo that all that hath been ſaid falleth to the ground: For maintaining whereof, I ſay, that the proportion of the velocities is much leſſe than that of the gravities; and thereby I do not onely ſupport but confirme the premiſes. And for proof of this I appeal unto experience, which will ſhew us, that a grave body, howbeit thirty or fourty times bigger then another; as for example, a ball of lead, and another of ſugar, will not move much more than twice as faſt. Now if the projection would not be made, albeit the velocity of the cadent body ſhould diminiſh according to the proportion of the gravity, much leſſe would it be made ſo long as the velocity is but little diminiſhed, by abating much from the gravity. But yet ſuppoſing that the velocity diminiſheth with a proportion much greater than that wherewith the gravity decreaſeth, nay though it were the ſelf-ſame wherewith thoſe parallels conteined between the tangent and circumference do decreaſe, yet cannot I ſee any neceſſity why I ſhould grant the projection of matters of never ſo great levity; yea I farther averre, that there could no ſuch projection follow, meaning alwayes of matters not properly and abſolutely light, that is, void of all gravity, and that of their own natures move upwards, but that deſcend very ſlowly, and have very ſmall gravity. And that which moveth me ſo to think is, that the diminution of gravity, made according to the proportion of the parallels between the tangent and the circumference, hath for its ultimate and higheſt term the nullity of weight, as thoſe parallels have for their laſt term of their diminution the contact it ſelf, which is an indiviſible point: Now gravity never diminiſheth ſo far as to its laſt term, for then the moveable would ceaſe to be grave; but yet the ſpace of the reverſion of the project to the circumference is reduced to the ultimate minuity, which is when the moveable reſteth upon the circumference in the very point of contact; ſo as that to return thither it hath no need of ſpace: and therefore let the propenſion to the motion of deſcent be never

ver ſo ſmall, yet is it alwayes more than ſufficient to reconduct the moveable to the circumference, from which it is diſtant but its leaſt ſpace, that is, nothing at all.

SAGR. Your diſcourſe, I muſt confeſs, is very accurate; and yet no leſs concluding than it is ingenuous; and it muſt be granted that to go about to handle natural queſtions, without *Geometry*, is to attempt an impoſſibility.

SALV. But *Simplicius* will not ſay ſo; and yet I do not think that he is one of thoſe *Peripateticks* that diſſwade their Diſciples from ſtudying the *Mathematicks*, as Sciences that vitiate the reaſon, and render it leſſe apt for contemplation.

SIMP. I would not do ſo much wrong to *Plato*, but yet I may truly ſay with *Ariſtotle*, that he too much loſt himſelf in, and too much doted upon that his *Geometry*: for that in concluſion theſe Mathematical ſubtilties *Salviatus* are true in abſtract, but applied to ſenſible and Phyſical matter, they hold not good. For the Mathematicians will very well demonſtrate for example, that *Sphæra tangit planum in puncto*; a poſition like to that in diſpute, but when one cometh to the matter, things ſucceed quite another way. And ſo I may ſay of theſe angles of contact, and theſe proportions; which all evaporate into Air, when they are applied to things material and ſenſible.

SALV. You do not think then, that the tangent toucheth the ſuperficies of the terreſtrial Globe in one point only?

SIMP. No, not in one ſole point; but I believe that a right line goeth many tens and hundreds of yards touching the ſurface not onely of the Earth, but of the water, before it ſeparate from the ſame.

SALV. But if I grant you this, do not you perceive that it maketh ſo much the more againſt your cauſe? For if it be ſuppoſed that the tangent was ſeparated from the terreſtrial ſuperficies, yet it hath been however demonſtrated that by reaſon of the great acuity of the angle of contingence (if happily it may be call'd an angle) the project would not ſeparate from the ſame; how much leſſe cauſe of ſeparation would it have, if that angle ſhould be wholly cloſed, and the ſuperficies and the tangent become all one? Perceive you not that the Projection would do the ſame thing upon the ſurface of the Earth, which is aſmuch as to ſay, it would do juſt nothing at all? You ſee then the power of truth, which while you ſtrive to oppoſe it, your own aſſaults themſelves uphold and defend it. But in regard that you have retracted this errour, I would be loth to leave you in that other which you hold, namely, that a material Sphere doth not touch a plain in one ſole point: and I could wiſh ſome few hours converſation with ſome perſons converſant in *Geometry*, might make you a little more intelligent amongſt

The truth ſometimes gaines ſtrength by contradiction.

amongſt thoſe who know nothing thereof. Now to ſhew you how great their errour is who ſay, that a Sphere *v.g.* of braſſe, doth not touch a plain *v.g.* of ſteel in one ſole point, Tell me what conceipt you would entertain of one that ſhould conſtantly aver, that the Sphere is not truly a Sphere.

SIMP. I would eſteem him wholly devoid of reaſon.

The ſphere although material, toucheth the material plane but in one point onely.

SALV. He is in the ſame caſe who ſaith that the material Sphere doth not touch a plain, alſo material, in one onely point; for to ſay this is the ſame, as to affirm that the Sphere is not a Sphere. And that this is true, tell me in what it is that you conſtitute the Sphere to conſiſt, that is, what it is that maketh the Sphere differ from all other ſolid bodies.

The definition of the ſphere.

SIMP. I believe that the eſſence of a Sphere conſiſteth in having all the right lines produced from its centre to the circumference, equal.

SALV. So that, if thoſe lines ſhould not be equal, there ſame ſolidity would be no longer a ſphere?

SIMP. True.

SALV. Go to; tell me whether you believe that amongſt the many lines that may be drawn between two points, that may be more than one right line onely.

SIMP. There can be but one.

SALV. But yet you underſtand that this onely right line ſhall again of neceſſity be the ſhorteſt of them all?

SIMP. I know it, and alſo have a demonſtration thereof, produced by a great *Peripatetick* Philoſopher, and as I take it, if my memory do not deceive me, he alledgeth it by way of reprehending *Archimedes*, that ſuppoſeth it as known, when it may be demonſtrated.

SALV. This muſt needs be a great Mathematician, that knew how to demonſtrate that which *Archimedes* neither did, nor could demonſtrate. And if you remember his demonſtration, I would gladly hear it: for I remember very well, that *Archimedes* in his Books, *de Sphærâ & Cylindro*, placeth this Propoſition amongſt the *Poſtulata*; and I verily believe that he thought it demonſtrated.

SIMP. I think I ſhall remember it, for it is very eaſie and ſhort.

SALV. The diſgrace of *Archimedes*, and the honour of this Philoſopher ſhall be ſo much the greater.

The demonſtration of a Peripatetick, to prove the right line to be the ſhorteſt of all lines.

SIMP. I will deſcribe the Figure of it. Between the points A and B, [*in Fig.* 5.] draw the right line A B, and the curve line A C B, of which we will prove the right to be the ſhorter: and the proof is this; take a point in the curve-line, which let be C, and draw two other lines, A C and C B, which two lines together, are longer than the ſole line A B, for ſo demonſtrateth *Euclid.*

But

But the curve-line A C B, is greater than the two right-lines A C, and C B; therefore, *à fortiori*, the curve-line A C B, is much greater than the right line A B, which was to be demonſtrated.

The Paralogiſm of the ſame Peripatetick, which proveth ignotum pe ignotius.

SALV. I do not think that if one ſhould ranſack all the Paralogiſms of the world, there could be found one more commodious than this, to give an example of the moſt ſolemn fallacy of all fallacies, namely, than that which proveth *ignotum per ignotius*.

SIMP. How ſo?

SALV. Do you ask me how ſo? The unknown concluſion which you deſire to prove, is it not, that the curved line A C B, is longer than the right line A B; the middle term which is taken for known, is that the curve-line A C B, is greater than the two lines A C and C B, the which are known to be greater than A B; And if it be unknown whether the curve-line be greater than the ſingle right-line A B, ſhall it not be much more unknown whether it be greater than the two right lines A C & C B, which are known to be greater than the ſole line A B, & yet you aſſume it as known?

SIMP. I do not yet very well perceive wherein lyeth the fallacy.

SALV. As the two right lines are greater than A B, (as may be known by *Euclid*) and in as much as the curve line is longer than the two right lines A C and B C, ſhall it not not be much greater than the ſole right line A B?

SIMP. It ſhall ſo.

SALV. That the curve-line A C B, is greater than the right line A B, is the concluſion more known than the middle term, which is, that the ſame curve-line is greater than the two right-lines A C and C . Now when the middle term is leſs known than the concluſion, it is called a proving *ignotum per ignotius*. But to return to our purpoſe, it is ſufficient that you know the right line to be the ſhorteſt of all the lines that can be drawn between two points. And as to the principal concluſion, you ſay, that the material ſphere doth not touch the ſphere in one ſole point. What then is its contact?

SIMP. It ſhall be a part of its ſuperficies.

SALV. And the contact likewiſe of another ſphere equal to the firſt, ſhall be alſo a like particle of its ſuperficies?

SIMP. There is no reaſon vvhy it ſhould be othervviſe.

A demonſtration that the ſphere toucheth the plane but in one point.

SALV. Then the tvvo ſpheres vvhich touch each other, ſhall touch vvith the tvvo ſame particles of a ſuperficies, for each of them agreeing to one and the ſame plane, they muſt of neceſſity agree in like manner to each other. Imagine now that the two ſpheres [*in Fig. 6.*] whoſe centres are A and B, do touch one another: and let their centres be conjoyned by the right line A B, which paſſeth through the contact. It paſſeth thorow the point C, and another

another point in the contact being taken as D, conjoyn the two right lines A D and B D, ſo as that they make the triangle A D B; of which the two ſides A D and D B ſhall be equal to the other one A C B, both thoſe and this containing two ſemidiameters, which by the definition of the ſphere are all equal: and thus the right line A B, drawn between the two centres A and B, ſhall not be the ſhorteſt of all, the two lines A D and D B being equal to it: which by your own conceſſion is abſurd.

SIMP. This demonſtration holdeth in the abſtracted, but not in the material ſpheres.

SALV. Inſtance then wherein the fallacy of my argument conſiſteth, if as you ſay it is not concluding in the material ſpheres, but holdeth good in the immaterial and abſtracted.

Why the ſphere in abſtract, toucheth the plane onely in one point, and not the material in concrete.

SIMP. The material ſpheres are ſubject to many accidents, which the immaterial are free from. And becauſe it cannot be, that a ſphere of metal paſſing along a plane, its own weight ſhould not ſo depreſs it, as that the plain ſhould yield ſomewhat, or that the ſphere it ſelf ſhould not in the contact admit of ſome impreſſion. Moreover, it is very hard for that plane to be perfect, if for nothing elſe, yet at leaſt for that its matter is porous: and perhaps it will be no leſs difficult to find a ſphere ſo perfect, as that it hath all the lines from the centre to the ſuperficies, exactly equal.

SALV. I very readily grant you all this that you have ſaid; but it is very much beſide our purpoſe: for whilſt you go about to ſhew me that a material ſphere toucheth not a material plane in one point alone, you make uſe of a ſphere that is not a ſphere, and of a plane that is not a plane; for that, according to what you ſay, either theſe things cannot be found in the world, or if they may be found, they are ſpoiled in applying them to work the effect. It had been therefore a leſs evil, for you to have granted the concluſion, but conditionally, to wit, that if there could be made of matter a ſphere and a plane that were and could continue perfect, they would touch in one ſole point, and then to have denied that any ſuch could be made.

SIMP. I believe that the propoſition of Philoſophers is to be underſtood in this ſenſe; for it is not to be doubted, but that the imperfection of the matter, maketh the matters taken in concrete, to diſagree with thoſe taken in abſtract.

SALV. What, do they not agree? Why, that which you your ſelf ſay at this inſtant, proveth that they punctually agree.

SIMP. How can that be?

SALV. Do you not ſay, that through the imperfection of the matter, that body which ought to be perfectly ſpherical, and that plane which ought to be perfectly level, do not prove to be the

ſame

ſame in concrete, as they are imagined to be in abſtract?

SIMP. This I do affirm.

SALV. Then when ever in concrete you do apply a material Sphere to a material plane, youapply an imperfect Sphere to an imperfect plane, & theſe you ſay do not touch only in one point. But I muſt tell you, that even in abſtract an immaterial Sphere, that is, not a perfect Sphere, may touch an immaterial plane, that is, not a perfect plane, not in one point, but with part of its ſuperficies, ſo that hitherto that which falleth out in concrete, doth in like manner hold true in abſtract. And it would be a new thing that the computations and rates made in abſtract numbers, ſhould not afterwards anſwer to the Coines of Gold and Silver, and to the merchandizes in concrete. But do you know *Simplicius*, how this commeth to paſſe? Like as to make that the computations agree with the Sugars, the Silks, the Wools, it is neceſſary that the accomptant reckon his tares of cheſts, bags, and ſuch other things: So when the *Geometricall Philoſopher* would obſerve in concrete the effects demonſtrated in abſtract, he muſt defalke the impediments of the matter, and if he know how to do that, I do aſſure you, the things ſhall jump no leſſe exactly, than *Arithmetical* computations. The errours therefore lyeth neither in abſtract, nor in concrete, nor in *Geometry*, nor in *Phyſicks*, but in the Calculator, that knoweth not how to adjuſt his accompts. Therefore if you had a perfect Sphere and plane, though they were material, you need not doubt but that they would touch onely in one point. And if ſuch a Sphere was and is impoſſible to be procured, it was much beſides the purpoſe to ſay, *Quod Sphæra ænea non tangit in puncto.* Furthermore, if I grant you *Simplicius*, that in matter a figure cannot be procured that is perfectly ſpherical, or perfectly level: Do you think there may be had two materiall bodies, whoſe ſuperficies in ſome part, and in ſome ſort are incurvated as irregularly as can be deſired?

Things are exactly the ſame in abſtract as in concrete.

SIMP. Of theſe I believe that there is no want.

SALV. If ſuch there be, then they alſo will touch in one ſole point; for this contact in but one point alone is not the ſole and peculiar priviledge of the perfect Sphere and perfect plane. Nay, he that ſhould proſecute this point with more ſubtil contemplations would finde that it is much harder to procure two bodies that touch with part of their ſuperficies, than with one point onely. For if two ſuperficies be required to combine well together, it is neceſſary either, that they be both exactly plane, or that if one be convex, the other be concave; but in ſuch a manner concave, that the concavity do exactly anſwer to the convexity of the other: the which conditions are much harder to be found, in regard of their too narrow determination, than thoſe others, which in their caſuall latitude are infinite.

Contact in a ſingle point is not peculiar to the perfect Spheres onely, but belongeth to all curved figures.

It is more difficult to find Figures that touch with a part of their ſurface, than in one ſole point.

SIMP. You believe then, that two ſtones, or two pieces of Iron taken at chance, and put together, do for the moſt part touch in one ſole point?

SALV. In caſual encounters, I do not think they do; as well becauſe for the moſt part there will be ſome ſmall yielding filth upon them, as becauſe that no diligence is uſed in applying them without ſtriking one another; and every ſmall matter ſufficeth to make the one ſuperficies yield ſomewhat to the other; ſo that they interchangeably, at leaſt in ſome ſmall particle, receive figure from the impreſſion of each other. But in caſe their ſuperficies were very terſe and polite, and that they were both laid upon a table, that ſo one might not preſſe upon the other, and gently put towards one another, I queſtion not, but that they might be brought to the ſimple contact in one onely point.

SAGR. It is requiſite, with your permiſſion, that I propound a certain ſcruple of mine, which came into my minde, whil'ſt I heard propoſed by *Simplicius*, the impoſſibility of finding a materiall and ſolid body, that is, perfectly of a Spherical figure, and whil'ſt I ſaw *Salviatus* in a certain manner, not gainſaying, to give his conſent thereto; therefore I would know, whether there would be the ſame difficulty in forming a ſolid of ſome other figure, that is, to expreſſe my ſelf better, whether there is more difficulty in reducing a piece of Marble into the figure of a perfect Sphere, than into a perfect Pyramid, or into a perfect Horſe, or into a perfect Graſſe-hopper?

SALV. To this I will make you the firſt anſwer: and in the firſt place, I will acquit my ſelf of the aſſent which you think I gave to *Simplicius*, which was only for a time; for I had it alſo in my thoughts, before I intended to enter upon any other matter, to ſpeak that, which, it may be, is the ſame, or very like to that which you are about to ſay; And anſwering to your firſt queſtion, I ſay, that if any figure can be given to a Solid, the Spherical is the eaſieſt of all others, as it is likewiſe the moſt ſimple, and holdeth the ſame place amongſt ſolid figures, as the Circle holdeth amongſt the ſuperficial. The deſcription of which Circle, as being more eaſie than all the reſt, hath alone been judged by *Mathematicians* worthy to be put amongſt the * *poſtulata* belonging to the deſcription of all other figures. And the formation of the Sphere is ſo very eaſie, that if in a plain plate of hard metal you take an empty or hollow circle, within which any Solid goeth caſually revolving that was before but groſly rounded, it ſhall, without any other artifice be reduced to a Spherical figure, as perfect as is poſſible for it to be; provided, that that ſame Solid be not leſſe than the Sphere that would paſſe thorow that Circle. And that which is yet more worthy of our conſideration is, that within the ſelf-ſame incavity

The Spherical Figure is eaſier to be made than any other.

The circular Figure only is placed amongſt the poſtulata *of Mathematicians.*

* Demands or Petitions.

incavity one may form Spheres of ſeveral magnitudes. But what is required to the making of an Horſe, or (as you ſay) of a Graſs-hopper, I leave to you to judge, who know that there are but few ſtatuaries in the world able to undertake ſuch a piece of work. And I think that herein *Simplicius* will not diſſent from me.

Difficulty of imitation.

SIMP. I know not whether I do at all diſſent from you; my opinion is this, that none of the afore-named figures can be perfectly obteined; but for the approaching as neer as is poſſible to the moſt perfect degree, I believe that it is incomparably more eaſie to reduce the Solid into a Spherical figure, than into the ſhape of an Horſe, or Graſſe-hopper?

SAGR. And this greater difficulty, wherein think you doth it depend?

SIMP. Like as the great facility in forming the Sphere ariſeth from its abſolute ſimplicity and uniformity ſo the great irregularity rendereth the conſtruction of all other figures difficult.

Irregular forms difficult to be introduced.

SAGR. Therefore the irregularity being the cauſe of the difficulty, than the figure of a ſtone broken with an hammer by chance, ſhall be one of the figures that are difficult to be introduced, it being perhaps more irregular than that of the horſe?

SIMP. So it ſhould be.

SAGR. But tell me; that figure what ever it is which the ſtone hath, hath it the ſame in perfection, or no?

SIMP. What it hath, it hath ſo perfectly, that nothing can be more exact.

SAGR. Then, if of figures that are irregular, and conſequently hard to be procured, there are yet infinite which are moſt perfectly obteined, with what reaſon can it be ſaid, that the moſt ſimple, and conſequently the moſt eaſie of all, is impoſſible to be procured?

SALV. Gentlemen, with your favour, I may ſay that we have ſallied out into a diſpute not much more worth than the wool of a goat; and whereas our argumentations ſhould continually be converſant about ſerious and weighty points, we conſume our time in frivolous and impertinent wranglings. Let us call to minde, I pray you, that the ſearch of the worlds conſtitution, is one of the greateſt and nobleſt Problems that are in nature; and ſo much the greater, inaſmuch as it is directed to the reſolving of that other; to wit, of the cauſe of the Seas ebbing and flowing, enquired into by all the famous men, that have hitherto been in the world, and poſſibly found out by none of them. Therefore if we have nothing more remaining for the full confutation of the argument taken from the Earths *vertigo*, which was the laſt, alledged to prove its immobility upon its own centre, let us paſſe to the examination of thoſe things that are alledged for, and againſt the *Annual Motion.*

The conſtitution of the Univerſe is one of the moſt noble Problems.

SAGR. I would not have you, *Salviatus*, meaſure our wits by the ſcale of yours : you, who uſe to be continually buſied about the ſublimeſt contemplations, eſteem thoſe notions frivolous and below you, which we think matters worthy of our profoundeſt thoughts : yet ſometimes for our ſatisfaction do not diſdain to ſtoop ſo low as to give way a little to our curioſity. As to the refutation of the laſt argument, taken from the extruſions of the diurnal *vertigo*, far leſs than what hath been ſaid, would have given me ſatisfaction : and yet the things ſuperfluouſly ſpoken, ſeemed to me ſo ingenious, that they have been ſo far from wearying my fancy, as that they have, by reaſon of their novelty, entertained me all along with ſo great delight, that I know not how to deſire greater : Therefore, if you have any other ſpeculation to add, produce it, for I, as to my own particular, ſhall gladly hearken to it.

SALV. I have always taken great delight in thoſe things which I have had the fortune to diſcover, and next to that, which is my chief content, I find great pleaſure in imparting them to ſome friends, that apprehendeth and ſeemeth to like them: Now, in regard you are one of theſe, ſlacking a little the reins of my ambition, which is much pleaſed when I ſhew my ſelf more perſpicacious, than ſome other that hath the reputation of a ſharp ſight, I will for a full and true meaſure of the paſt diſpute, produce another fallacy of the Sectators of *Ptolomey* and *Ariſtotle*, which I take from the argument alledged.

SAGR. See how greedily I wait to hear it.

SALV. We have hitherto over-paſſed, and granted to *Ptolomey*, as an effect indubitable, that the extruſion of the ſtone proceeding from the velocity of the wheel turn'd round upon its centre, the cauſe of the ſaid extruſion encreaſeth in proportion, as the velocity of the *vertigo* (or whirling) is augmented : from whence it was inferred, that the velocity of the Earth's *vertigo* being very much greater than that of any machin whatſoever, that we can make to turn round artificially; the extruſion of ſtones, of animals, &c. would conſequently be far more violent. Now, I obſerve, that there is a great fallacy in this diſcourſe, in that we do compare theſe velocities indifferently and abſolutely to one another. It's true, that if I compare the velocities of the ſame wheel, or of two wheels equal to each other, that which ſhall be more ſwiftly turn'd round, ſhall extrude the ſtone with greater violence; and the velocity encreaſing, the cauſe of the projection ſhall likewiſe encreaſe : but when the velocity is augmented, not by encreaſing the velocity in the ſame wheel, which would be by cauſing it to make a greater number of revolutions in equal times; but by encreaſing the diameter, and making the wheel greater, ſo as that the [illegible] on taking up the ſame time in the leſſer wheel,

as

as in the greater, the velocity is greater onely in the bigger wheel, for that its circumference is bigger; there is no man that thinketh that the cauſe of the extruſion in the great wheel will encreaſe according to the proportion of the velocity of its circumference, to the velocity of the circumference of the other leſſer wheel; for that this is moſt falſe, as by a moſt expeditious experiment I ſhall thus groſly declare: We may fling a ſtone with a ſtick of a yard long, farther than we can do with a ſtick ſix yards long, though the motion of the end of the long ſtick, that is of the ſtone placed in the ſlit thereof, were more than double as ſwift as the motion of the end of the other ſhorter ſtick, as it would be if the velocities were ſuch that the leſſer ſtick ſhould turn thrice round in the time whilſt the greater is making one onely converſion.

The cauſe of the projection increaſeth not according to the proportion of the velocity, increaſed by making the wheel bigger.

SAGR. This which you tell me, *Salviatus*, muſt, I ſee, needs ſucceed in this very manner; but I do not ſo readily apprehend the cauſe why equal velocities ſhould not operate equally in extruding projects, but that of the leſſer wheel much more than the other of the greater wheel; therefore I intreat you to tell me how this cometh to paſs?

SIMP. Herein, *Sagredus*, you ſeem to differ much from your ſelf, for that you were wont to penetrate all things in an inſtant, and now you have overlook'd a fallacy couched in the experiment of the ſtick, which I my ſelf have been able to diſcover: and this is the different manner of operating, in making the projection one while with the ſhort ſling and another while with the long one, for if you will have the ſtone fly out of the ſlit, you need not continue its motion uniformly, but at ſuch time as it is at the ſwifteſt, you are to ſtay your arm, and ſtop the velocity of the ſtick; whereupon the ſtone which was in its ſwifteſt motion, flyeth out, and moveth with impetuoſity: but now that ſtop cannot be made in the great ſtick, which by reaſon of its length and flexibility, doth not entirely obey the check of the arm, but continueth to accompany the ſtone for ſome ſpace, and holdeth it in with ſo much leſs force, and not as if you had with a ſtiff ſling ſent it going with a jerk: for if both the ſticks or ſlings ſhould be check'd by one and the ſame obſtacle, I do believe they would fly aſwell out of the one, as out of the other, howbeit their motions were equally ſwift.

SAGR. With the permiſſion of *Salviatus*, I will anſwer ſomething to *Simplicius*, in regard he hath addreſſed himſelf to me; and I ſay, that in his diſcourſe there is ſomewhat good and ſomewhat bad: good, becauſe it is almoſt all true; bad, becauſe it doth not agree with our caſe: Truth is, that when that which carrieth the ſtones with velocity, ſhall meet with a check

check that is immoveable, they ſhall fly out with great impetuoſity : the ſame effect following in that caſe, which we ſee dayly to fall out in a boat that running a ſwift courſe, runs a-ground, or meets with ſome ſudden ſtop, for all thoſe in the boat, being ſurprized, ſtumble forwards, and fall towards the part whither the boat ſteered. And in caſe the Earth ſhould meet with ſuch a check, as ſhould be able to reſiſt and arreſt its *vertigo*, then indeed I do believe that not onely beaſts, buildings and cities, but mountains, lakes and ſeas would overturn, and the globe it ſelf would go near to ſhake in pieces; but nothing of all this concerns our preſent purpoſe, for we ſpeak of what may follow to the motion of the Earth, it being turn'd round uniformly, and quietly about its own centre, howbeit with a great velocity. That likewiſe which you ſay of the ſlings, is true in part; but was not alledged by *Salviatus*, as a thing that punctually agreed with the matter whereof we treat, but onely, as an example, for ſo in groſs it may prompt us in the more accurate conſideration of that point, whether, the velocity increaſing at any rate, the cauſe of the projection doth increaſe at the ſame rate : ſo that *v. g.* if a wheel of ten yards diameter, moving in ſuch a manner that a point of its circumference will paſs an hundred yards in a minute of an hour, and ſo hath an *impetus* able to extrude a ſtone, that ſame *impetus* ſhall be increaſed an hundred thouſand times in a wheel of a million of yards diameter; the which *Salviatus* denieth, and I incline to his opinion; but not knowing the reaſon thereof, I have requeſted it of him, and ſtand impatiently expecting it.

Granting the diurnal vertigo of the Earth, & that by ſome ſudden ſtop or obſtacle it were arreſted, houſes, mountains themſelves, and perhaps the whole Globe would be ſhaken in pieces.

SALV. I am ready to give you the beſt ſatisfaction, that my abilities will give leave : And though in my firſt diſcourſe you thought that I had enquired into things eſtranged from our purpoſe, yet nevertheleſſe I believe that in the ſequel of the diſpute, you will find that they do not prove ſo. Therefore let *Sagredus* tell me wherein he hath obſerved that the reſiſtance of any moveable to motion doth conſiſt.

SAGR. I ſee not for the preſent that the moveable hath any internal reſiſtance to motion, unleſſe it be its natural inclination and propenſion to the contrary motion, as in grave bodies, that have a propenſion to the motion downwards, the reſiſtance is to the motion upwards; and I ſaid an internal reſiſtance, becauſe of this, I think, it is you intend to ſpeak, and not of the external reſiſtances, which are many and accidental.

SALV. It is that indeed I mean, and your nimbleneſſe of wit hath been too hard for my craftineſſe, but if I have been too ſhort in asking the queſtion, I doubt whether *Sagredus* hath been full enough in his anſwer to ſatisfie the demand; and whether there be not in the moveable, beſides the natural inclination to the contrary

contrary term, another intrinſick and natural quality, which maketh it averſe to motion. Therefore tell me again; do you not think that the inclination *v. g.* of grave bodies to move downwards, is equal to the reſiſtance of the ſame to the motion of projection upwards?

The inclination of grave bodies to the motion downwards, is equal to their reſiſtance to the motion upwards.

SAGR. I believe that it is exactly the ſame. And for this reaſon I ſee that two equal weights being put into a ballance; they do ſtand ſtill in *equilibrium*, the gravity of the one reſiſting its being raiſed by the gravity wherewith the other preſſing downwards would raiſe it.

SALV. Very well; ſo that if you would have one raiſe up the other, you muſt encreaſe the weight of that which depreſſeth, or leſſen the weight of the other. But if the reſiſtance to aſcending motion conſiſt onely in gravity, how cometh it to paſſe, that in ballances of unequal arms, to wit in the * *Stiliard*, a weight ſometimes of an hundred pounds, with its preſſion downwards, doth not ſuffice to raiſe up on of four pounds; that ſhall counterpoiſe with it, nay this of four, deſcending ſhall raiſe up that of an hundred; for ſuch is the effect of the pendant weight upon the weight which vve vvould vveigh? If the reſiſtance to motion reſideth onely in the gravity, hovv can the arm with its vveight of four pounds onely, reſiſt the vveight of a ſack of wool, or bale of ſilk, vvhich ſhall be eight hundred, or a thouſand vveight; yea more, hovv can it overcome the ſack vvith its moment, and raiſe it up? It muſt therefore be confeſt *Sagredus*, that here it maketh uſe of ſome other reſiſtance, and other force, beſides that of ſimple gravity.

* A portable ballance wherewith market-people weigh their commodities, giving it gravity by removing the weight farther from the cock: call'd by the Latines, *Campana trutina.*

SAGR. It muſt needs be ſo; therefore tell me vvhat this ſecond virtue ſhould be.

SALV. It is that vvhich vvas not in the ballance of equal arms; you ſee then vvhat variety there is in the Stiliard; and upon this doubtleſſe dependeth the cauſe of the nevv effect.

SAGR. I think that your putting me to it a ſecond time, hath made me remember ſomething that may be to the purpoſe. In both theſe beams the buſineſs is done by the weight, and by the motion; in the ballance, the motions are equal, and therefore the one weight muſt exceed it in gravity before it can move it; in the ſtiliard, the leſſer weight will not move the greater, unleſs when this latter moveth little, as being hung at a leſſer diſtance, and the other much, as hanging at a greater diſtance from the Jacquet or cock. It is neceſſary therefore to conclude, that the leſſer weight overcometh the reſiſtance of the greater, by moving much, whilſt the other is moved but little.

SALV. Which is as much as to ſay, that the velocity of the moveable leſs grave, compenſateth the gravity of the moveable more grave and leſs ſwift.

SAGR.

The greater velocity exactly compenſates the greater gravity.

SAGR. But do you think that the velocity doth fully make good the gravity? that is, that the moment and force of a moveable of *v. g.* four pounds weight, is as great as that of one of an hundred weight, whenſoever that the firſt hath an hundred degrees of velocity, and the later but four onely?

SALV. Yes doubtleſs, as I am able by many experiments to demonſtrate: but for the preſent, let this onely of the ſtiliard ſuffice: in which you ſee that the light end of the beam is then able to ſuſtain and equilibrate the great Wool ſack, when its diſtance from the centre, upon which the ſtiliard reſteth and turneth, ſhall ſo much exceed the leſſer diſtance, by how much the abſolute gravity of the Wool-ſack exceedeth that of the pendent weight. And we ſee nothing that can cauſe this inſufficiencie in the great ſack of Wool, to raiſe with its weight the pendent weight ſo much leſs grave, ſave the diſparity of the motions which the one and the other ſhould make, whilſt that the Wool-ſack by deſcending but one inch onely, will raiſe the pendent weight an hundred inches: (ſuppoſing that the ſack did weigh an hundred times as much, and that the diſtance of the ſmall weight from the centre of the beam were an hundred times greater, than the diſtance between the ſaid centre and the point of the ſacks ſuſpenſion.) And again, the pendent weight its moving the ſpace of an hundred inches, in the time that the ſack moveth but one inch onely, is the ſame as to ſay, that the velocity of the motion of the little pendent weight, is an hundred times greater than the velocity of the motion of the ſack. Now fix it in your belief, as a true and manifeſt axiom, that the reſiſtance which proceedeth from the velocity of motion, compenſateth that which dependeth on the gravity of another moveable: So that conſequently, a moveable of one pound, that moveth with an hundred degrees of velocity, doth as much reſiſt all obſtruction, as another moveable of an hundred weight, whoſe velocity is but one degree onely. And two equal moveables will equally reſiſt their being moved, if that they ſhall be moved with equal velocity: but if one be to be moved more ſwiftly than the other, it ſhall make greater reſiſtance, according to the greater velocity that ſhall be conferred on it. Theſe things being premiſed, let us proceed to the explanation of our Problem; and for the better underſtanding of things, let us make a ſhort Scheme thereof. Let two unequal wheels be deſcribed about this centre A, [*in Fig.* 7.] and let the circumference of the leſſer be B G, and of the greater C E H, and let the ſemidiameter A B C, be perpendicular to the Horizon; and by the points B and C, let us draw the right lined Tangents B F and C D; and in the arches B G and C E, take two equal parts B G and C E: and let the two wheels be ſuppoſed to be turn'd round

round upon their centres with equal velocities, ſo as that two moveables, which ſuppoſe for example to be two ſtones placed in the points B and C, come to be carried along the circumferences B G and C E, with equal velocities; ſo that in the ſame time that the ſtone B ſhall have run the arch B G, the ſtone C will have paſt the arch C E. I ſay now, that the whirl or *vertigo* of the leſſer wheel is much more potent to make the projection of the ſtone B, than the *vertigo* of the bigger wheel to make that of the ſtone C. Therefore the projection, as we have already declared, being to be made along the tangent, when the ſtones B and C are to ſeparate from their wheels, and to begin the motion of projection from the points B and C, then ſhall they be extruded by the *impetus* conceived from the *vertigo* by (or along) the tangents B F and C D. The two ſtones therefore have equal impetuoſities of running along the tangents B F and C D, and would run along the ſame, if they were not turn'd aſide by ſome other force: is it not ſo *Sagredus*?

SAGR. In my opinion the buſineſſe is as you ſay.

SALV. But what force, think you, ſhould that be which averts the ſtones from moving by the tangents, along which they are certainly driven by the *impetus* of the *vertigo*.

SAGR. It is either their own gravity, or elſe ſome glutinous matter that holdeth them faſt and cloſe to the wheels.

SALV. But for the diverting of a moveable from the motion to which nature inciteth it, is there not required greater or leſſer force, according as the deviation is intended to be greater or leſſer? that is, according as the ſaid moveable in its deviation hath a greater or leſſer ſpace to move in the ſame time?

SAGR. Yes certainly: for it was concluded even now, that to make a moveable to move; the movent vertue muſt be increaſed in proportion to the velocity wherewith it is to move.

SALV. Now conſider, that for the deviating the ſtone upon the leſſe wheel from the motion of projection, which it would make by the tangent B F, and for the holding of it faſt to the wheel, it is required, that its own gravity draw it back the whole length of the ſecant F G, or of the perpendicular raiſed from the point G, to the line B F, whereas in the greater wheel the retraction needs to be no more than the ſecant D E, or the perpendicular let fall from the tangent D C to the point E, leſſe by much than F G, and alwayes leſſer and leſſer according as the wheel is made bigger. And foraſmuch as theſe retractions (as I may call them) are required to be made in equal times, that is, whil'ſt the wheels paſſe the two equal arches B G and C E, that of the ſtone B, that is, the retraction F G ought to be more ſwift than the other D E; and therefore much greater force will be required for

holding faſt the ſtone B to its little wheel, than for the holding the ſtone C to its great one, which is as much as to ſay, that ſuch a ſmall thing will impede the extruſion in the great wheel, as will not at all hinder it in the little one. It is manifeſt therefore that the more the wheel augmenteth, the more the cauſe of the projection diminiſheth.

SAGR. From this which I now underſtand, by help of your minute diſſertation, I am induced to think, that I am able to ſatisfie my judgment in a very few words. For equal *impetus* being impreſſed on both the ſtones that move along the tangents, by the equal velocity of the two wheels, we ſee the great circumference, by means of its ſmall deviation from the tangent, to go ſeconding, as it were, and in a fair way refraining in the ſtone the appetite, if I may ſo ſay, of ſeparating from the circumference; ſo that any ſmall retention, either of its own inclination, or of ſome glutination ſufficeth to hold it faſt to the wheel. Which, again, is not able to work the like effect in the little wheel, which but little proſecuting the direction of the tangent, ſeeketh with too much eagerneſſe to hold faſt the ſtone; and the reſtriction and glutination not being ſtronger than that which holdeth the other ſtone faſt to the greater wheel, it *breaks looſe, and runneth along the tangent. Therefore I do not only finde that all thoſe have erred, who have believed the cauſe of the projection to increaſe according to the augmentation of the *vertigo's* velocity; but I am further thinking, that the projection diminiſhing in the inlarging of the wheel, ſo long as the ſame velocity is reteined in thoſe wheels; it may poſſibly be true, that he that would make the great wheel extrude things like the little one; would be forced to increaſe them as much in velocity, as they increaſe in diameter, which he might do, by making them to finiſh their converſions in equal times; and thus we may conclude, that the Earths revolution or *vertigo* would be no more able to extrude ſtones, than any little wheel that goeth ſo ſlowly, as that it maketh but one turn in twenty four hours.

* Scrappar la cavezza, *is to break the bridle.*

SALV. We will enquire no further into this point for the preſent: let it ſuffice that we have abundantly (if I deceive not my ſelf) demonſtrated the invalidity of the argument, which at firſt ſight ſeemed very concluding, and was ſo held by very famous men: and I ſhall think my time and words well beſtowed, if I have but gained ſome belief in the opinion of *Simplicius*, I will not ſay of the Earths mobility, but only that the opinion of thoſe that believe it, is not ſo ridiculous and fond, as the rout of vulgar Philoſophers eſteem it.

SIMP. The anſwers hitherto produced againſt the arguments brought againſt this *Diurnal Revolution* of the Earth taken from

grave

grave bodies falling from the top of a Tower, and from projections made perpendicularly upwards, or according to any inclination sideways towards the East, West, North, South, &c. have somewhat abated in me the antiquated incredulity I had conceived against that opinion: but other greater doubts run in my mind at this very instant, which I know not in the least how to free my self of, and haply you your self will not be able to resolve them; nay, its possible you may not have heard them, for they are very modern. And these are the objections of two Authours, that *ex professo* write against *Copernicus*. Some of which are read in a little Tract of natural conclusions; The rest are by a great both Philosopher and Mathematician, inserted in a Treatise which he hath written in favour of *Aristotle*, and his opinion touching the inalterability of the Heavens, where he proveth, that not onely the Comets, but also the new stars, namely, that *anno* 1572. in *Cassiopeia*, and that *anno* 1604. in *Sagittarius* were not above the Spheres of the Planets, but absolutely beneath the concave of the Moon in the Elementary Sphere, and this he demonstrateth against *Tycho*, *Kepler*, and many other Astronomical Observators, and beateth them at their own weapon; to wit, the Doctrine of Parallaxes. If you like thereof, I will give you the reasons of both these Authours, for I have read them more than once, with attention; and you may examine their strength, and give your opinion thereon.

Other objections of two modern Authors against Copernicus.

SALV. In regard that our principal end is to bring upon the stage, and to consider what ever hath been said for, or against the two Systemes, *Ptolomaick*, and *Copernican*, it is not good to omit any thing that hath been written on this subject.

SIMP. I will begin therefore with the objections which I finde in the Treatise of Conclusions, and afterwards proceed to the rest. In the first place then, he bestoweth much paines in calculating exactly how many miles an hour a point of the terrestrial Globe situate under the Equinoctial, goeth, and how many miles are past by other points situate in other parallels: and not being content with finding out such motions in horary times, he findeth them also in a minute of an hour; and not contenting himself with a minute, he findes them also in a second minute; yea more, he goeth on to shew plainly, how many miles a Cannon bullet would go in the same time, being placed *in* the concave of the Lunar Orb, supposing it also as big as *Copernicus* himself representeth it, to take away all subterfuges from his adversary. And having made this most ingenious and exquisite supputation, he sheweth, that a grave body falling from thence above would consume more than six dayes in attaining to the centre of the Earth, to which all grave bodies naturally move. Now if by the absolute Divine

The first objection of the modern Author of the little tract of Conclusions.

A Cannon bullet would spend more than six days in falling from the Concave of the Moon to the centre of the Earth, according to the opinion of that modern Author of the Conclusions.

Power, or by ſome Angel, a very great Cannon bullet were carried up thither, and placed in our Zenith or vertical point, and from thence let go at liberty, it is in his, and alſo in my opinion, a moſt incredible thing that it, in deſcending downwards, ſhould all the way maintain it ſelf in our vertical line, continuing to turn round with the Earth, about its centre, for ſo many dayes, deſcribing under the Equinoctial a Spiral line in the plain of the great circle it ſelf: and under other Parallels, Spiral lines about Cones, and under the Poles falling by a ſimple right line. He, in the next place, ſtabliſheth and confirmeth this great improbability by proving, in the way of interrogations, many difficulties impoſſible to be removed by the followers of *Copernicus*; and they are, if I do well remember-----.

SALV. Take up a little, good *Simplicius*, and do not load me with ſo many novelties at once: I have but a bad memory, and therefore I muſt not go too faſt. And in regard it cometh into my minde, that I once undertook to calculate how long time ſuch a grave body falling from the concave of the Moon, would be in paſſing to the centre of the Earth, and that I think I remember that the time would not be ſo long; it would be fit that you ſhew us by what rule this Author made his calculation.

SIMP. He hath done it by proving his intent *à fortiori*, a ſufficient advantage for his adverſaries, ſuppoſing that the velocity of the body falling along the vertical line, towards the centre of the Earth, were equal to the velocity of its circular motion, which it made in the grand circle of the concave of the Lunar Orb. Which by equation would come to paſſe in an hour, twelve thouſand ſix hundred German miles; a thing which indeed favours of impoſſibility: Yet nevertheleſſe, to ſhew his abundant caution, and to give all advantages to his adverſaries, he ſuppoſeth it for true, and concludeth, that the time of the fall ought however to be more than ſix dayes.

SALV. And is this the ſum of his method? And doth he by this demonſtration prove the time of the fall to be above ſix dayes?

SAGR. Me thinks that he hath behaved himſelf too modeſtly, for that having it in the power of his will to give what velocity he pleaſed to ſuch a deſcending body, and might aſwell have made it ſix moneths, nay, ſix years in falling to the Earth, he is content with ſix dayes. But, good *Salviatus*, ſharpen my appetite a little, by telling me in what manner you made your computation, in regard you ſay, that you have heretofore caſt it up: for I am confident that if the queſtion had not required ſome ingenuity in working it, you would never have applied your minde unto it.

SALV.

SALV. It is not enough, *Sagredus*, that the ſubjects be noble and great, but the buſineſſe conſiſts in handling it nobly. And who knoweth not, that in the diſſection of the members of a beaſt, there may be diſcovered infinite wonders of provident and prudent Nature; and yet for one, that the Anatomiſt diſſects, the butcher cuts up a thouſand. Thus I, who am now ſeeking how to ſatisfie your demand, cannot tell with which of the two ſhapes I had beſt to appear on the Stage; but yet, taking heart from the example of *Simplicius*, his Authour, I will, without more delays, give you an account (if I have not forgot) how I proceeded. But before I go any further, I muſt not omit to tell you, that I much fear that *Simplicius* hath not faithfully related the manner how this his Authour found, that the Cannon bullet in coming from the concave of the Moon to the centre of the Earth, would ſpend more than ſix dayes: for if he had ſuppoſed that its velocity in deſcending was equal to that of the concave (as *Simplicius* ſaith he doth ſuppoſe) he would have ſhewn himſelf ignorant of the firſt, and more ſimple principles of *Geometry*; yea, I admire that *Simplicius*, in admitting the ſuppoſition which he ſpeaketh of, doth not ſee the monſtrous abſurdity that is couched in it.

SIMP. Its poſſible that I may have erred in relating it; but that I ſee any fallacy in it, I am ſure is not true.

SALV. Perhaps I did not rightly apprehend that which you ſaid. Do you not ſay, that this Authour maketh the velocity of the bullet in deſcending equall to that which it had in turning round, being in the concave of the Moon, and that coming down with the ſame velocity, it would reach to the centre in ſix dayes?

SIMP. So as I think he writeth.

SALV. And do not you perceive a ſhamefull errour therein? But queſtionleſſe you diſſemble it: For it cannot be, but that you ſhould know that the ſemidiameter of the Circle is leſſe than the ſixth part of the circumference; and that conſequently, the time in which the moveable ſhall paſſe the ſemidiameter, ſhall be leſſe than the ſixth part of the time; in which, being moved with the ſame velocity, it would paſſe the circumference; and that therefore the bullet deſcending with the velocity, wherewith it moved in the concave, will arrive in leſſe than four hours at the centre, ſuppoſing that in the concave one revolution ſhould be conſummate in twenty four hours, as he muſt of neceſſity have ſuppoſed it, for to keep it all the way in the ſame vertical line.

A ſhamefull errour in the Argument taken from the bullets falling out of the Moons concave.

SIMP. Now I thorowly perceive the miſtake: but yet I would not lay it upon him undeſervedly, for it's poſſible that I may

may have erred in rehearſing his Argument, and to avoid running into the ſame miſtakes for the future, I could wiſh I had his Book; and if you had any body to ſend for it, I would take it for a great favour.

SAGR. You ſhall not want a Lacquey that will runne for it with all ſpeed: and he ſhall do it preſently, without loſing any time; in the mean time *Salviatus* may pleaſe to oblige us with his computation.

SIMP. If he go, he ſhall finde it lie open upon my Desk, together with that of the other Author, who alſo argueth againſt *Copernicus*.

SAGR. We will make him bring that alſo for the more certainty: and in the interim *Salviatus* ſhall make his calculation: I have diſpatch't away a meſſenger.

An exact compute of the time of the fall of the Cannon bullet from the Moons concave to the Earths centre.

SALV. Above all things it muſt be conſidered, that the motion of deſcending grave bodies is not uniform, but departing from reſt they go continually accelerating: An effect known and obſerved by all men, unleſſe it be by the forementioned modern Authour, who not ſpeaking of acceleration, maketh it even and uniforme. But this general notion is of no avail, if it be not known according to what proportion this increaſe of velocity is made; a concluſion that hath been until our times unknown to all *Philoſophers*; and was firſt found out & demonſtrated by the **Academick*, our common friend, who in ſome of his * writings not yet publiſhed, but in familiarity ſhewn to me, and ſome others of his acquaintance he proveth, how that the acceleration of the right motion of grave bodies, is made according to the numbers uneven beginning *ab unitate*, that is, any number of equal times being aſſigned, if in the firſt time the moveable departing from reſt ſhall have paſſed ſuch a certain ſpace, as for example, an ell, in the ſecond time it ſhall have paſſed three ells, in the third five, in the fourth ſeven, and ſo progreſſively, according to the following odd numbers; which in ſhort is the ſame, as if I ſhould ſay, that the ſpaces paſſed by the moveable departing from its reſt, are unto each other in proportion double to the proportion of the times, in which thoſe ſpaces are meaſured; or we will ſay, that the ſpaces paſſed are to each other, as the ſquares of their times.

* The Author.

* By theſe *Writings*, he every where meanes his Dialogues, *De motu*, which I promiſe to give you in my ſecond Volume.

Acceleration of the natural motion of grave bodies is made according to the odde numbers beginning at unity.

The ſpaces paſt by the falling grave body are as the ſquares of their times.

SAGR. This is truly admirable: and do you ſay that there is a Mathematical demonſtration for it?

An intire and new Science of the Academick *concerning local motion.*

SALV. Yes, purely Mathematical; and not onely for this, but for many other very admirable paſſions, pertaining to natural motions, and to projects alſo, all invented, and demonſtrated by *Our Friend*, and I have ſeen and conſidered them all to my very great content and admiration, ſeeing a new compleat Doctrine to ſpring up touching a ſubject, upon which have been written hundreds of Volumes;

Volumes; and yet not ſo much as one of the infinite admirable concluſions that thoſe his writings contain, hath ever been obſerved, or underſtood by any one, before *Our Friend* made them out.

SAGR. You make me loſe the deſire I had to underſtand more in our diſputes in hand, onely that I may hear ſome of thoſe demonſtrations which you ſpeak of; therefore either give them me preſently, or at leaſt promiſe me upon your word, to appoint a particular conference concerning them, at which *Simplicius* alſo may be preſent, if he ſhall have a mind to hear the paſſions and accidents of the primary effect in Nature.

SIMP. I ſhall undoubtedly be much pleaſed therewith, though indeed, as to what concerneth Natural Philoſophy, I do not think that it is neceſſary to deſcend unto minute particularities, a general knowledg of the definition of motion, and of the diſtinction of natural and violent, even and accelerate, and the like, ſufficing: For if this were not ſufficient, I do not think that *Ariſtotle* would have omitted to have taught us what ever more was neceſſary.

SALV. It may be ſo. But let us not loſe more time about this, which I promiſe to ſpend half a day apart in, for your ſatisfaction; nay, now I remember, I did promiſe you once before to ſatisfie you herein. Returning therefore to our begun calculation of the time, wherein the grave cadent body would paſs from the concave of the Moon to the centre of the Earth, that we may not proceed arbitrarily and at randon, but with a Logical method, we will firſt attempt to aſcertain our ſelves by experiments often repeated, in how long time a ball *v. g.* of Iron deſcendeth to the Earth from an altitude of an hundred yards.

SAGR. Let us therefore take a ball of ſuch a determinate weight, and let it be the ſame wherewith we intend to make the computation of the time of deſcent from the Moon.

SALV. This is not material, for that a ball of one, of ten, of an hundred, of a thouſand pounds, will all meaſure the ſame hundred yards in the ſame time.

SIMP. But this I cannot believe, nor much leſs doth *Ariſtotle* think ſo, who writeth, that the velocities of deſcending grave bodies, are in the ſame proportion to one another; as their gravities.

The error of Ariſtotle *in affirming, falling grave bodies to move according to the proportion of their gravities.*

SALV. If you will admit this for true, *Simplicius*, you muſt believe alſo, that two balls of the ſame matter, being let fall in the ſame moment, one of an hundred pounds, and another of one, from an altitude of an hundred yards, the great one arriveth at the ground, before the other is deſcended but one yard onely: Now bring your fancy, if you can, to imagine, that you ſee the great ball

ball got to the ground, when the little one is ſtill within leſs than a yard of the top of the Tower.

SAGR. That this propoſition is moſt falſe, I make no doubt in the world; but yet that yours is abſolutely true, I cannot well aſſure my ſelf: nevertheleſs, I believe it, ſeeing that you ſo reſolutely affirm it; which I am ſure you would not do, if you had not certain experience, or ſome clear demonſtration thereof.

SALV. I have both: and when we ſhall handle the buſineſs of motions apart, I will communicate them: in the interim, that we may have no more occaſions of interrupting our diſcourſe, we will ſuppoſe, that we are to make our computation upon a ball of Iron of an hundred (*a*) pounds, the which by reiterated experiments deſcendeth from the altitude of an hundred (*b*) yards, in five ſecond-minutes of an hour. And becauſe, as we have ſaid, the ſpaces that are meaſured by the cadent moveable, increaſe in double proportion; that is, according to the ſquares of the times, being that the time of one firſt-minute is duodecuple to the time of five ſeconds, if we multiply the hundred yards by the ſquare of 12, that is by 144, we ſhall have 14400, which ſhall be the number of yards that the ſame moveable ſhall paſs in one firſt-minute of an hour: and following the ſame rule becauſe one hour is 60 minutes, multiplying 14400, the number of yards paſt in one minute, by the ſquare of 60, that is, by 3600, there ſhall come forth 51840000, the number of yards to be paſſed in an hour, which make 17280 miles. And deſiring to know the ſpace that the ſaid ball would paſs in 4 hours, let us multiply 17280 by 16, (which is the ſquare of 4) and the product will be 276480 miles: which number is much greater than the diſtance from the Lunar concave to the centre of the Earth, which is but 196000 miles, making the diſtance of the concave 56 ſemidiameters of the Earth, as that modern Author doth; and the ſemidiameter of the Earth 3500 miles, of 3000 **Braces* to a †mile, which are our *Italian* miles.

(*a*)(*b*) Note that theſe Calculations are made in *Italian* weights and meaſures. And 100 pounds *Haverdupoiſe* make 133 *l. Florentine*. And 100 Engliſh yards makes 150⅔ Braces *Florent.* ſo that the brace or yard of our *Author* is ⅔ of our yard.

* The *Italian* meaſure which I commonly tranſlate yards.
† The *Italian* mile is $\frac{1000}{1760}$ of our mile.

Therefore, *Simplicius*, that ſpace from the concave of the Moon to the centre of the Earth, which your Accomptant ſaid could not be paſſed under more than ſix days, you ſee that (computing by experience, and not upon the fingers ends) that it ſhall be paſſed in much leſs than four hours; and making the computation exact, it ſhall be paſſed by the moveable in 3 hours, 22 *min. prim.* and 4 ſeconds.

SAGR. I beſeech you, dear Sir, do not defraud me of this exact calculation, for it muſt needs be very excellent.

SALV. So indeed it is: therefore having (as I have ſaid) by diligent tryal obſerved, that ſuch a moveable paſſeth in its deſcent, the height of 100 yards in 5 ſeconds of an hour, we will ſay, if 100 yards are paſſed in 5 ſeconds; in how many ſeconds ſhall

588000000

588000000 yards (for ſo many are in 56 diameters of the Earth) be paſſed? The rule for this work is, that the third number muſt be multiplied by the ſquare of the ſecond, of which doth come 14700000000, which ought to be divided by the firſt, that is, by 100, and the root ſquare of the quotient, that is, 12124 is the number ſought, namely 12124 *min. ſecun.* of an hour, which are 3 hours, 22 *min. prim.* and 4 ſeconds.

SAGR. I have ſeen the working, but I know nothing of the reaſon for ſo working, nor do I now think it a time to ask it.

SALV. Yet I will give it, though you do not ask it, becauſe it is very eaſie. Let us mark theſe three numbers with the Letters A firſt, B ſecond, C third. A and C are the numbers of the ſpaces, B is the number of the time; the fourth number is ſought, of the time alſo. And becauſe we know, that look what proportion the ſpace A, hath to the ſpuace C, the ſame proportion ſhall the ſquare of the time B have to the ſqare of the time, which is ſought.

100. A	5. B	588000000. C	25
1		14700000000	
		35956	
22		10	
241	60	12124	
		202	
2422		3	
24240			

Therefore by the Golden Rule, let the number C be multiplied by the ſquare of the number B, and let the product be divided by the number A, and the quotient ſhall be the ſquare of the number ſought, and its ſquare root ſhall be the number it ſelf that is ſought. Now you ſee how eaſie it is to be underſtood.

SAGR. So are all truths, when once they are found out, but the difficulty lyeth in finding them. I very well apprehend it, and kindly thank you. And if there remain any other curioſity touching this point, I pray you let us hear it; for if I may ſpeak my mind, I will with the favour of *Simplicius*, that from your diſcourſes I alwayes learn ſome new motion, but from thoſe of his Philoſophers, I do not remember that I have learn't any thing of moment.

SALV. There might be much more ſaid touching theſe local motions; but according to agreement, we will reſerve it to a particular conference; and for the preſent I will ſpeak ſomething touching the Author named by *Simplicius*, who thinketh he hath given a great advantage to the adverſe party in granting thar, that Canon bullet in falling from the concave of the Moon may deſcend with a velocity equal to the velocity wherewith it would

turn round, ſtaying there above, and moving along with the diurnal converſion. Now I tell him, that that ſame ball falling from the concave unto the centre, will acquire a degree of velocity much more than double the velocity of the diurnal motion of the Lunar concave; and this I will make out by ſolid and not impertinent ſuppoſitions. You muſt know therefore that the grave body falling and acquiring all the way new velocity according to the proportion already mentioned, hath in any whatſoever place of the line of its motion ſuch a degree of velocity, that if it ſhould continue to move therewith, uniformly without farther encreaſing it; in another time like to that of its deſcent, it would paſſe a ſpace double to that paſſed in the line of the precedent motion of deſcent. And thus for example, if that ball in coming from the concave of the Moon to its centre hath ſpent three hours, 22 min. *prim.* and 4 ſeconds, I ſay, that being arrived at the centre, it ſhall find it ſelf conſtituted in ſuch a degree of velocity, that if with that, without farther encreaſing it, it ſhould continue to move uniformly, it would in other 3 hours, 22 min. *prim.* and 4 ſeconds, paſſe double that ſpace, namely as much as the whole diameter of the Lunar Orb; and becauſe from the Moons concave to the centre are 196000 miles, which the ball paſſeth in 3 hours 22 *prim.* min. and 4 ſeconds, therefore (according to what hath been ſaid) the ball continuing to move with the velocity which it is found to have in its arrival at the centre, it would paſſe in other 3 hours 22 min. prim. and 4 ſeconds, a ſpace double to that; namely 392000 miles; but the ſame continuing in the concave of the Moon, which is in circuit 1232000 miles, and moving therewith in a diurnal motion, it would make in the ſame time, that is, in 3 hours 22 min. prim. and 4 ſeconds, 172880 miles, which are fewer by many than the half of the 392000 miles. You ſee then that the motion in the concave is not as the modern Author ſaith, that is, of a velocity impoſſible for the falling ball to partake of, *&c.*

The falling moveable if it move with a degree of velocity acquired in a like time with an uniform motion, it ſhall paſs a ſpace double to that paſſed with the accelerated motion.

SAGR. The diſcourſe would paſs for current, and would give me full ſatisfaction, if that particular was but ſalved, of the moving of the moveable by a double ſpace to that paſſed in falling in another time equal to that of the deſcent, in caſe it doth continue to move uniformly with the greateſt degree of velocity acquired in deſcending. A propoſition which you alſo once before ſuppoſed as true, but never demonſtrated.

SALV. This is one of the demonſtrations of *Our Friend*, and you ſhall ſee it in due time; but for the preſent, I will with ſome conjectures (not teach you any thing that is new, but) remember you of a certain contrary opinion, and ſhew you, that it may haply ſo be. A bullet of lead hanging in a long and fine thread faſtened to the roof,

roof, if we remove it far from perpendicularity, and then let it go, have you not obſerved that, it declining, will paſs freely, and well near as far to the other ſide of the perpendicular?

SAGR. I have obſerved it very well, and find (eſpecially if the plummet be of any conſiderable weight) that it riſeth ſo little leſs than it deſcended, ſo that I have ſometimes thought, that the aſcending arch is equal to that deſcending, and thereupon made it a queſtion whether the vibrations might not perpetuate themſelves; and I believe that they might, if that it were poſſible to remove the impediment of the Air, which reſiſting penetration, doth ſome ſmall matter retard and impede the motion of the *pendulum*, though indeed that impediment is but ſmall: in favour of which opinion the great number of vibrations that are made before the moveable wholly ceaſeth to move, ſeems to plead.

The motion of grave penduli *might be perpetuated, impediments being removed.*

SALV. The motion would not be perpetual, *Sagredus*, although the impediment of the Air were totally removed, becauſe there is another much more abſtruſe.

SAGR. And what is that? as for my part I can think of no other?

SALV. You will be pleaſed when you hear it, but I ſhall not tell it you till anon: in the mean time, let us proceed. I have propoſed the obſervation of this *Pendulum*, to the intent that you ſhould underſtand, that the *impetus* acquired in the deſcending arch, where the motion is natural, is of it ſelf able to drive the ſaid ball with a violent motion, as far on the other ſide in the like aſcending arch; if ſo, I ſay, of it ſelf, all external impediments being removed: I believe alſo that every one takes it for granted, that as in the deſcending arch the velocity all the way increaſeth, till it come to the loweſt point, or its perpendicularity; ſo from this point, by the other aſcending arch, it all the way diminiſheth, untill it come to its extreme and higheſt point: and diminiſhing with the ſame proportions, wherewith it did before increaſe, ſo that the dgrees of the velocities in the points equidiſtant from the point of perpendicularity, are equal to each other. Hence it ſeemeth to me (arguing with all due modeſty) that I might eaſily be induced to believe, that if the Terreſtrial Globe were bored thorow the centre, a Canon bullet deſcending through that Well, would acquire by that time it came to the centre, ſuch an impulſe of velocity, that, it having paſſed beyond the centre, would ſpring it upwards the other way, as great a ſpace, as that was wherewith it had deſcended, all the way beyond the centre diminiſhing the velocity with decreaſements like to the increaſements acquired in the deſcent: and the time ſpent in this ſecond motion of aſcent, I believe, would be equal to the time of deſcent. Now if the moveable by diminiſhing that its greateſt degree of velocity which it had

If the Terreſtrial Globe were perforated, a grave body deſcending by that bore, would paſs and aſcend as far beyond the centre, as it did deſcend.

had in the centre, ſucceſſively until it come to total extinction, do carry the moveable in ſuch a time ſuch a certain ſpace, as it had gone in ſuch a like quantity of time, by the acquiſt of velocity from the total privation of it until it came to that its greateſt degree; it ſeemeth very reaſonable, that if it ſhould move always with the ſaid greateſt degree of velocity it would paſs, in ſuch another quantity of time, both thoſe ſpaces: For if we do but in our mind ſucceſſively divide thoſe velocities into riſing and falling degrees, as *v. g.* theſe numbers in the margine; ſo that the firſt ſort unto 10 be ſuppoſed the increaſing velocities, and the others unto 1, be the decreaſing; and let thoſe of the time of the deſcent, and the others of the time of the aſcent being added all together, make as many, as if one of the two ſums of them had been all of the greateſt degrees, and therefore the whole ſpace paſſed by all the degrees of the increaſing velocities, and decreaſing, (which put together is the whole diameter) ought to be equal to the ſpace paſſed by the greateſt velocities, that are in number half the aggregate of the increaſing and decreaſing velocities. I know that I have but obſcurely expreſſed my ſelf, and I wiſh I may be underſtood.

1 2 3 4 5 6 7 8 9 10 10 9 8

SAGR. I think I underſtand you very well; and alſo that I can in a few words ſhew, that I do underſtand you. You had a mind to ſay, that the motion begining from reſt, and all the way increaſing the velocity with equal augmentations, ſuch as are thoſe of continuate numbers begining at 1, rather at 0, which repreſenteth the ſtate of reſt, diſpoſed as in the margine: and continued at pleaſure, ſo as that the leaſt degree may be 0, and the greateſt *v. g.* 5, all theſe degrees of velocity wherewith the moveable is moved, make the ſum of 15; but if the moveable ſhould move with as many degrees in number as theſe are, and each of them equal to the biggeſt, which is 5, the aggregate of all theſe laſt velocities would be double to the others, namely 30. And therefore the moveable moving with a like time, but with uniform velocity, which is that of the higheſt degree 5, ought to paſs a ſpace double to that which it paſſeth in the accelerate time, which beginneth at the ſtate of reſt.

7 6 5 4 3 2 1 0 1 2 3 4 5

SALV. According to your quick and piercing way of apprehending things, you have explained the whole buſineſs with more plainneſs than I my ſelf; and put me alſo in mind of adding ſomething more: for in the accelerate motion, the augmentation being continual, you cannot divide the degrees of velocity, which continually increaſe, into any determinate number, becauſe changing every moment, they are evermore infinite. Therefore we ſhall be the better able to exemplifie our intentions by deſcribing a Triangle, which let be this A B C, [*in Fig.* 8.] taking in the

ſide

ſide A C, as many equal parts as we pleaſe, A D, D E, E F, F G, and drawing by the points D, E, F, G, right lines parallel to the baſe B C. Now let us imagine the parts marked in the line A C, to be equal times, and let the parallels drawn by the points D, E, F, G, repreſent unto us the degrees of velocity accelerated, and increaſing equally in equal times; and let the point A be the ſtate of reſt, from which the moveable departing, hath *v. g.* in the time A D, acquired the degree of velocity D H, in the ſecond time we will ſuppoſe, that it hath increaſed the velocity from D H, as far as to E I, and ſo ſuppoſing it to have grown greater in the ſucceeding times, according to the increaſe of the lines F K, G L, *&c.* but becauſe the acceleration is made continually from moment to moment, and not disjunctly from one certain part of time to another; the point A being put for the loweſt moment of velocity, that is, for the ſtate of reſt, and A D for the firſt inſtant of time following; it is manifeſt, that before the acquiſt of the degree of velocity D H, made in the time A D, the moveable muſt have paſt by infinite other leſſer and leſſer degrees gained in the infinite inſtants that are in the time D A; anſwering the infinite points that are in the line D A; therefore to repreſent unto us the infinite degrees of velocity that precede the degree D H, it is neceſſary to imagine infinite lines ſucceſſively leſſer and leſſer, which are ſuppoſed to be drawn by the infinite points of the line D A; and parallels to D H, the which infinite lines repreſent unto us the ſuperficies of the Triangle A H D, and thus we may imagine any ſpace paſſed by the moveable, with a motion which begining at reſt, goeth uniformly accelerating, to have ſpent and made uſe of infinite degrees of velocity, increaſing according to the infinite lines that begining from the point A, are ſuppoſed to be drawn parallel to the line H D, and to the reſt I E, K F, L G, the motion continuing as far as one will.

The acceleration of grave bodies naturally deſcendent, increaſeth from moment to moment.

Now let us compleat the whole Parallelogram A M B C, and let us prolong as far as to the ſide thereof B M, not onely the Parallels marked in the Triangle, but thoſe infinite others imagined to be drawn from all the points of the ſide A C; and like as B C, was the greateſt of thoſe infinite parallels of the Triangle, repreſenting unto us the greateſt degree of velocity acquired by the moveable in the accelerate motion, and the whole ſuperficies of the ſaid Triangle, was the maſs and ſum of the whole velocity, wherewith in the time A C it paſſed ſuch a certain ſpace, ſo the parallelogram is now a maſs and aggregate of a like number of degrees of velocity, but each equal to the greateſt B C, the which maſs of velocities will be double to the maſs of the increaſing velocities in the Triangle, like as the ſaid Parallelogram is double to the Triangle: and therefore if the moveable that falling did make uſe

of

of the accelerated degrees of velocity, anſwering to the triangle A B C, hath paſſed in ſuch a time ſuch a ſpace, it is very reaſonable and probable, that making uſe of the uniform velocities anſwering to the parallelogram, it ſhall paſſe with an even motion in the ſame time a ſpace double to that paſſed by the accelerate motion.

SAGR. I am entirely ſatisfied. And if you call this a probable Diſcourſe, what ſhall the neceſſary demonſtrations be? I wiſh that in the whole body of common Philoſophy, I could find one that was but thus concludent.

In natural Sciences it is not neceſſary to ſeek Mathematicall evidence.

SIMP. It is not neceſſary in natural Philoſophy to ſeek exquiſite Mathematical evidence.

SAGR. But this point of motion, is it not a natural queſtion? and yet I cannot find that *Ariſtotle* hath demonſtrated any the leaſt accident of it. But let us no longer divert our intended Theme, nor do you fail, I pray you *Salviatus*, to tell me that which you hinted to me to be the cauſe of the *Pendulum's* quieſcence, beſides the reſiſtance of the *Medium* to penetration.

SALV. Tell me; of two *penduli* hanging at unequal diſtances, doth not that which is faſtned to the longer threed make its vibrations more ſeldome?

The pendulum *hanging at a longer threed, maketh its vibrations more ſeldome than the* pendulum *hanging at a ſhorter threed.*

SAGR. Yes, if they be moved to equall diſtances from their perpendicularity.

The vibrations of the ſame pendulum *are made with the ſame frequency, whether they be ſmall or great.*

SALV. This greater or leſſe elongation importeth nothing at all, for the ſame *pendulum* alwayes maketh its reciprocations in equall times, be they longer or ſhorter, that is, though the *pendulum* be little or much removed from its perpendicularity, and if they are not abſolutely equal, they are inſenſibly different, as experience may ſhew you: and though they were very unequal, yet would they not diſcountenance, but favour our cauſe. Therefore let us draw the perpendicular A B [*in Fig.9.*] and hang from the point A, upon the threed A C, a plummet C, and another upon the ſame threed alſo, which let be E, and the threed A C, being removed from its perpendicularity, and then letting go the plummets C and E, they ſhall move by the arches C B D, E G F, and the plummet E, as hanging at a leſſer diſtance, and withall, as (by what you ſaid) leſſe removed, will return back again faſter, and make its vibrations more frequent than the plummet C, and therefore ſhall hinder the ſaid plummet C, from running ſo much farther towards the term D, as it would do, if it were free: and thus the plummet E bringing unto it in every vibration continuall impediment, it ſhall finally reduce it to quieſcence. Now the ſame threed, (taking away the middle plummet) is a compoſition of many grave *penduli*, that is, each of its parts is ſuch a *pendulum* faſtned neerer and neerer to the point A, and therefore diſpoſed

The cauſe which impedeth the pendulum, *and reduceth it to reſt.*

ſed to make its vibrations ſucceſſively more and more frequent; and conſequently is able to bring a continual impediment to the plummet C, and for a proof that this is ſo, if we do but obſerve the thread A C, we ſhall ſee it diſtended not directly, but in an arch; and if inſtead of the thread we take a chain, we ſhall diſcern the effect more perfectly; and eſpecially removing the gravity C, to a conſiderable diſtance from the perpendicular A B, for that the chain being compoſed of many looſe particles, and each of them of ſome weight, the arches A E C, and A F D, will appear notably incurvated. By reaſon therefore, that the parts of the chain, according as they are neerer to the point A, deſire to make their vibrations more frequent, they permit not the lower parts of the ſaid chain to ſwing ſo far as naturally they would: and by continual detracting from the vibrations of the plummet C, they finally make it ceaſe to move, although the impediment of the air might be removed.

The thread or chain to which a pendulum is faſtned, maketh an arch, and doth not ſtretch it ſelfe ſtreight out in its vibrations.

SAGR. The books are now come; here take them *Simplicius*, and find the place you are in doubt of.

SIMP. See, here it is where he beginneth to argue againſt the diurnal motion of the Earth, he having firſt confuted the annual. *Motus terræ annuus aſſerere* Copernicanos *cogit converſionem ejuſdem quotidianam; alias idem terræ Hemiſphærium continenter ad Solem eſſet converſum obumbrato ſemper averſo.* [*In Engliſh thus:*] The annual motion of the Earth doth compell the *Copernicans* to aſſert the daily converſion thereof; otherwiſe the ſame Hemiſphere of the Earth would be continually turned towards the Sun, the ſhady ſide being always averſe. And ſo one half of the Earth would never come to ſee the Sun.

SALV. I find at the very firſt ſight, that this man hath not rightly apprehended the *Copernican Hypotheſis*, for if he had but taken notice how he alwayes makes the Axis of the terreſtrial Globe perpetually parallel to it ſelf, he would not have ſaid, that one half of the Earth would never ſee the Sun, but that the year would be one entire natural day, that is, that thorow all parts of the Earth there would be ſix moneths day, and ſix moneths night, as it now befalleth to the inhabitants under the Pole, but let this miſtake be forgiven him, and let us come to what remaineth.

SIMP. It followeth, *Hanc autem gyrationem Terræ impoſſibilem eſſe ſic demonſtramus.* Which ſpeaks in Engliſh thus: That this gyration of the Earth is impoſſible we thus demonſtrate. That which enſueth is the declaration of the following figure, wherein is delineated many deſcending grave bodies, and aſcending light bodies, and birds that fly to and again in the air, &c.

SAGR. Let us ſee them, I pray you. Oh! what fine figures, what

what birds, what balls, and what other pretty things are here?

SIMP. Theſe are balls which come from the concave of the Moon.

SAGR. And what is this?

SIMP. This is a kind of Shell-fiſh, which here at *Venice* they call *buovoli*; and this alſo came from the Moons concave.

SAGR. Indeed, it ſeems then, that the Moon hath a great power over theſe Oyſter-fiſhes, which we call * *armed fiſhes.*

* Peſci armati, *or* armati.

SIMP. And this is that calculation, which I mentioned, of this Journey in a natural day, in an hour, in a firſt minute, and in a ſecond, which a point of the Earth would make placed under the Equinoctial, and alſo in the parallel of 48 *gr.* And then followeth this, which I doubted I had committed ſome miſtake in reciting; therefore let us read it. *His poſitis, neceſſe eſt, terra circulariter mota, omnia ex aëre eidem, &c. Quod ſi haſce pilas æquales ponemus pondere, magnitudine, gravitate, & in concavo Sphæræ Lunaris poſitas libero deſcenſui permittamus, ſi motum deorſum æquemus celeritate motui circum, (quod tamen ſecus eſt, cum pila A, &c.) elabentur minimum (ut multum cedamus adverſariis) dies ſex: quo tempore ſexies circa terram, &c.* [*In Engliſh thus.*] Theſe things being ſuppoſed, it is neceſſary, the Earth being circularly moved, that all things from the air to the ſame, &c. So that if we ſuppoſe theſe balls to be equal in magnitude and gravity, and being placed in the concave of the Lunar Sphere, we permit them a free deſcent, and if we make the motion downwards equal in velocity to the motion about, (which nevertheleſs is otherwiſe, if the ball A, &c.) they ſhall be falling at leaſt (that we may grant much to our adverſaries) ſix dayes; in which time they ſhall be turned ſix times about the Earth, &c.

SALV. You have but too faithfully cited the argument of this perſon. From hence you may collect *Simplicius*, with what caution they ought to proceed, who would give themſelves up to believe others in thoſe things, which perhaps they do not believe themſelves. For me thinks it a thing impoſſible, but that this Author was adviſed, that he did deſign to himſelf a circle, whoſe diameter (which amongſt Mathematicians, is leſſe than one third part of the circumference) is above 72 times bigger than it ſelf: an errour that affirmeth that to be conſiderably more than 200, which is leſſe than one.

SAGR. It may be, that theſe Mathematical proportions, which are true in abſtract, being once applied in concrete to Phyſical and Elementary circles, do not ſo exactly agree: And yet, I think, that the Cooper, to find the ſemidiameter of the bottom, which he is to fit to the Cask, doth make uſe of the rule of Mathematicians in abſtract, although ſuch bottomes be things meerly material,

and

and concrete: therefore let *Simplicius* plead in excuſe of this Author; and whether he thinks that the Phyſicks can differ ſo very much from the Mathematicks.

SIMP. The ſubſtractions are in my opinion inſufficient to ſalve this difference, which is ſo extreamly too great to be reconciled: and in this caſe I have no more to ſay but that, *Quandoque bonus dormitet Homerus*. But ſuppoſing the calculation of * *Salviatus* to be more exact, and that the time of the deſcent of the ball were no more than three hours; yet me thinks, that coming from the concave of the Moon, which is ſo great a diſtance off, it would be an admirable thing, that it ſhould have an inſtinct of maintaining it ſelf all the way over the ſelf-ſame point of the Earth, over which it did hang in its departure thence, and not rather be left a very great way behind.

* Not *Sagredus*, as the Latine hath it.

SALV. The effect may be admirable, and not admirable, but natural and ordinary, according as the things precedent may fall out. For if the ball (according to the Authors ſuppoſitions) whilſt it ſtaid in the concave of the Moon, had the circular motion of twenty four hours together with the Earth, and with the reſt of the things contained within the ſaid Concave; that very vertue which made it turn round before its deſcent, will continue it in the ſame motion in its deſcending. And ſo far it is from not keeping pace with the motion of the Earth, and from ſtaying behind, that it is more likely to out-go it; being that in its approaches to the Earth, the motion of gyration is to be made with circles continually leſſer and leſſer; ſo that the ball retaining in it ſelf that ſelf-ſame velocity which it had in the concave, it ought to anticipate, as I have ſaid, the *vertigo* or converſion of the Earth. But if the ball in the concave did want that circulation, it is not obliged in deſcending to maintain it ſelf perpendicularly over that point of the Earth, which was juſt under it when the deſcent began. Nor will *Copernicus*, or any of his followers affirm the ſame.

SIMP. But the Author maketh an objection, as you ſee, demanding on what principle this circular motion of grave and light bodies, doth depend: that is, whether upon an internal or an external principle.

SALV. Keeping to the Probleme of which we ſpeak, I ſay, that that very principle which made the ball turn round, whil'ſt it was in the Lunar concave, is the ſame that maintaineth alſo the circulation in the deſcent: yet I leave the Author at liberty to make it internal or external at his pleaſure.

SIMP. The Author proveth, that it can neither be inward nor outward.

SALV. And I will ſay then, that the ball in the concave did

not move, and ſo he ſhall not be bound to ſhew how that in deſcending it continueth all the way vertically over one point, for that it will not do any ſuch thing.

SIMP. Very well; But if grave bodies, and light can have no principle, either internal or external of moving circularly, than neither can the terreſtrial Globe move with a circular motion: and thus you have the intent of the Author.

SALV. I did not ſay, that the Earth had no principle, either interne, or externe to the motion of gyration, but I ſay, that I do not know which of the two it hath; and yet my not knowing it hath not a power to deprive it of the ſame; but if this Author can tell by what principle other mundane bodies are moved round, of whoſe motion there is no doubt; I ſay, that that which maketh the Earth to move, is a vertue, like to that, by which *Mars* and *Jupiter* are moved, and wherewith he believes that the ſtarry Sphere it ſelf alſo doth move; and if he will but aſſure me, who is the mover of one of theſe moveables, I will undertake to be able to tell him who maketh the Earth to move. Nay more; I will undertake to do the ſame; if he can but tell me, who moveth the parts of the Earth downwards.

SIMP. The cauſe of this is moſt manifeſt, and every one knows that it is gravity.

SALV. You are out, *Simplicius*, you ſhould ſay, that every one knowes, that it is called Gravity: but I do not queſtion you about the name, but the eſſence of the thing, of which eſſence you know not a tittle more than you know the eſſence of the mover of the ſtars in gyration; unleſſe it be the name that hath been put to this, and made familiar, and domeſtical, by the many experiences which we ſee thereof every hour in the day,: but not as if we really underſtand any more, what principle or vertue that is which moveth a ſtone downwards, than we know who moveth it upwards, when it is ſeparated from the projicient, or who moveth the Moon round, except (as I have ſaid) onely the name, which more particularly and properly we have aſſigned to the motion of deſcent, namely, Gravity; whereas for the cauſe of circular motion, in more general termes, we aſſign the *Vertue impreſſed*, and call the ſame an *Intelligence*, either aſſiſting, or informing; and to infinite other motions we aſcribe Nature for their cauſe.

We know no more who moveth grave bodies downwards; than who moveth the Stars round, nor know we any thing of theſe cauſes, more than the names impoſed on them by us.

SIMP. It is my opinion, that this Author asketh far leſſe than that, to which you deny to make anſwer; for he doth not ask what is nominally and particularly the principle that moveth grave and light bodies circularly; but whatſoever it be, he deſireth to know, whether you think it intrinſecal, or extrinſecal: For howbeit, *v.gr.* I do not know, what kind of thing that gravity is, by which the Earth deſcendeth; yet I know that it is an intern princi-

principle, seeing that if it be not hindered, it moveth spontaneously: and on the contrary, I know that the principle which moveth it upwards, is external; although that I do not know, what thing that vertue is, impressed on it by the projicient.

SALV. Into how many questions must we excurre, if we would decide all the difficulties, which successively have dependance one upon another! You call that an external (and you also call it a preternatural and violent) principle, which moveth the grave project upwards; but its possible that it may be no lesse interne and natural, than that which moveth it downwards; it may peradventure be called external and violent, so long as the moveable is joyned to the projicient; but being separated, what external thing remaineth for a mover of the arrow, or ball? In summe, it must necessarliy be granted, that that vertue which carrieth such a moveable upwards, is no lesse interne, than that which moveth it downwards; and I think the motion of grave bodies ascending by the *impetus* conceived, to be altogether as natural, as the motion of descent depending on gravity.

The vertue which carrieth grave projects upwards, is no lesse natural to them, than the gravity which moveth them downwards.

SIMP. I will never grant this; for the motion of descent hath its principle internal, natural, and perpetual, and the motion of ascent hath its principle externe, violent, and finite.

SALV. If you refuse to grant me, that the principles of the motions of grave bodies downwards and upwards, are equally internal and natural; what would you do, if I should say, that they may also be the same in number?

Contrary principles cannot naturally reside in the same subject.

SIMP. I leave it to you to judge.

SALV. But I desire you your self to be the Judge: Therefore tell me, Do you believe that in the same natural body, there may reside interne principles, that are contrary to one another?

SIMP. I do verily believe there cannot.

SALV. What do you think to be the natural inclination of Earth, of Lead, of Gold, and in sum, of the most ponderous matters; that is, to what motion do you believe that their interne principle draweth them?

SIMP. To that towards the centre of things grave, that is, to the centre of the Universe, and of the Earth, whither, if they be not hindered, it will carry them.

SALV. So that, if the Terrestrial Globe were bored thorow, and a Well made that should passe through the centre of it, a Cannon bullet being let fall into the same, as being moved by a natural and intrinsick principle, would passe to the centre; and it would make all this motion spontaneously, and by intrinsick principle, is it not so?

SIMP. So I verily believe.

SALV. But when it is arrived at the centre, do you think that

it will paſſe any further, or elſe that there it would immediately ſtand ſtill, and move no further?

SIMP. I believe that it would continue to move a great way further.

SALV. But this motion beyond the centre, would it not be upwards, and according to your aſſertion preternatural, and violent? And yet on what other principle do you make it to depend, but only upon the ſelf ſame, which did carry the ball to the centre, and which you called intrinſecal, and natural? Finde, if you can, another external projicient, that overtaketh it again to drive it upwards. And this that hath been ſaid of the motion thorow the centre, is alſo ſeen by us here above; for the interne *impetus* of a grave body falling along a declining ſuperficies, if the ſaid ſuperficies be reflected the other way, it ſhall carry it, without a jot interrupting the motion, alſo upwards. A ball of lead that hangeth by a thread, being removed from its perpendicularity, deſcendeth ſpontaneouſly, as being drawn by its internal inclination, and without any interpoſure of reſt, paſſeth beyond the loweſt point of perpendicularity: and without any additional mover, moveth upwards. I know that you will not deny, but that the principle of grave bodies that moveth them downwards, is no leſs natural, and intrinſecal, than that principle of light bodies, vvhich moveth them upwards: ſo that I propoſe to your conſideration a ball of lead, vvhich deſcending through the Air from a great altitude, and ſo moving by an intern principle, and comming to a depth of vvater, continueth its deſcent, and without any other externe mover, ſubmergeth a great vvay; and yet the motion of deſcent in the vvater is preternatural unto it; but yet nevertheleſs dependeth on a principle that is internal, and not external to the ball. You ſee it demonſtrated then, that a moveable may be moved by one and the ſame internal principle, with contrary motions.

The natural motion changeth it ſelfe into that which is called preternatural and violent.

SIMP. I believe there are ſolutions to all theſe objections, though for the preſent I do not remember them; but however it be, the Author continueth to demand, on what principle this circular motion of grave and light bodies dependeth; that is, whether on a principle internal, or external; and proceeding forvvards, ſheweth, that it can be neither on the one, nor on the other, ſaying; *Si ab externo; Deuſne illum excitat per continuum miraculum? an verò Angelus, an aër? Et hunc quidem multi aſſignant. Sed contra*—— [*In Engliſh thus*] If from an externe principle; Whether God doth not excite it by a continued Miracle? or an Angel, or the Air? And indeed many do aſſign this. But on the contrary——.

SALV. Trouble not your ſelf to read his argument; for I am

none

none of thoſe who aſcribe that principle to the ambient air. As to the Miracle, or an Angel, I ſhould rather incline to this ſide; for that which taketh beginning from a Divine Miracle, or from an Angelical operation; as for inſtance, the tranſportation of a Cannon ball or bullet into the concave of the Moon, doth in all probability depend on the vertue of the ſame principle for performing the reſt. But, as to the Air, it ſerveth my turn, that it doth not hinder the circular motion of the moveables, which we did ſuppoſe to move thorow it. And to prove that, it ſufficeth (nor is more required) that it moveth with the ſame motion, and finiſheth its circulations with the ſame velocity, that the Terreſtrial Globe doth.

SIMP. And he likewiſe makes his oppoſition to this alſo; demanding who carrieth the air about, Nature, or Violence? And proveth, that it cannot be Nature, alledging that that is contrary to truth, experience, and to *Copernicus* himſelf.

SALV. It is not contrary to *Copernicus* in the leaſt, who writeth no ſuch thing; and this Author aſcribes theſe things to him with two exceſſive courteſie. It's true, he ſaith, and for my part I think he ſaith well, that the part of the air neer to the Earth, being rather a terreſtrial evaporation, may have the ſame nature, and naturally follow its motion; or, as being contiguous to it, may follow it in the ſame manner, as the Peripateticks ſay, that the ſuperiour part of it, and the Element of fire, follow the motion of the Lunar Concave, ſo that it lyeth upon them to declare, whether that motion be natural, or violent.

SIMP. The Author will reply, that if *Copernicus* maketh only the inferiour part of the Air to move, and ſuppoſeth the upper part thereof to want the ſaid motion, he cannot give a reaſon, how that quiet air can be able to carry thoſe grave bodies along with it, and make them keep pace with the motion of the Earth.

The propenſion of elementary bodies to follow the Earth, hath a limited Sphere of activity.

SALV. *Copernicus* will ſay, that this natural propenſion of the elementary bodies to follow the motion of the Earth, hath a limited Sphere, out of which ſuch a natural inclination would ceaſe; beſides that, as I have ſaid, the Air is not that which carrieth the moveables along with it; which being ſeparated from the Earth, do follow its motion; ſo that all the objections come to nothing, which this Author produceth to prove, that the Air cannot cauſe ſuch effects.

SIMP. To ſhew therefore, that that cannot be, it will be neceſſary to ſay, that ſuch like effects depend on an interne principle, againſt which poſition, *oboriuntur difficillimæ, immò inextricabiles quæſtiones ſecundæ*, of which ſort are theſe that follow. *Principium illud internum vel eſt accidens, vel ſubſtantia. Si primum; quale nam illud? nam qualitas locomotiva circum, hactenus nulla vidi-*

videtur agnita. (*In Engliſh thus:*) Contrary to which poſition there do ariſe moſt difficult, yea inextricable ſecond queſtions, ſuch as theſe; That intern principle is either an accident, or a ſubſtance. If the firſt; what manner of accident is it? For a locomotive quality about the centre, ſeemeth to be hitherto acknowledged by none.

SALV. How, is there no ſuch thing acknowledged? Is it not known to us, that all theſe elementary matters move round, together with the Earth? You ſee how this Author ſuppoſeth for true, that which is in queſtion.

SIMP. He ſaith, that we do not ſee the ſame; and me thinks, he hath therein reaſon on his ſide.

SALV. We ſee it not, becauſe we turn round together with them.

SIMP. Hear his other Argument. *Quæ etiam ſi eſſet, quomodò tamen inveniretur in rebus tam contrariis? in igne, ut in aquâ; in aëre, ut in terrâ; in viventibus, ut in animâ carentibus?* [*in Engliſh thus:*] Which although it were, yet how could it be found in things ſo contrary? in the fire, as in the water? in the air, as in the earth? in living creatures, as in things wanting life?

SALV. Suppoſing for this time, that water and fire are contraries; as alſo the air and earth; (of which yet much may be ſaid) the moſt that could follow from thence would be, that thoſe motions cannot be common to them, that are contrary to one another: ſo that *v. g.* the motion upwards, which naturally agreeth to fire, cannot agree to water; but that, like as it is by nature contrary to fire: ſo to it that motion ſuiteth, which is contrary to the motion of fire, which ſhall be the motion *deorſum*; but the circular motion, which is not contrary either to the motion *ſurſum*, or to the motion *deorſum*, but may mix with both, as *Ariſtotle* himſelf affirmeth, why may it not equally ſuit with grave bodies and with light? The motions in the next place, which cannot be common to things alive, and dead, are thoſe which depend on the ſoul: but thoſe which belong to the body, in as much as it is elementary, and conſequently participateth of the qualities of the elements, why may not they be common as well to the dead corps, as to the living body? And therefore, if the circular motion be proper to the elements, it ought to be common to the mixt bodies alſo.

SAGR. It muſt needs be, that this Author holdeth, that a dead cat, falling from a window, it is not poſſible that a live cat alſo could fall; it not being a thing convenient, that a carcaſe ſhould partake of the qualities which ſuit with things alive.

SALV. Therefore the diſcourſe of this Author concludeth nothing

nothing againſt one that ſhould affirm, that the principle of the circular motions of grave and light bodies is an intern accident: I know not how he may prove, that it cannot be a ſubſtance.

SIMP. He brings many Arguments againſt this. The firſt of which is in theſe words: *Si ſecundum (nempè, ſi dicas tale principium eſſe ſubſtantiam) illud eſt aut materia, aut forma, aut compoſitum. Sed repugnant iterum tot diverſæ rerum naturæ, quales ſunt aves, limaces, ſaxa, ſagittæ, nives, fumi, grandines, piſces, &c. quæ tamen omnia ſpecie & genere differentia, moverentur à naturâ ſuâ circulariter, ipſa naturis diverſiſſima, &c.* [*In Engliſh thus*] If the ſecond, (that is, if you ſhall ſay that this principle is a ſubſtance) it is either matter, or form, or a compound of both. But ſuch diverſe natures of things are again repugnant, ſuch as are birds, ſnails, ſtones, darts, ſnows, ſmoaks, hails, fiſhes, &c. all which notwithſtanding their differences in ſpecies and kind, are moved of their own nature circularly, they being of their natures moſt different, &c.

SALV. If theſe things before named are of diverſe natures, and things of diverſe natures cannot have a motion in common, it muſt follow, if you would give ſatisfaction to all, that you are to think of, more than two motions onely of upwards and downwards: and if there muſt be one for the arrows, another for the ſnails, another for the ſtones, and another for fiſhes; then are you to bethink your ſelf of worms, topazes and muſhrums, which are not leſs different in nature from one another, than ſnow and hail.

SIMP. It ſeems that you make a jeſt of theſe Arguments.

SALV. No indeed, *Simplicius*, but it hath been already anſwered above, to wit, that if one motion, whether downwards or upwards, can agree with all thoſe things afore named, a circular motion may no leſs agree with them: and as you are a *Peripatetick*, do not you put a greater difference between an elementary comet and a celeſtial ſtar, than between a fiſh and a bird? and yet both thoſe move circularly. Now propoſe your ſecond Argument.

SIMP. *Si terra ſtaret per voluntatem Dei, rotarèntne cætera, an non? ſi hoc, falſum eſt à naturâ gyrare; ſi illud, redeunt priores quæſtiones. Et ſanè mirum eſſet, quòd Gavia piſciculo, Alauda nidulo ſuo, & corvus limaci, petraque, etiam volans, imminere non poſſet.* [*Which I thus render:*] If the Earth be ſuppoſed to ſtand ſtill by the will of God, ſhould the reſt of bodies turn round or no? If not, then it's falſe that they are revolved by nature; if the other, the former queſtions will return upon us. And truly it would be ſtrange that the Sea-pie ſhould not be able to hover over the ſmall fiſh, the Lark over her neſt, and the Crow over the ſnail and rock, though flying.

SALV.

SALV. I would anſwer for my ſelf in general terms, that if it were appointed by the will of God, that the Earth ſhould ceaſe from its diurnal revolution, thoſe birds would do what ever ſhould pleaſe the ſame Divine will. But if this Author deſire a more particular anſwer, I ſhould tell him, that they would do quite contrary to what they do now, if whilſt they, being ſeparated from the Earth, do bear themſelves up in the air, the Terreſtrial Globe by the will of God, ſhould all on a ſudden be put upon an precipitate motion; it concerneth this Author now to aſcertain us what would in this caſe ſucceed.

SAGR. I pray you, *Salviatus*, at my requeſt to grant to this Author, that the Earth ſtanding ſtill by the will of God, the other things, ſeparated from it, would continue to turn round of their own natural motion, and let us hear what impoſſibilities or inconveniences would follow: for I, as to my own particular, do not ſee how there can be greater diſorders, than theſe produced by the Author himſelf, that is, that Larks, though they ſhould flie, could not be able to hover over their neſts, nor Crows over ſnails, or rocks: from whence would follow, that Crows muſt ſuffer for want of ſnails, and young Larks muſt die of hunger, and cold, not being able to be fed or ſheltered by the wings of the old ones. This is all the ruine that I can conceive would follow, ſuppoſing the Authors ſpeech to be true. Do you ſee, *Simplicius*, if greater inconveniences would happen?

SIMP. I know not how to diſcover greater; but it is very credible, that the Author beſides theſe, diſcovered other diſorders in Nature, which perhaps in reverend reſpect of her, he was not willing to inſtance in. Therefore let us proceed to the third Objection: *Inſuper quæ ſit, ut iſtæ res tàm variæ tantùm moveantur ab Occaſu in Ortum, parallelæ ad Æquatorem? ut ſemper moveantur, nunquam quieſcant?* [*which ſpeaks to this ſenſe:*] Moreover, how comes it to paſs that theſe things, ſo diverſe, are onely moved from the Weſt towards the Eaſt, parallel to the Æquinoctial? that they always move, and never reſt?

SALV. They move from Weſt to Eaſt parallel to the Æquinoctial without ceaſing, in the ſame manner as you believe the fixed ſtars to move from Eaſt to Weſt, parallel to the Æquinoctial, without ever reſting.

SIMP. *Quarè, quò ſunt altiores, celeriùs; quò humiliores, tardiùs?* (*i. e.*) Why are the higher the ſwifter, and the lower the ſlower?

SALV. Becauſe that in a Sphere or circle, that turns about upon its own centre, the remoter parts deſcribe greater circuits, and the parts nearer at hand deſcribe leſſer in the ſame time.

SIMP. *Quare, quæ Æquinoctiali propriores, in majori; quæ remotiores,*

remotiores, in minori circulo feruntur? [*ſcilicet:*] Why are thoſe near the Æquinoctial carried about in a greater circle; and thoſe which are remote in a leſſer?

SALV. To imitate the ſtarry Sphere, in which thoſe neareſt to the Æquinoctial, move in greater circles, than the more remote.

SIMP. *Quarè Pila eadem ſub Æquinoctiali tota circa centrum terræ, ambitu maximo, celeritate incredibili; ſub Polo verò circa centrum proprium, gyro nullo, tarditate ſuprema volveretur?* [*That is:*] Why is the ſame ball under the Æquinoctial wholly turned round the centre of the Earth in the greateſt circumference, with an incredible celerity; but under the Pole about its own centre, in no circuite, but with the ultimate degree of tardity?

SALV. To imitate the ſtars of the Firmament, that would do the like if they had the diurnal motion.

SIMP. *Quare eadem res, pila v. g. plumbea, ſi ſemel terram circuivit, deſcripto circulo maximo, eandem ubique non circumigret ſecundùm circulum maximum, ſed tranſlata extra Æquinoctialem in circulis minoribus agetur?* [*Which ſpeaketh thus:*] Why doth not the ſame thing, as for example, a ball of lead turn round every where according to the ſame great circle, if once deſcribing a great circle, it hath incompaſſed the Earth, but being removed from the Æquinoctial, doth move in leſſer circles?

SALV. Becauſe ſo would, nay, according to the doctrine of *Ptolomey*, ſo have ſome fixed ſtars done, which once were very near the Æquinoctial, and deſcribed very vaſt circles, and now that they are farther off, deſcribe leſſer.

SAGR. If I could now but keep in mind all theſe fine notions, I ſhould think that I had made a great purchaſe; I muſt needs intreat you, *Simplicius*, to lend me this Book, for there cannot chuſe but be a ſea of rare and ingenious matters contained in it.

SIMP. I will preſent you with it.

SAGR. Not ſo, Sir; I would not deprive you of it: but are the Queries yet at an end?

SIMP. No Sir; hearken therefore. *Si latio circularis gravibus & levibus eſt naturalis, qualis eſt ea quæ fit ſecundùm lineam rectam? Nam ſi naturalis, quomodo & is motus qui circum eſt, naturalis eſt, cùm ſpecie differat à recto? Si violentus, quî fit, ut miſſile ignitum ſurſum evolans ſcintilloſum caput ſurſum à terrâ, non autem circum volvatur, &c.* [*Which take in our idiom:*] If a circular lation is natural to heavy and light things, what is that which is made according to a right line? For if it be natural, how then is that motion which is about the centre natural; ſeeing it

differs in ſpecies from a right motion? If it be violent, how is it that a fiery dart flying upwards, ſparkling over our heads at a diſtance from the Earth, but not turning about, *&c.*

Of the mixt motion we ſee not the part that is circular, becauſe we partake thereof.

SALV. It hath been ſaid already very often, that the circular motion is natural to the whole, and to its parts, whilſt they are in perfect diſpoſure, and the right is to reduce to order the parts diſordered; though indeed it is better to ſay, that neither the parts ordered or diſordered ever move with a right motion, but with one mixed, which might as well be averred meerly circular: but to us but one part onely of this motion is viſible and obſervable, that is, the part of the right, the other part of the circular being imperceptible to us, becauſe we partake thereof. And this anſwers to the rays which move upwards, and round about, but we cannot diſtinguiſh their circular motion, for that, with that we our ſelves move alſo. But I believe that this Author never thought of this mixture; for you may ſee that he reſolutely ſaith, that the rays go directly upwards, and not at all in gyration.

SIMP. *Quare centrum ſphæræ delapſæ ſub Æquatore ſpiram deſcribit in ejus plano: ſub aliis parallelis ſpiram deſcribit in cono? ſub Polo deſcendit in axe lineam gyralem, decurrens in ſuperficie cylindricâ conſignatam?* (In Engliſh to this purpoſe:) Why doth the centre of a falling Globe under the Æquinoctial deſcribe a ſpiral line in the plane of the Æquator; and in other parallels a ſpiral about a Cone; and under the Pole deſcend in the axis deſcribing a gyral line, running in a Cylindrical Superficies?

SALV. Becauſe of the lines drawn from the Centre to the circumference of the ſphere, which are thoſe by which *graves* deſcend, that which terminates in the Æquinoctial deſigneth a circle, and thoſe that terminate in other parallels deſcribe conical ſuperficies; now the axis deſcribeth nothing at all, but continueth in its own being. And if I may give you my judgment freely, I will ſay, that I cannot draw from all theſe Queries, any ſenſe that interfereth with the motion of the Earth; for if I demand of this Author, (granting him that the Earth doth not move) what would follow in all theſe particulars, ſuppoſing that it do move, as *Copernicus* will have it; I am very confident, that he would ſay that all theſe effects would happen, that he hath objected, as inconveniences to diſprove its mobility: ſo that in this mans opinion neceſſary conſequences are accounted abſurdities: but I beſeech you, if there be any more, diſpatch them, and free us ſpeedily from this weariſom task.

SIMP. In this which follows he oppoſes *Copernicus* & his Sectators, who affirm, that the motion of the parts ſeparated from their whole, is onely to unite themſelves to their whole; but that the moving

circularly

circularly along with the vertigenous diurnal revolution is abſolutely natural : againſt which he objecteth, ſaying, that according to theſe mens opinion; *Si tota terra, unà cum aquâ in nihilum redigeretur, nulla grando aut pluvia è nube decideret, ſed naturaliter tantùm circumferetur, neque ignis ullus, aut igneum aſcenderet, cùm illorum non improbabili ſententiâ ignis nullus ſit ſuprà.* [Which I tranſlate to this ſenſe:] If the whole Earth, together with the Water were reduced into nothing, no hail or rain would fall from the clouds, but would be onely naturally carried round; neither any fire or fiery thing would aſcend, ſeeing to theſe that men it is no improbable opinion that there is no fire above.

SALV. The providence of this Philoſopher is admirable, and worthy of great applauſe; for he is not content to provide for things that might happen, the courſe of Nature continuing, but will ſhew his care in what may follow from thoſe things that he very well knows ſhall never come to paſs. I will grant him therefore, (that I may get ſom pretty paſſages out of him) that if the Earth and Water ſhould be reduced to nothing, there would be no more hails or rains, nor would igneal matters aſcend any longer upwards, but would continually turn round : what will follow? what will the Philoſopher ſay then?

SIMP. The objection is in the words which immediately follow; here they are : *Quibus tamen experientia & ratio adverſatur.* Which nevertheleſs (ſaith he) is contrary to experience and reaſon.

SALV. Now I muſt yield, ſeeing he hath ſo great an advantage of me as experience, of which I am unprovided. For as yet I never had the fortune to ſee the Terreſtrial Globe and the element of Water turn'd to nothing, ſo as to have been able to obſerve what the hail and water did in that little Chaos. But he perhaps tells us for our inſtruction what they did.

SIMP. No, he doth not.

SALV. I would give any thing to change a word or two with this perſon, to ask him, whether when this Globe vaniſhed, it carried away with it the common centre of gravity, as I believe it did; in which caſe, I think that the hail and water would remain inſenſate and ſtupid amongſt the clouds, without knowing what to do with themſelves. It might be alſo, that attracted by that great void *Vacuum*, left by the Earths abſenting, all the ambients would be rarified, and particularly, the air, which is extreme eaſily drawn, and would run thither with very great haſte to fill it up. And perhaps the more ſolid and material bodies, as birds, (for there would in all probability be many of them ſcattered up and down in the air) would retire more towards the centre of the great vacant ſphere; (for it ſeemeth very reaſonable, that ſubſtances that

under ſmall bulk contain much matter, ſhould have narrower places aſſigned them, leaving the more ſpacious to the more rarified) and there being dead of hunger, and reſolved into Earth, would form a new little Globe, with that little water, which at that time was among the clouds. It might be alſo, that thoſe matters as not beholding the light, would not perceive the Earths departure, but like blind things, would deſcend according to their uſual cuſtom to the centre, whither they would now go, if that globe did not hinder them. And laſtly, that I may give this Philoſopher a leſs irreſolute anſwer, I do tell him, that I know as much of what would follow upon the annihilation of the Terreſtrial Globe, as he would have done that was to have followed in and about the ſame, before it was created. And becauſe I am certain he will ſay, that he would never have been able to have known any of all thoſe things which experience alone hath made him knowing in, he ought not to deny me pardon, and to excuſe me if I know not that which he knows, touching what would enſue upon the annihilation of the ſaid Globe: for that I want that experience which he hath. Let us hear if he have any thing elſe to ſay.

SIMP. There remains this figure, which repreſents the Terreſtrial Globe with a great cavity about its centre, full of air; and to ſhew that *Graves* move not downwards to unite with the Terreſtrial Globe, as *Copernicus* ſaith, he conſtituteth this ſtone in the centre; and demandeth, it being left at liberty, what it would do; and he placeth another in the ſpace of this great vacuum, and asketh the ſame queſtion. Saying, as to the firſt: *Lapis in centro conſtitutus, aut aſcendet ad terram in punctum aliquod, aut non. Si ſecundum; falſum eſt, partes ob ſolam ſejunctionem à toto, ad illud moveri. Si primum; omnis ratio & experientia renititur, neque gravia in ſuæ gravitatis centro conquieſcent. Item ſi ſuſpenſus lapis, liberatus decidat in centrum, ſeparabit ſe à toto, contra* Copernicum: *ſi pendeat, refragatur omnis experientia, cùm videamus integros fornices corruere.* (Wherein he ſaith:) The ſtone placed in the centre, either aſcendeth to the Earth in ſome point, or no. If the ſecond, it is falſe that the parts ſeparated from the whole, move unto it. If the firſt; it contradicteth all reaſon and experience, nor doth the grave body reſt in the centre of its gravity. And if the ſtone being ſuſpended in the air, be let go, do deſcend to the centre, it will ſeparate from its vvhole, contrary to *Copernicus*: if it do hang in the air, it contradicteth all experience: ſince we ſee whole Vaults to fall dovvn.

SALV. I vvill anſvver, though vvith great diſadvantage to my ſelf, ſeeing I have to do vvith one vvho hath ſeen by experience, vvhat theſe ſtones do in this great Cave: a thing, vvhich for my part I have not ſeen; and vvill ſay, that things grave have an exiſtence

ſtence before the common centre of gravity : ſo that it is not one centre alone, vvhich is no other than indiviſible point, and therefore of no efficacie, that can attract unto it grave matters; but that thoſe matters conſpiring naturally to unite, form to themſelves a common centre, which is that about which parts of equal moment conſiſt : ſo that I hold, that if the great aggregate of grave bodies vvere gathered all into any one place, the ſmall parts that vvere ſeparated from their vvhole, vvould follovv the ſame, and if they vvere not hindered, vvould penetrate vvherever they ſhould find parts leſs grave than themſelves : but coming vvhere they ſhould meet vvith matters more grave, they vvould deſcend no farther. And therefore I hold, that in the Cave full of air, the vvhole Vault vvould preſs, and violently reſt it ſelf onely upon that air, in caſe its hardneſs could not be overcome and broken by its gravity; but looſe ſtones, I believe, would deſcend to the centre, and not ſwim above in the air : nor may it be ſaid, that they move not to their whole, though they move whither all the parts of the whole would transfer themſelves, if all impediments were removed.

Things grave are before the centre of gravity.

The great maſs of grave bodies being transferred out of their place, the ſeparated parts would follow that maſs.

SIMP. That which remaineth, is a certain Errour which he obſerveth in a Diſciple of *Copernicus*, who making the Earth to move with an annual motion, and a diurnal, in the ſame manner as the Cart-wheel moveth upon the circle of the Earth, and in it ſelf, did conſtitute the Terreſtrial Globe too great, or the great Orb too little; for that 365 revolutions of the Æquinoctial, are leſs by far than the circumference of the great Orb.

SALV. Take notice that you miſtake, and tell us the direct contrary to what muſt needs be written in that Book; for you ſhould ſay, that that ſame *Copernican* Author did conſtitute the Terreſtrial Globe too little, and the great Orb too big; and not the Terreſtrial Globe too big, and the annual too little.

SIMP. The miſtake is not mine; ſee here the words of the Book. *Non videt, quòd vel circulum annuum æquo minorem, vel orbem terreum juſto multò fabricet majorem.* (In Engliſh thus :) He ſeeth not, that he either maketh the annual circle equal to the leſs, or the Terreſtrial Orb much too big.

SALV. I cannot tell whether the firſt Author erred or no, ſince the Author of this Tractate doth not name him; but the error of this Book is certain and unpardonable, whether that follower of *Copernicus* erred or not erred; for that your Author paſſeth by ſo material an error, without either detecting or correcting it. But let him be forgiven this fault, as an error rather of inadvertencie, than of any thing elſe : Farthermore, were it not, that I am already wearied and tired with talking and ſpending ſo much time with very little profit, in theſe frivolous janglings and altercations, I could ſhew, that it is not impoſſible for a circle, though no

It is not impoſſible with the circumference of a ſmall circle few times revolved to meaſure and deſcribe a line bigger than any great circle whatſoever.

no bigger than a Cart-wheel, with making not 365, but leſſe than 20 revolutions, to deſcribe and meaſure the circumference, not onely of the grand Orb, but of one a thouſand times greater; and this I ſay to ſhew, that there do not want far greater ſubtilties, than this wherewith your Author goeth about to detect the errour of *Copernicus*: but I pray you, let us breath a little, that ſo we may proceed to the other Philoſopher, that oppoſeth of the ſame *Copernicus*.

SAGR. To confeſſe the truth, I ſtand as much in need of reſpite as either of you; though I have onely wearied my eares: and were it not that I hope to hear more ingenious things from this other Author, I queſtion whether I ſhould not go my ways, to take the air in my * Pleaſure-boat.

* Gondola.

SIMP. I believe that you will hear things of greater moment; for this is a moſt accompliſhed Philoſopher, and a great Mathematician, and hath confuted *Tycho* in the buſineſſe of the Comets, and new Stars.

* The name of the *Author* is *Scipio Claramontius.*

SALV. Perhaps he is the ſame with the Author of the Book, called *Anti-Tycho*?

SIMP. He is the very ſame: but the confutation of the new Stars is not in his *Anti-Tycho*, onely ſo far as he proveth, that they were not prejudicial to the inalterability and ingenerability of the Heavens, as I told you before; but after he had publiſhed his *Anti-Tycho*, having found out, by help of the Parallaxes, a way to demonſtrate, that they alſo are things elementary, and contained within the concave of the Moon, he hath writ this other Book, *de tribus novis Stellis, &c.* and therein alſo inſerted the Arguments againſt *Copernicus*: I have already ſhewn you what he hath written touching theſe new Stars in his *Anti-Tycho*, where he denied not, but that they were in the Heavens; but he proved, that their production altered not the inalterability of the Heavens, and that he did, with a Diſcourſe purely philoſophical, in the ſame manner as you have already heard. And I then forgot to tell you, how that he afterwards did finde out a way to remove them out of the Heavens; for he proceeding in this confutation, by way of computations and parallaxes, matters little or nothing at all underſtood by me, I did not mention them to you, but have bent all my ſtudies upon theſe arguments againſt the motion of the Earth, which are purely natural.

SALV. I underſtand you very well: and it will be convenient after we have heard what he hath to ſay againſt *Copernicus*, that we hear, or ſee at leaſt the manner wherewith he, by way of Parallaxes, proveth thoſe new ſtars to be elementary, which ſo many famous Aſtronomers conſtitute to be all very high, and amongſt the ſtars of the Firmament; and as this Author accompliſheth ſuch

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an enterprize of pulling the new ſtars out of heaven, and placing them in the elementary Sphere, he ſhall be worthy to be highly exalted, and transferred himſelf amongſt the ſtars, or at leaſt, that his name be by fame eternized amongſt them. Yet before we enter upon this, let us hear what he alledgeth againſt the opinion of *Copernicus*, and do you begin to recite his Arguments.

SIMP. It will not be neceſſary that we read them *ad verbum*, becauſe they are very prolix; but I, as you may ſee, in reading them ſeveral times attentively, have marked in the margine thoſe words, wherein the ſtrength of his arguments lie, and it will ſuffice to read them. The firſt Argument beginneth here. *Et primo, ſi opinio Copernici recipiatur, Criterium naturalis Philoſophiæ, ni prorſus tollatur, vehementer ſaltem labefactari videtur.* [In our Idiom thus] And firſt, if *Copernicus* his opinion be imbraced, the *Criterium* of natural Philoſophy will be, if not wholly ſubverted, yet at leaſt extreamly ſhaken.

The opinion of Copernicus *overthrows the* Criterium *of Philoſophy*

Which, according to the opinion of all the ſects of Philoſophers requireth, that Senſe and Experience be our guides in philoſophating: But in the *Copernican* poſition the Senſes are greatly deluded, whil'ſt that they viſibly diſcover neer at hand in a pure *Medium*, the graveſt bodies to deſcend perpendicularly downwards, never deviating a ſingle hairs breadth from rectitude; and yet according to the opinion of *Copernicus*, the ſight in ſo manifeſt a thing is deceived, and that motion is not reall ſtraight, but mixt of right and circular.

SALV. This is the firſt argument, that *Ariſtotle*, *Ptolomy*, and all their followers do produce; to vvhich we have abundantly anſwered, and ſhewn the Paralogiſme, and with ſufficient plainneſſe proved, that the motion in common to us and other moveables, is, as if there were no ſuch thing; but becauſe true concluſions meet with a thouſand accidents, that confirme them, I vvill, with the favour of this Philoſopher, adde ſomething more; and you *Simplicius* perſonating him, anſwer me to vvhat I ſhall ask you: And firſt tell me, vvhat effect hath that ſtone upon you, which falling from the top of the Tower, is the cauſe that you perceive that motion; for if its fall doth operate upon you neither more nor leſſe, than its ſtanding ſtill on the Towers top, you doubtleſſe could not diſcern its deſcent, or diſtinguiſh its moving from its lying ſtill.

Common motion is, as if it never were.

The argument taken from things falling perpendicularly, another way confuted.

SIMP. I comprehend its moving, in relation to the Tower, for that I ſee it one while juſt againſt ſuch a mark in the ſaid Tower, and another while againſt another lower, and ſo ſucceſſively, till that at laſt I perceive it arrived at the ground.

SALV. Then if that ſtone were let fall from the tallons of an Eagle flying, and ſhould deſcend thorow the ſimple inviſible Air, and

and you had no other object viſible and ſtable, wherewith to make compariſons to that, you could not perceive its motion?

Whence the motion of a cadent body is collected.

SIMP. No, nor the ſtone it ſelf; for if I would ſee it, when it is at the higheſt, I muſt raiſe up my head, and as it deſcendeth, I muſt hold it lower and lower, and in a word, muſt continually move either that, or my eyes, following the motion of the ſaid ſtone.

The motion of the eye argueth the motion of the object looked on.

SALV. You have novv rightly anſwered: you knovv then that the ſtone lyeth ſtill, vvhen without moving your eye, you alwayes ſee it before you; and you know that it moveth, when for the keeping it in ſight, you muſt move the organ of ſight, the eye. So then vvhen ever without moving your eye, you continually behold an object in the ſelf ſame aſpect, you do alvvays judge it immoveable.

SIMP. I think it muſt needs be ſo.

SALV. Novv fancy your ſelf to be in a ſhip, and to have fixed your eye on the point of the Sail-yard: Do you think, that becauſe the ſhip moveth very faſt, you muſt move your eye, to keep your ſight alvvayes upon the point of the Sail-yard, and to follow its motion?

SIMP. I am certain, that I ſhould need to make no change at all; and that not only in the ſight; but if I had aimed a Musket at it, I ſhould never have need, let the ſhip move how it vvill, to ſtir it an hairs breadth to keep it full upon the ſame.

SALV. And this happens becauſe the motion, which the Ship conferreth on the Sail-yard, it conferreth alſo upon you, and upon your eye; ſo that you need not ſtir it a jot to behold the top of the Sail-yard: and conſequently, it vvill ſeem to you immoveable. Now this Diſcourſe being applied to the revolution of the Earth, and to the ſtone placed in the top of the Tower, in which you cannot diſcern any motion, becauſe that you have that motion vvhich is neceſſary for the following of it, in common with it from the Earth; ſo that you need not move your eye. When again there is conferred upon it the motion of deſcent, which is its particular motion, and not yours, and that it is intermixed with the circular, that part of the circular which is common to the ſtone, and to the eye, continueth to be imperceptible, and the right onely is perceived, for that to the perception of it, you muſt follow it with your eye, looking lower and lower. I wiſh for the undeceiving of this Philoſopher, that I could adviſe him, that ſome time or other going by water, he would carry along with him a Veſſel of reaſonable depth full of water, and prepare a ball of wax, or other matter that would deſcend very ſlowly to the bottome, ſo that in a minute of an hour, it would ſcarce ſink a yard; and that rowing the boat as faſt as could be, ſo that in a minute of an hour

An experiment that ſheweth how the common motion is imperceptible.

it

it ſhould run above an hundred yards, he would let the ball ſubmerge into the water, & freely deſcend, & diligently obſerve its motion. If he would but do thus, he ſhould ſee, firſt, that it would go in a direct line towards that point of the bottom of the veſſel, whither it would tend, if the boat ſhould ſtand ſtill; & to his eye, and in relation to the veſſel, that motion would appear moſt ſtraight and perpendicular, and yet he could not ſay, but that it would be compoſed of the right motion downwards, and of the circular about the element of water. And if theſe things befall in matters not natural, and in things that we may experiment in their ſtate of reſt; & then again in the contrary ſtate of motion, and yet as to appearance no diverſity at all is diſcovered, & that they ſeem to deceive our ſenſe what can we diſtinguiſh touching the Earth, which hath been perpetually in the ſame conſtitution, as to motion and reſt? And in what time can we experiment whether any difference is diſcernable amongſt theſe accidents of local motion, in its diverſe ſtates of motion and reſt, if it eternally indureth in but one onely of them?

SAGR. Theſe Diſcourſes have ſomewhat whetted my ſtomack, which thoſe fiſhes, and ſnails had in part nauſeated; and the former made me call to minde the correction of an errour, that hath ſo much appearance of truth, that I know not whether one of a thouſand would refuſe to admit it as unqueſtionable. And it was this, that ſailing into *Syria*, and carrying with me a very good *Teleſcope*, that had been beſtowed on me by our *Common Friend*, who not many dayes before had invented, I propoſed to the Mariners, that it would be of great benefit in Navigation to make uſe of it upon the round top of a ſhip, to diſcover and kenne Veſſels afar off. The benefit was approved, but there was objected the difficulty of uſing it, by reaſon of the Ships continual fluctuation; and eſpecially on the round top, where the agitation is ſo much greater, and that it would be better for any one that would make uſe thereof to ſtand at the Partners upon the upper Deck, where the toſſing is leſſe than in any other place of the Ship. I (for I will not conceal my errour) concurred in the ſame opinion, and for that time ſaid no more: nor can I tell you by what hints I was moved to return to ruminate with my ſelf upon this buſineſſe, and in the end came to diſcover my ſimplicity (although excuſable) in admitting that for true, which is moſt falſe; falſe I ſay, that the great agitation of the basket or round top, in compariſon of the ſmall one below, at the partners of the Maſt, ſhould render the uſe of the *Teleſcope* more difficult in finding out the object.

An ingenuous conſideration about the poſſibility of uſing the Teleſcope *with as much facility on the round top of the Maſt of a ſhip, as on the Deck.*

SALV. I ſhould have accompanied the Mariners, and your ſelf at the beginning.

SIMP. And ſo ſhould I have done, and ſtill do: nor can I believe, if I ſhould think of it an hundred years, that I could underſtand it otherwiſe.

SAGR. I may then, it ſeems, for once prove a Maſter to you both. And becauſe the proceeding by interrogatories doth in my opinion much dilucidate things, beſides the pleaſure which it affords of confounding our companion, forcing from him that which he thought he knew not, I will make uſe of that artifice. And firſt, I ſuppoſe that the Ship, Gally, or other Veſſel, which we would diſcover, is a great way off, that is, four, ſix, ten, or twenty * miles, for that to kenne thoſe neer at hand there is no need of theſe Glaſſes: & conſequently, the *Teleſcope* may at ſuch a diſtance of four or ſix miles conveniently diſcover the whole Veſſel, & a muchgreater bulk. Now I demand what for ſpecies, & how many for number are the motions that are made upon the round top, depending on the fluctuation of the Ship.

* I deviate here from the ſtrict Sea Dialect, which denominates all diſtances by Leagues.

Different motions depending on the fluctuation of the Ship.

SALV. We will ſuppoſe that the Ship goeth towards the Eaſt. Firſt, in a calme Sea, it would have no other motion than this of progreſſion, but adding the undulation of the Waves, there ſhall reſult thence one, which alternately hoyſting and lowering the poop and prow, maketh the round top, to lean forwards and backwards; other waves driving the veſſel ſidewayes, bow the Maſt to the Starboard and Larboard; others, may bring the ſhip ſomewhat abovt, and bear her away by the Miſne from Eaſt, one while towards the * Northeaſt, another while toward the Southeaſt; others bearing her up by the Carine may make her onely to riſe, and fall; and in ſum, theſe motions are for ſpecies two, one that changeth the direction of the *Teleſcope* angularly, the other lineally, without changing angle, that is, alwayes keeping the tube of the Inſtrument parallel to its ſelf.

* *Greco*, which the Latine Tranſlator according to his uſual careleſſeneſſe (to call it no worſe) tranſlates *Corum Ventum*, the Northweſt Wind; for *Ventum Libanotum*.

Two mutations made in the Teleſcope, depending on the agitation of the Ship.

SAGR. Tell me, in the next place, if we, having firſt directed the *Teleſcope* yonder away towards the Tower of * *Burano*, ſix miles from hence, do turn it angularly to the right hand, or to the left, or elſe upwards or downwards, but a * ſtraws breadth, what effect ſhall it have upon us touching the finding out of the ſaid tower?

* This is a Caſtle ſix Italian miles from *Venice* Northwards.

SALV. It would make us immediately loſe ſight of it, for ſuch a declination, though ſmall here, may import there hundreds and thouſands of yards.

* *Unnero d'ugna*, the black or paring of a nail.

SAGR. But if without changing the angle, keeping the tube alwayes parallel to it ſelf, we ſhould transfer it ten or twelve yards farther off to the right or left hand, upwards or downwards, what alteration would it make as to the Tower?

SALV. The change would be abſolutely undiſcernable; for that the ſpaces here and there being contained between parallel rayes, the mutations made here and there, ought to be equal, and becauſe the ſpace which the Inſtrument diſcovers yonder, is capable of many of thoſe Towers; therefore we ſhall not loſe ſight of it.

SAGR. Returning now to the Ship, we may undoubtedly affirm, that the *Teleſcope* moving to the right or left, upwards, or down-

downwards, and alſo forwards or backwards ten or fifteen fathom, keeping it all the while parallel to its ſelf, the viſive ray cannot ſtray from the point obſerved in the object, more than thoſe fifteen fathom; and becauſe in a diſtance of eight or ten miles, the Inſtrument takes in a much greater ſpace than the Gally or other Veſſel kenn'd; therefore that ſmall mutation ſhall not make me loſe ſight of her. The impediment therefore, and the cauſe of loſing the object cannot befall us, unleſſe upon the mutation made angularly; ſince that *Teleſcopes* tranſportation higher or lower, to the right, or to the left, by the agitation of the ſhip, cannot import any great number of fathomes. Now ſuppoſe that you had two *Teleſcopes* fixed, one at the Partners cloſe by the Deck, and the other at the round top, nay at the main top, or main top-gallant top, where you hang forth the *Pennon* or ſtreamer, and that they be both directed to the Veſſel that is ten miles off, tell me, whether you believe that any agitation of the ſhip, & inclination of the Maſt, can make greater changes, as to the angle, in the higher tube, than in the lower? One wave ariſing, the prow will make the main top give back fifteen or twenty fathom more than the foot of the Maſt; and it ſhall carry the upper tube along with it ſo great a ſpace, & the lower it may be not a palm; but the angle ſhall change in one Inſtrument aſwell as in the other; and likewiſe a ſide-billow ſhall bear the higher tube an hundred times as far to the Larboard or Starboard, as it will the other below; but the angles change not at all, or elſe alter both alike. But the mutation to the right hand or left, forwards or backwards, upwards or downwards, bringeth no ſenſible impediment in the kenning of objects remote, though the alteration of the angle maketh great change therein; Therefore it muſt of neceſſity be confeſſed, that the uſe of the *Teleſcope* on the round top is no more difficult than upon the Deck at the Partners; ſeeing that the angular mutations are alike in both places.

SALV. How much circumſpection is there to be uſed in affirming or denying a propoſition? I ſay again, that hearing it reſolutely affirmed, that there is a greater motion made on the Maſts top, than at its partners, every one will perſwade himſelf, that the uſe of the *Teleſcope* is much more difficult above than below. And thus alſo I will excuſe thoſe Philoſophers, who grow impatient and fly out into paſſion againſt ſuch as will not grant them, that that Cannon bullet which they cleerly ſee to fall in a right line perpendicularly, doth abſolutely move in that manner; but will have its motion to be by an arch, and alſo very much inclined and tranſverſal: but let us leave them in theſe labyrinths, and let us hear the other objections, that our Author in hand brings againſt *Copernicus*.

SIMP. The Author goeth on to demonſtrate that in the Doctrine of *Copernicus*, it is requiſite to deny the Senſes, and the

The annual motion of the Earth muſt cauſe a perpetual and ſtrong winde.

greateſt Senſations, as for inſtance it would be, if we that feel the reſpirations of a gentle gale, ſhould not feel the impulſe of a perpetual winde that beateth upon us with a velocity that runs more than 2529 miles an hour, for ſo much is the ſpace that the centre of the Earth in its annual motion paſſeth in an hour upon the circumference of the grand Orb, as he diligently calculates; and becauſe, as he ſaith, by the judgment of *Copernicus*, *Cum terra movetur circumpoſitus aër, motus tamen ejus, velocior licet ac rapidior celerrimo quocunque vento, à nobis non ſentiretur, ſed ſumma tum tranquilitas reputaretur, niſi alius motus accederet. Quid eſt verò decipi ſenſum, niſi hæc eſſet deceptio?* [*Which I make to ſpeak to this ſenſe.*] The circumpoſed air is moved with the Earth, yet its motion, although more ſpeedy and rapid than the ſwifteſt wind whatſoever, would not be perceived by us, but then would be thought a great tranquillity, unleſſe ſome other motion ſhould happen; what then is the deception of the ſenſe, if this be not?

SALV. It muſt needs be that this Philoſopher thinketh, that that Earth which *Copernicus* maketh to turn round, together with the ambient air along the circumference of the great Orb, is not that whereon we inhabit, but ſome other ſeparated from this; for that this of ours carrieth us alſo along with it with the ſame velocity, as alſo the circumjacent air: And what beating of the air can we feel, when we fly with equal ſpeed from that which ſhould accoſt us? This Gentleman forgot, that we no leſs than the Earth and air are carried about, and that conſequently we are always touch'd by one and the ſame part of the air, which yet doth not make us feel it.

The air always touching us with the ſame part of it cannot make us feel it.

SIMP. But I rather think that he did not ſo think; hear the words which immediately follow. *Præterea nos quoque rotamur ex circumductione terræ &c.*

SALV. Now I can no longer help nor excuſe him; do you plead for him and bring him off, *Simplicius*.

SIMP. I cannot thus upon the ſudden think of an excuſe that pleaſeth me.

SALV. Go to; take this whole night to think on it, and defend him to morrow; in the mean time let us hear ſome other of his objections.

He that will follow Copernicus, *muſt deny his ſenſes.*

SIMP. He proſecuteth the ſame Objection, ſhewing, that in the way of *Copernicus*, a man muſt deny his own ſenſes. For that this principle whereby we turn round with the Earth, either is intrinſick to us, or external; that is, a rapture of that Earth; and if it be this ſecond, we not feeling any ſuch rapture, it muſt be confeſſed that the ſenſe of feeling, doth not feel its own object touching it, nor its impreſſion on the ſenſible part: but if the principle

ciple be intrinſecal, we ſhall not perceive a local motion that is derived from our ſelves, and we ſhall never diſcover a propenſion perpetually annexed to our ſelves.

SALV. So that the inſtance of this Philoſopher lays its ſtreſs upon this, that whether the principle by which we move round with the Earth be either extern, or intern, yet however we muſt perceive it, and not perceiving it, it is neither the one nor the other, and therefore we move not, nor conſequently the Earth. Now I ſay, that it may be both ways, and yet we not perceive the ſame. And that it may be external, the experiment of the boat ſuperabundantly ſatisfieth me; I ſay, ſuperabundantly, becauſe it being in our power at all times to make it move, and alſo to make it ſtand ſtill, and with great exactneſs to make obſervation, whether by ſome diverſity that may be comprehended by the ſenſe of feeling, we can come to know whether it moveth or no, ſeeing that as yet no ſuch ſcience is obtained: Will it then be any matter of wonder, if the ſame accident is unknown to us on the Earth, the which may have carried us about perpetually, and we, without our being ever able to experiment its reſt? You, *Simplicius*, as I believe, have gone by boat many times to *Padoua*, and if you will confeſs the truth, you never felt in your ſelf the participation of that motion, unleſs when the boat running a-ground, or encountring ſome obſtacle, did ſtop, and that you with the other Paſſengers being taken on a ſudden, were with danger over-ſet. It would be neceſſary that the Terreſtrial Globe ſhould meet with ſome rub that might arreſt it, for I aſſure you, that then you would diſcern the impulſe reſiding in you, when it ſhould toſs you up towards the Stars. It's true, that by the other ſenſes, but yet aſſiſted by Reaſon, you may perceive the motion of the boat, that is, with the ſight, in that you ſee the trees and buildings placed on the ſhoar, which being ſeparated from the boat, ſeem to move the contrary way. But if you would by ſuch an experiment receive intire ſatisfaction in this buſineſs of the Terreſtrial motion, look on the ſtars, which upon this reaſon ſeem to move the contrary way. As to the wondering that we ſhould not feel ſuch a principle, ſuppoſing it to be internal, is a leſs reaſonable conceit; for if we do not feel ſuch a one, that cometh to us from without, and that frequently goeth away, with what reaſon can we expect to feel it, if it immutably and continually reſides in us? Now let us ſee what you have farther to allege on this argument.

Our motion may be either interne or externe, and yet we never perceive or feel it.

The motion of a Boat inſenſible to thoſe that are with in it, as to the ſenſe of feeling.

The boats motion is perceptible to the ſight joyn'd with reaſon.

The terreſtrial motion collected from the ſtars.

SIMP. Take this ſhort exclamation. *Ex hac itaque opinione neceſſe eſt diffidere noſtris ſenſibus, ut penitùs fallacibus vel ſtupidis in ſenſilibus, etiam conjunctiſſimis, dijudicandis. Quam ergò veritatem ſperare poſſumus à facultate adeò fallaci ortum trahentem?* [Which I render thus:] From this opinion likewiſe, we muſt of neceſſity

neceſſity ſuſpect our own ſenſes, as wholly fallible, or ſtupid in judging of ſenſible things even very near at hand. What truth therefore can we hope for, to be derived from ſo deceiveable a faculty?

SALV. But I deſire not to deduce precepts more profitable, or more certain, learning to be more circumſpect and leſs confident about that which at firſt bluſh is repreſented to us by the ſenſes, which may eaſily deceive us. And I would not have this Author trouble himſelf in attemptiug to make us comprehend by ſenſe, that this motion of deſcending Graves is ſimply right, and of no other kind; nor let him exclaim that a thing ſo clear, manifeſt, and obvious ſhould be brought in queſtion; for in ſo doing, he maketh others believe, that he thinketh thoſe that deny that motion to be abſolutely ſtreight, but rather circular, the ſtone did ſenſibly ſee it to move in an arch, ſeeing that he inviteth their ſenſes more than their Reaſon, to judg of that effect: which is not true, *Simplicius*, for like as I, that am indifferent in all theſe opinions, and onely in the manner of a Comedian, perſonate *Copernicus* in theſe our repreſentations, have never ſeen, nor thought that I have ſeen that ſtone fall otherwiſe than perpendicularly, ſo I believe, that to the eyes of all others it ſeemed to do the ſame. Better it is therefore, that depoſing that appearance in which all agree, we make uſe of our Reaſon, either to confirm the reality of that, or to diſcover its fallacy.

SAGR. If I could any time meet with this Philoſopher, who yet me thinks is more ſublime than the reſt of the followers of the ſame doctrines, I would in token of my affection put him in mind of an accident which he hath doubtleſs very often beheld; from which, with great conformity to that which we now diſcourſe of, it may be collected how eaſily one may be deceived by the bare appearance, or, if you will, repreſentation of the ſenſe. And the accident is, the Moons ſeeming to follow thoſe that walk the ſtreets in the night, with a pace equal to theirs, whilſt they ſee it go gliding along the Roofs of houſes, upon which it ſheweth juſt like a cat, that really running along the ridges of houſes, leaveth them behind. An appearance that, did not reaſon interpoſe, would but too manifeſtly delude the ſight.

Arguments againſt the Earths motion taken, ex rerum natura.

SIMP. Indeed there want not experiments that render us certain of the fallacy of the meer ſenſes; therefore ſuſpending ſuch ſenſations for the preſent, let us hear the Arguments that follow which are taken, as he ſaith, *ex rerum naturâ*. The firſt of which is, that the Earth cannot of its own nature move with three motions very different; or otherwiſe we muſt deny many manifeſt Axioms. The firſt whereof is, that *Omnis effectus dependeat ab aliquâ cauſâ*; [*i. e.*] that every effect dependeth on ſome cauſe.

Three Axioms that are ſuppoſed manifeſt.

The

The ſecond, that *Nulla res ſeipſam producat*; [*i. e.*] that nothing produceth it ſelf: from whence it follows, that it is not poſſible that the mover and moved ſhould be totally the ſame thing: And this is manifeſt, not onely in things that are moved by an extrinſick mover; but it is gathered alſo from the principles propounded, that the ſame holdeth true in the natural motion dependent on an intrinſick principle; otherwiſe, being that the mover, as a mover, is the cauſe, and the thing moved, as moved, is the effect, the ſame thing would totally be both the cauſe and effect. Therefore a body doth not move its whole ſelf, that is, ſo as that all moveth, and all is moved; but its neceſſary in the thing moved to diſtinguiſh in ſome manner the efficient principle of the motion, and that which with that motion is moved. The third Axiom is, that *in rebus quæ ſenſui ſubjiciuntur, unum, quatenus unum, unam ſolam rem producat*; *i. e.* That in things ſubject to the ſenſes, one, as it is one, produceth but onely one thing: That is, the ſoul in animals produceth its true divers operations, as the ſight, the hearing, the ſmell, generation, *&c.* but all theſe with ſeveral inſtruments. And in ſhort, in things ſenſible, the diverſity of operations, is obſerved to derive it ſelf from the diverſity that is in the cauſe. Now if we put all theſe Axioms together, it will be a thing very manifeſt, that one ſimple body, as is the Earth, cannot of its own nature move at the ſame time with three motions, very divers: For by the foregoing ſuppoſitions, all moveth not its ſelf all; it is neceſſary therefore to diſtinguiſh in it three principles of its three motions; otherwiſe one and the ſame principle would produce many motions; but if it contein in it three principles of natural motions, beſides the part moved, it ſhall not be a ſimple body, but compounded of three principle movers, and of the part moved. If therefore the Earth be a ſimple body, it ſhall not move with three motions; nay more, it will not move with any of thoſe which *Copernicus* aſcribeth to it, it being to move but with one alone, for that it is manifeſt, by the reaſons of *Ariſtotle*, that it moveth to its centre, as its parts do ſhew, which deſcend at right angles to the Earths Spherical Surface.

A ſimple body as the Earth, cannot move with three ſeveral motions.

The Earth cannot move with any of the motions aſſigned it by Copernicus.

SALV. Many things might be ſaid, and conſidered touching the connection of this argument; but in regard that we can reſolve it in few words, I will not at this time without need inlarge upon it; and ſo much the rather, becauſe the ſame Author hath furniſhed me with an anſwer, when he ſaith that from one ſole prinple in animals, there are produced divers operations; ſo that for the preſent my anſwer ſhall be, that in the ſame manner the Earth from one onely principle deriveth ſeveral operations.

Anſwers to the arguments contrary to the Earths motion, taken ex rerum natura.

SIMP. But this anſwer will not at all ſatisfie the Author who makes

makes the objection, yea, it is totally overthrown by that which immediately after he addeth for a greater confirmation of his argument, as you ſhall hear. He re-inforceth his argument, I ſay, with another Axiome, which is this; That *natura in rebus neceſſariis nec deficiat, nec abundat: i.e.* That nature in things neceſſary is neither defective, nor ſuperfluous. This is obvious to the obſervers of natural things, and chiefly of animals, in which, becauſe they are to move with many motions; Nature hath made many flexures, and hath thereunto commodiouſly knitted the parts for motion, as to the knees, to the hips, for the inabling of living creatures to go, and run at their pleaſure. Moreover in man he hath framed many flexions, and joynts, in the elbow, and hand, to enable them to perform many motions. From theſe things the argument is taken againſt the threefold motion of the Earth. [*Either the Body, that is one, and continuate, without any manner of knittings or flexions, can exerciſe divers motions, or cannot: If it can without them, then in vain hath nature framed the flexures in animals; which is contrary to the Axiome: but if it cannot without them, then the Earth, one body, and continuate, and deprived of flexures, and joynts, cannot of its own nature move with plurality of motions.*] You ſee now how craftily he falls upon your anſwer, as if he had foreſeen it.

A fourth Axiome againſt the motion of the Earth

Flexures neceſſary in animals for the diverſity of their motions.

Another argument againſt the threefold motion of the Earth.

SALV. Are you ſerious, or do you jeſt?

SIMP. I ſpeak it with the beſt judgment I have.

SALV. You muſt therefore ſee that you have as fortunate an hand in defending the reply of this Philoſopher, againſt ſome other rejoynders made to him; therefore anſwer for him, I pray you, ſeeing we cannot have him here. You firſt admit it for true, that Nature hath made the joynts, flexures, and knuckles of living creatures, to the intent that they might move with ſundry and divers motions; and I deny this propoſition; and ſay, that theſe flexions are made, that the animal may move one, or more of its parts, the reſt remaining immoved: and I ſay, that as to the ſpecies and differences of motions thoſe are of one kind alone, to wit, all circular, and for this cauſe you ſee all the ends of the moveable bones to be convex or concave, and of theſe ſome are ſpherical, as are thoſe that are to move every way, as in the ſhoulder-joynt, the arme of the Enſigne doth, in diſplaying the Colours, and that of the Falconer in bringing his Hawk to the lure; and ſuch is the flexure of the elbow, upon which the hand turns round, in boring with an augure: others are circular onely one way, and as it were cylindrical, which ſerve for the members that bend onely in one faſhion, as the joynts of the fingers one above another, &c. But without more particular inductions, one only general diſcourſe may make this truth underſtood; and this is, that of a ſolid body

The Flexures in animals are not made for the diverſity of motions.

The motions of animals are of one ſort.

The ends of the bones are all rotund.

It is demonſtrated, that the ends of the bones are of neceſſity to be rotund.

body that moveth, one of its extreams ſtanding ſtill without chanching place, the motion muſt needs be circular, and no other : and becauſe in the living creatures moving, one of its members doth not ſeparate from the other its conterminal, therefore that motion is of neceſſity circular.

The motion of animals are all circular.

SIMP. How can this be? For I ſee the animal move with an hundred motions that are not circular, and very different from one another, as to run, to skip, to climbe, to deſcend, to ſwim, and many others.

SALV. Tis well : but theſe are ſecondary motions, depending on the preceding motions of the joynts and flexures. Upon the plying of the legs to the knees, and the thighs to the hips, which are circular motions of the parts, is produced, as conſequents, the skip, or running, which are motions of the whole body, and theſe may poſſibly not be circular. Now becauſe one part of the terreſtrial Globe is not required to move upon another part immoveable, but that the motion is to be of the whole body, there is no need in it of flexures.

Secondary motions of animals dependent on the firſt

The Terreſtriall Globe *hath noe need of flexures.*

SIMP. This (will the aduerſary rejoyn) might be, if the motion were but one alone, but they being three, and thoſe very different from each other, it is not poſſible that they ſhould concur in an * articulate body.

* Without joynts

SALV. I verily believe that this would be the anſwer of the Philoſopher. Againſt which I make oppoſition another way ; and ask you, whether you think that by way of joynts and flexures one may adapt the terreſtrial Globe to the participation of three different circular motions? Do you not anſwer me? Seeing you are ſpeechleſſe, I will undertake to anſwer for the Philoſopher, who would abſolutely reply that they might ; for that otherwiſe it would have been ſuperfluous, and beſides the purpoſe to have propoſed to conſideration, that nature maketh the flexions, to the end, the moveable may move with different motions ; and that therefore the terreſtrial Globe having no flexures, it cannot have thoſe three motions which are aſcribed to it. For if he had thought, that neither by help of flexures, it could be rendered apt for ſuch motions, he would have freely affirmed, that the Globe could not move with three motions. Now granting this, I intreat you, and by you, if it were poſſible, that Philoſopher, Author of the Argument, to be ſo courteous as to teach me in what manner thoſe flexures ſhould be accommodated, ſo that thoſe three motions might commodiouſly be excerciſed ; and I grant you four or ſix moneths time to think of an anſwer. As to me, it ſeemeth that one principle onely may cauſe a plurality of motions in the Terreſtrial Globe, juſt in the ſame manner that, as I told you before, one onely principle with the help of various inſtruments

It is deſired to know, by means of what flexures and joynts the Terreſtrial Globe *might move with three diverſe motions.*

One only principle may cauſe a plurality of motions in the Earth.

produceth ſundry and divers motions in living creatures. And as to the flexures there is no need of them, the motions being of the whole, and not of ſome particular parts; and becauſe they are to be circular, the meer ſpherical figure is the moſt perfect articulation or flection that can be deſired.

SIMP. The moſt that ought to be granted upon this, would be, that it may hold true in one ſingle motion, but in three different motions, in my opinion, and that of the Author, it is impoſſible; as he going on, proſecuting the objection, writes in the following words. *Let us ſuppoſe, with* Copernicus, *that the Earth moveth of its own faculty, and upon an intrinſick principle from Weſt to Eaſt in the plane of the Ecliptick; and again, that it alſo by an intrinſick principle revolveth about its centre, from Eaſt to Weſt; and for a third motion, that it of its own inclination declineth from North to South, and ſo back again.* It being a continuate body, and not knit together with joints and flections, our fancy and our judgment will never be able to comprehend, that one and the ſame natural and indiſtinct principle, that is, that one and the ſame propenſion, ſhould actuate it at the ſame inſtant with different, and as it were of contrary motions. I cannot believe that any one would ſay ſuch a thing, unleſſe he had undertook to maintain this poſition right or wrong.

SALV. Stay a little; and find me out this place in the Book. *Fingamus modo cum Copernico, terram aliqua ſuâ vi, & ab indito principio impelli ab Occaſu ad Ortum in Eclipticæ plano; tum rurſus revolvi ab indito etiam principio, circa ſuimet centrum, ab Ortu in Occaſum; tertio deflecti rurſus ſuopte nutu à ſeptentrione in Auſtrum, & viciſſim.* I had thought, *Simplicius*, that you might have erred in reciting the words of the Author, but now I ſee that he, and that very groſſely, deceiveth himſelf; and to my grief, I find that he hath ſet himſelf to oppoſe a poſition, which he hath not well underſtood; for theſe are not the motions which *Copernicus* aſſignes to the Earth. Where doth he find that *Copernicus* maketh the annual motion by the Ecliptick contrary to the motion about its own centre? It muſt needs be that he never read his Book, which in an hundred places, and in the very firſt Chapters affirmeth thoſe motions to be both towards the ſame parts, that is from Weſt to Eaſt. But without others telling him, ought he not of himſelf to comprehend, that attributing to the Earth the motions that are taken, one of them from the Sun, and the other from the *primum mobile*, they muſt of neceſſity both move one and the ſame way.

A groſſe error of the oppoſer of Copernicus.

SIMP. Take heed that you do not erre your ſelf, and *Copernicus* alſo. The Diurnal motion of the *primum mobile*, is it not from

A ſubtil and withal ſimple argument againſt Copernicus.

Eaſt

Eaſt to Weſt? And the annual motion of the Sun through the Ecliptick, is it not on the contrary from Weſt to Eaſt? How then can you make theſe motions being conferred on the Earth, of contraries to become conſiſtents?

SAGR. Certainly, *Simplicius* hath diſcovered to us the original cauſe of error of this Philoſopher; and in all probability he would have ſaid the very ſame.

SALV. Now if it be in our power, let us at leaſt recover *Simplicius* from this errour; who ſeeing the Stars in their riſing to appear above the Oriental Horizon, will make it no difficult thing to underſtand, that in caſe that motion ſhould not belong to the Stars, it would be neceſſary to confeſſe, that the Horizon, with a contrary motion would go down; and that conſequently the Earth would reoolve in it ſelf a contrary way to that wherewith the Stars ſeem to move, that is from Weſt to Eaſt, which is according to the order of the Signes of the Zodiack. As, in the next place, to the other motion, the Sun being fixed in the centre of the Zodiack, and the Earth moveable about its circumference, to make the Sun ſeem unto us to move about the ſaid Zodiack, according to the order of the Signes, it is neceſſary, that the Earth move according to the ſame order, to the end that the Sun may ſeem to us to poſſeſſe alwayes that degree in the Zodiack, that is oppoſite to the degree in which we find the Earth; and thus the Earth running, *verbi gratia*, through *Aries*, the Sun will appear to run thorow *Libra*; and the Earth paſſing thorow the ſigne *Taurus*, the Sun will paſſe thorow *Scorpio*, and ſo the Earth going thorow *Gemini*, the Sun ſeemeth to go thorow *Sagittarius*; but this is moving both the ſame way, that is according to the order of the ſignes; as alſo was the revolution of the Earth about its own centre.

The error of the Antagoniſt is manifeſt, by declaring that the annual and diurnal motions belonging to the Earth are both one way, and not contrary.

SIMP. I underſtand you very well, and know not what to alledge in excuſe of ſo groſſe an error.

SALV. And yet, *Simplicius*, there is one yet worſe then this; and it is, that he makes the Earth move by the diurnal motion about its own centre from Eaſt to Weſt; and perceives not that if this were ſo, the motion of twenty four hours appropriated by him to the Univerſe, would, in our ſeeming, proceed from Weſt to Eaſt; the quite contrary to that which we behold.

SIMP. Oh ſtrange! Why I, that have ſcarce ſeen the firſt elements of the Sphere, would not, I am confident, have erred ſo horribly.

SALV. Judg now what pains this Antagoniſt may be thought to have taken in the Books of *Copernicus*, if he abſolutely invert the ſenſe of this grand and principal Hypotheſis, upon which is founded the whole ſumme of thoſe things wherein *Copernicus* diſſenteth

By another groſs error it is ſeen that the Antagoniſt had but little ſtudied Copernicus.

It is queſtioned, whether the opponent underſtood the third motion aſſigned to the Earth by Copernicus.

diſſenteth from the doctrine of *Ariſtotle* and *Ptolomy*. As again, to this third motion, which the Author aſſignes to the Terreſtrial Globe, as the judgment of *Copernicus*, I know not which he would mean thereby: it is not that queſtionleſſe, which *Copernicus* aſcribes unto it conjunctly with the other two, annual and diurnal, which hath nothing to do with declining towards the South and North; but onely ſerveth to keep the axis of the diurnal revolution continually parallel to it ſelf; ſo that it muſt be confeſt, that either the Authour did not underſtand this, or that elſe he diſſembled it. But although this great miſtake ſufficeth to free us from any obligation of a farther enquiry into his objections; yet nevertheleſſe I ſhall have them in eſteem; as indeed they deſerve to be valued much before the many others of impertinent Antagoniſts. Returning therefore to his objection, I ſay, that the two motions, annual and diurnal, are not in the leaſt contrary, nay are towards the ſame way, and therefore may depend on one and the ſame principle. The third is of it ſelf, and voluntarily ſo conſequential to the annual, that we need not trouble our ſelves (as I ſhall ſhew in its place) to ſtudy for principles either internal or external, from which, as from its cauſe, to make it produced.

SAGR. I ſhall alſo, as being induced thereto by natural reaſon, ſay ſomething to this Antagoniſt. He will condemn *Copernicus*, unleſſe I be able to anſwer him to all objections, and to ſatisfie him in all queſtions he ſhall ask; as if my ignorance were a neceſſary argument of the falſhood of his Doctrine. But if this way of condemning Writers be in his judgment legal, he ought not to think it unreaſonable, if I ſhould not approve of *Ariſtotle* and *Ptolomy*, when he cannot reſolve, better than my ſelf, thoſe doubts which I propound to him, touching their Doctrine. He asketh me, what are the principles by which the Terreſtrial Globe is moved with the Annual motion through the Zodiack, and with the Diurnal through the Equinoctial about its own axis. I anſwer, that they are like to thoſe by which *Saturn* is moved about the Zodiack in thirty years, and about its own centre in a much ſhorter time along the Equinoctial, as the collateral apparition and occultation of its Globes doth evince. They are principles like to thoſe, whereby he ſcrupleth not to grant, that the Sun runneth thorow the Ecliptick in a year, and revolveth about its own centre parallel to the Equinoctial in leſſe than a moneth, as its ſpots doth ſenſibly demonſtrate. They are things like to thoſe whereby the Medicean Stars run through the Zodiack in twelve years, and all the while revolve in ſmall circles, and ſhort periods of time about *Jupiter*.

The ſame argument anſwered by examples of the like motions in other cœleſtial bodies.

SIMP. This Author will deny all theſe things, as deluſions of the ſight, cauſed by the cryſtals of the *Teleſcope*.

SAGR.

SAGR. But this would be to draw a further inconvenience upon himſelf, in that he holdeth, that the bare eye cannot be deceived in judging of the right motion of deſcending graves, and yet holds that it is deceived in beholding theſe other motions at ſuch time as its viſive vertue is perfected, and augmented to thirty times as much as it was before. We tell him therefore, that the Earth in like manner partaketh of the plurality of motions: and it is perhaps the ſame, whereby the Loadſtone hath its motion downwards, as grave, and two circular motions, one Horizontal, and the other Vertical under the Meridian. But what more; tell me, *Simplicius*, between which do you think this Author would put a greater difference, 'twixt right and circular motion, or 'twixt motion and reſt?

SIMP. 'Twixt motion and reſt, certainly. And this is manifeſt, for that circular motion is not contrary to the right, according to *Ariſtotle*; nay, he granteth that they may mix with each other; which it is impoſſible for motion and reſt to do.

Motion and reſt are more different than right motion and circular.

SAGR. Therefore its a propoſition leſſe improbable to place in one natural body two internal principles, one to right motion, and the other to circular, than two ſuch interne principles one to motion, and the other to reſt. Now both theſe poſitions agree to the natural inclination that reſideth in the parts of the Earth to return to their whole, when by violence they are divided from it; and they onely diſſent in the operation of the whole: for the latter of them will have it by an interne principle to ſtand ſtill, and the former aſcribeth to it the circular motion. But by your conceſſion, and the confeſſion of this Philoſopher, two principles, one to motion, and the other to reſt, are incompatible together, like as their effects are incompatible: but now this evenes not in the two motions, right, and circular, which have no repugnance to each other.

One may more rationally aſcrile to the Earth two internal principles to the right, and circular motion, than two to motion and reſt.

SALV. Adde this more, that in all probability it may be that the motion, that the part of the Earth ſeparated doth make whilſt it returneth towards its whole, is alſo circular, as hath been already declared; ſo that in all reſpects, as far as concernes the preſent caſe, Mobility ſeemeth more likely than Reſt. Now proceed, *Simplicius*, to what remains.

The motion of the parts of the Earth returning to their whole may be circular.

SIMP. The Authour backs his Argument with producing another abſurdity, that is, that the ſame motions agree to Natures extreamly different; but experience ſheweth, that the operations and motions of different natures, are different; and Reaſon confirmeth the ſame: for otherwiſe we ſhould have no way left to know and diſtinguiſh of natures, if they ſhould not have their particular motions and operations, that might guide us to the knowledge of their ſubſtances.

The diverſity of motions helpeth us in knowing the diverſity of natures.

SAGR.

SAGR. I have twice or thrice obſerved in the diſcourſes of this Authour, that to prove that a thing is ſo, or ſo, he ſtill alledgeth, that in that manner it is conformable with our underſtanding; or that otherwiſe we ſhould never be able to conceive of it; or that the *Criterium* of Philoſophy would be overthrown. As if that nature had firſt made mens brains, and then diſpoſed all things in conformity to the capacity of their intellects. But I incline rather to think that Nature firſt made the things themſelves, as ſhe beſt liked, and afterwards framed the reaſon of men capable of conceiving (though not without great pains) ſome part of her ſecrets.

Nature firſt made things as ſhe pleaſed, and afterwards capacitated mens underſtandings for conceiving of them.

SALV. I am of the ſame opinion. But tell me, *Simplicius*, which are theſe different natures, to which, contrary to experience and reaſon, *Copernicus* aſſignes the ſame motions and operations.

SIMP. They are theſe. The Water, the Air, (which doubtleſſe are Natures different from the Earth) and all things that are in thoſe elements compriſed, ſhall each of them have thoſe three motions, which *Copernicus* pretends to be in the Terreſtriall Globe; and my Authour proceedeth to demonſtrate Geometrically, that, according to the *Copernican* Doctrine, a cloud that is ſuſpended in the Air, and that hangeth a long time over our heads without changing place, muſt of neceſſity have all thoſe three motions that belong to the Terreſtrial Globe. The demonſtration is this, which you may read your ſelf, for I cannot repeat it without book.

Copernicus *erroneouſly aſſigneth the ſame operations to different natures*

SALV. I ſhall not ſtand reading of it, nay I think it an impertinency in him to have inſerted it, for I am certain, that no *Copernican* will deny the ſame. Therefore admitting him what he would demonſtrate, let us ſpeak to the objection, which in my judgment hath no great ſtrength to conclude any thing contrary to the *Copernican Hypotheſis*, ſeeing that it derogates nothing from thoſe motions, and thoſe operations, whereby we come to the knowledge of the natures, &c. Anſwer me, I pray you, *Simplicius*: Thoſe accidents wherein ſome things exactly concur, can they ſerve to inform us of the different natures of thoſe things?

From commune accidents one cannot know different natures.

SIMP. No Sir: nay rather the contrary, for from the idendity of operations and of accidents nothing can be inferred, but an idendity of natures.

SALV. So that the different natures of the Water, Earth, Air, and other things conteined in theſe Elements, is not by you argued from thoſe operations, wherein all theſe Elements and their affixes agree, but from other operations; is it ſo?

SIMP. The very ſame.

SALV. So that he who ſhould leave in the Elements all thoſe motions,

motions, operations, and other accidents, by which their natures are distinguished, would not deprive us of the power of coming to the knowledge of them; although he should remove those operations, in which they unitedly concur, and which for that reason are of no use for the distinguishing of those natures.

SIMP. I think your dissertation to be very good.

SALV. But that the Earth, Water, Air, are of a nature equally constituted immoveable about the centre, is it not the opinion of your self, *Aristotle*, *Ptolomy*, and all their sectators?

SIMP. Its on all hands granted as an undeniable truth.

SALV. Then from this common natural condition of quiescence about the centre, there is no argument drawn of the different natures of these Elements, and things elementary, but that knowledge must be collected from other qualities not common; and therefore whoso should deprive the Elements of this common rest only, and should leave unto them all their other operations, would not in the least block up the way that leadeth to the knowledge of their essences. But *Copernicus* depriveth them onely of this common rest, and changeth the same into a common motion, leaving them gravity, levity, the motions upwards, downwards, slower, faster, rarity, density, the qualities of hot, cold, dry, moist, and in a word, all things besides. Therefore such an absurdity, as this Authour imagineth to himself, is no *Copernican* position; nor doth the concurrence in an identity of motion import any more or less, than the concurrence in an identity of rest about the diversifying, or not diversifying of natures. Now tell us, if there be any argument to the contrary.

The concurrence of the Elements in a common motion importeth no more or lesse, than their concurrence in a common rest.

SIMP. There followeth a fourth objection, taken from a natural observation, which is, *That bodies of the same kind, have motions that agree in kinde, or else they agree in rest. But by the* Copernican Hypothesis, *bodies that agree in kinde, and are most semblable to one another, would be very discrepant, yea diametrically repugnant as to motion; for that Stars so like to one another, would be nevertheless so unlike in motion, as that six Planets would perpetually turn round; but the Sun and all the fixeed Stars would stand perpetually immoveable.*

A fourth argument against Copernicus.

Bodies of the same kinde have motions that agree in kinde.

SALV. The forme of the argument appeareth good; but yet I believe that the application or matter is defective: and if the Authour will but persist in his assumption, the consequence shall make directly against him. The Argument runs thus; Amongst mundane bodies, six there are that do perpetually move, and they are the six Planets; of the rest, that is, of the Earth, Sun, and fixed Stars, it is disputable which of them moveth, and which stands still, it being necessary, that if the Earth stand still, the Sun and fixed Stars do move; and it being also possible, that the Sun and

From the Earths obscurity, and the splendour of the Sun, and fixed Stars, is argued, that it is moveable, and they immoveable.

and fixed Stars may ſtand immoveable, in caſe the Earth ſhould move: the matter of fact in diſpute is, to which of them we may with moſt convenience aſcribe motion, and to which reſt. Natural reaſon dictates, that motion ought to be aſſigned to the bodies, which in kind and eſſence moſt agree with thoſe bodies which do undoubtedly move, and reſt to thoſe which moſt diſſent from them; and in regard that an eternal reſt and perpetual motion are moſt different, it is manifeſt, that the nature of the body always moveable ought to be moſt different from the body alwayes ſtable. Therefore, in regard that we are dubious of motion and reſt, let us enquire, whether by the help of ſome other eminent affection, we may diſcover, which moſt agreeth with the bodies certainly moveable, either the Earth, or the Sun and fixed Stars. But ſee how Nature, in favour of our neceſſity and deſire, preſents us with two eminent qualities, and no leſs different than motion and reſt, and they are light and darkneſs, to wit, the being by nature moſt bright, and the being obſcure, and wholly deprived of light: the bodies therefore adorned with an internal and eternal ſplendour, are moſt different in eſſence from thoſe deprived of light: The Earth is deprived of light, the Sun is moſt ſplendid in it ſelf, and ſo are the fixed Stars. The ſix Planets do abſolutely want light, as the Earth; therefore their eſſence agreeth with the Earth, and differeth from the Sun and fixed Stars. Therefore is the Earth moveable, immoveable the Sunne and Starry Sphere.

SIMP. But the Authour will not grant, that the ſix Planets are tenebroſe, and by that negative will he abide. Or he will argue the great conformity of nature between the ſix Planets, and the Sun, and Fixed Stars; and the diſparity between them and the Earth from other conditions than from tenebroſity and light; yea, now I remember in the fifth objection, which followeth, he layeth down the vaſt difference between the Earth and the Cœleſtial Bodies, in which he writeth, *That the* Copernican Hypotheſis *would make great confuſion and perturbation in the Syſteme of the Univerſe, and amongſt its parts:* As for inſtance, amongſt Cœlestial bodies that are immutable and incorruptible, according to *Ariſtotle, Tycho*, and others; amongſt bodies, I ſay, of ſuch nobility, by the confeſſion of every one, and *Copernicus* himſelf, who affirmeth them to be ordinate, and diſpoſed in a perfect conſtitution, and removeth from them all inconſtancy of vertue amongſt, theſe bodies, I ſay once more, ſo pure, that is to ſay, amongſt *Venus, Mars, &c.* to place the very ſink of all corruptible matters, to wit, the Earth, Water, Air, and all mixt bodies.

A fifth argument againſt Copernicus.

Another difference between the Earth and the Cœleſtial bodies, taken from purity & impurity.

But how much properer a diſtribution, and more with nature, yea with God himſelf, the Architect, is it, to ſequeſter the pure from

from the impure; the mortal from the immortal, as other Schools teach; which tell us that these impure and frail matters are conteined within the anguſt concave of the Lunar Orb, above which with uninterrupted Series the things Celeſtial diſtend themſelves.

Copernicus *introduceth confuſion in the Univerſe of* Ariſtotle.

SALV. It's true that the Copernican Syſteme introduceth diſtraction in the univerſe of *Ariſtotle*; but we ſpeak of our own Univerſe, that is true and real. Again if this Author will infer the diſparity of eſſence between the Earth and Celeſtial bodies from the incorruptibility of them, and the corruptibility of it in the method of *Ariſtotle*, from which diſparity he concludeth motion to belong to the Sun and fixed Stars, and the immobility of the Earth, he will flatter himſelf with a Paralogiſme, ſuppoſing that which is in queſtion; for *Ariſtotle* inferreth the incorruptibility of Celeſtial bodies from motion, which is in diſpute, whether it belongeth to them or to the Earth. Of the vanity of theſe Rhetorical Illations enough hath been ſpoken. And what can be more fond, than to ſay, that the Earth and Elements are baniſhed and ſequeſtred from the Celeſtial Spheres, and confined within the Lunar Orb? Is, not then the Moons Orb one of the Celeſtial Spheres, and according to conſent compriſed in the middle of all the reſt? Its a new way to ſeparate the pure from the impure, and the ſick from the ſound, to aſſigne the infected quarters in the heart of the City: I had thought that the * Peſthouſe ought to have been removed as far off as was poſſible. *Copernicus* admireth the diſpoſition of the parts of the Univerſe, for that God hath conſtituted the grand Lamp, which is to give light all over his Temple in the centre of it, and not on one ſide. And as to the Earths being betwixt *Venus* and *Mars*, we will but hint the ſame; and do you, in favour of this Author, trie to remove it thence. But let us not * mix theſe Rhetorical Flowers with ſolid Demonſtrations, rather let us leave them to the Orators, or if you will to the Poets, who know how in their drolling way to exalt by their prayſes things moſt ſordid, yea and ſometimes moſt pernicious. And if any thing elſe remain; let us diſpatch it, as we have done the reſt.

The Paralogiſme *of the Author of Anti-Tycho.*

It ſeemeth a folly to affirm the Earth to be without the Heavens.

* Lazeretto.

* *Intrecciare*, to twine flowers in a garland.

SIMP. There is the ſixth and laſt argument; wherein he maketh it a very improbale thing. [*That a corruptible and diſſipable body ſhould move with a perpetual and regular motion; and this he confirmeth with the example of living creatures, which moving with a motion natural to them, yet grow weary, and have need of repoſe to reſtore their ſtrength.*] But what hath this motion to do with that of the Earth, that in compariſon to theirs is immenſe? Beſides, to make it move with three motions that run and draw ſeveral wayes: Who would ever aſſert ſuch Paradoxes, unleſſe he had ſworn to be their defender? Nor doth that avail in this

A ſixth argument againſt Copernicus, *taken from animals, who have need of reſt, though their motion be natural.*

caſe, which *Copernicus* alledgeth, that by reaſon this motion is natural to the Earth and not violent, it worketh contrary effects to violent motions; and that thoſe things diſſolve and cannot long ſubſiſt, to which impulſe is conferred, but thoſe ſo made by nature do continue in their perfect diſpoſure; this anſwer ſufficeth not, I ſay, for it is overthrown by that of ours. For the animal is a natural body, and not made by art, and its motion is natural, deriving it ſelf from the ſoul, that is, from an intrinſick principle; and that motion is violent, whoſe beginning is without, and on which the thing moved conferreth nothing; however, if the animal continueth its motion any long time, it grows weary, and alſo dyeth, if it obſtinately ſtrive to perſiſt therein. You ſee then that in nature we meet on all ſides with notions contrary to the *Copernican Hypotheſis*, and none in favour of it. And for that I have nothing more wherein to take the part of this Opponent, hear what he produceth againſt *Keplerus* (with whom he diſputeth) upon that argument, which the ſaid *Kepler* bringeth againſt thoſe who think it an inconvenient, nay impoſſible thing, to augment the Starry Sphere immenſely, as the *Copernican* Hypotheſis requireth. *Kepler* therefore inſtanceth, ſaying: *Difficilius eſt, accidens præter modulum ſubjecti intendere, quàm ſubjectum ſine accidente augere. Copernicus ergo veriſimilius facit, qui auget Orbem Stellarum fixarum abſque motu, quam Ptolomæus, qui auget motum fixarum immenſâ velocitate.* [Which makes this Engliſh.] Its harder to ſtretch the accident beyond the model of the ſubject than to augment the ſubject without the accident. *Copernic* hath more probability on his ſide, who encreaſeth the Orb of the fixed Stars without motion, than *Ptolomy* who augmenteth the motion of the fixed Stars to an immenſe degree of velocity. Which objection the Author anſwereth, wondering how much *Kepler* deceived himſelf, in ſaying, that in the Ptolomaick Hypotheſis the motion encreaſeth beyond the model of the ſubject, for in his judgment it doth not encreaſe, ſave onely in conformity to the model, and that according to its encreaſement, the velocity of the motion is augmented. Which he proveth by ſuppoſing a machine to be framed, that maketh one revolution in twenty four hours, which motion ſhall be called moſt ſlow; afterwards ſuppoſing its ſemidiameter to be prolonged, as far as to the diſtance of the Sun, its extreme will equal the velocity of the Sun; and it being cantinued out unto the Starry Sphere, it will equal the velocity of the fixed Stars, though in the circumferrnce of the machine it be very ſlow. Now applying this conſideration of the machine to the Starry Sphere, let us imagine any point in its ſemidiameter, as neer to the centre as is the ſemidiameter of the machine; the ſame motion that in the Starry Sphere is exceeding ſwift,

An argument from Kepler *in favour of* Copernicus.

The Author of the Anti-Tycho oppoſeth Kepler.

The velocity of the circular motion increaſeth, according to the encreaſe of the diameter of the circle.

swift, shall in that point be exceeding slow; But the great magnitude of the body is that which maketh it of exceeding slow, to become exceeding swift, although it continueth still the same, and thus the velocity encreaseth, not beyond the model of the subject, but rather according to it, and to its magnitude; very differently from the imagination of *Kepler*.

SALV. I do not believe that this Author hath entertained so mean and poor a conceit of *Kepler*, as to perswade himself that he did not understand, that the highest term of a line drawn from the centre unto the Starry Sphere, moveth more swiftly than a point of the same line taken within a yard or two of the centre. And therefore of necessity he must have conceived and comprehended that the mind and intention of *Kepler* was to have said, that it is lesse inconvenient to encrease an immoveable body to an extraordinary magnitude, than to ascribe an extraordinary velocity to a body, though very bigge, having regard to the model, that is to the gauge, and to the example of other natural bodies; in which we see, that the distance from the centre encreasing, the velocity diminisheth; that is, that the periods of their circulations take up longer times. But in rest which is not capable of augmentation or diminution, the grandure or smalnesse of the body maketh no differeuce. So that if the answer of the Author would be directed against the argument of *Kepler*, it is necessary, that that Author doth hold, that to the movent principle its one and the same to move in the same time a body very small, or very immense, in regard that the augmentation of velocity inseparably attends the augmentation of the masse. But this again is contrary to the Architectonical rule of nature, which doth in the lesser Spheres, as we see in the Planets, and most sensibly in the Medicean Stars, observe to make the lesser Orbs to circulate in shorter times: Whence the time of *Saturns* revolution is longer than all the times of the other lesser Spheres, it being thirty years; now the passing from this to a Sphere very much bigger, and to make it move in 24. hours, may very well be said to exceed the rules of the model. So that if we would but attentively consider it, the Authors answer oppoſeth not the intent and sense of the argument, but the expressing and manner of delivering of it; where again the Author is injurious, and cannot deny but that he artificially dissembled his understanding of the words, that he might charge *Kepler* with grosse ignorance; but the imposture was so very dull and obvions, that he could not with all his craft alter the opinion which *Kepler* hath begot of his Doctrine in the minds of all the Learned. As in the next place, to the instance against the perpetual motion of the Earth, taken from the impossibility of its moving long without wearinesse, in regard that living creatures

An explanation of the true sense of Kepler *and his defence.*

The greatnesse and smalnesse of the body make a difference in motion and not in rest.

The order of nature is to make the lesser Orbs to circulate in shorter times, and the bigger in longer times.

tures themſelves, which yet move naturally, and from an intern principle, do grow weary, and have need of reſt to relax and refreſh their members ——

SAGR. Methinks I hear *Kepler* anſwer him to that, that there are ſome kinde of animals which refreſh themſelves after wearineſſe, by rowling on the Earth; and that therefore there is no need to fear that the Terreſtrial Globe ſhould tire, nay it may be reaſonably affirmed, that it enjoyeth a perpetual & moſt tranquil repoſe, keeping it ſelf in an eternal rowling.

The feigned anſwer of Kepler *covered with an artificial Irony.*

SALV. You are too tart and Satyrical, *Sagredus*: but let us lay aſide jeſts, whilſt we are treating of ſerious things.

SAGR. Excuſe me, *Salviatus*, this that I ſay is not ſo abſolutely beſides the buſineſs, as you perhaps make it; for a motion that ſerveth inſtead of reſt, and removeth wearineſs from a body tired with travail, may much more eaſily ſerve to prevent the coming of that wearineſs, like as preventive remedies are more eaſie than curative. And I hold for certain, that if the motion of animals ſhould proceed in the ſame manner as this that is aſcribed to the Earth, they would never grow weary; Seeing that the wearineſs of the living creature, deriveth it ſelf, in my opinion, from the imployment of but one part alone in the moving of its ſelf, and all the reſt of the body; as *v. g.* in walking, the thighs and the legs onely are imployed for carrying themſelves and all the reſt: on the contrary, you ſee the motion of the heart to be as it were indefatigable, becauſe it moveth it ſelf alone. Beſides, I know not how true it may be, that the motion of the animal is natural, and not rather violent: nay, I believe that one may truly ſay, that the ſoul naturally moveth the members of an animal with a motion preternatural, for if the motion upwards is preternatural to grave bodies, the lifting up of the legs, and the thighs, which are grave bodies, in walking, cannot be done without violence, and therefore not without labour to the mover. The climbing upwards by a ladder carrieth the grave body contrary to its natural inclination upwards, from whence followeth wearineſs, by reaſon of the bodies natural averſneſs to that motion: but in moving a moveable with a motion, to which it hath no averſion, what laſſitude, what diminution of vertue and ſtrength need we fear in the mover? and how ſhould the forces waſte, where they are not at all imployed?

Animals would not grow weary of their motion, proceeding as that which is aſſigned to the terreſtrial Globe.

The cauſe of the wearineſſe of animals.

The motion of an animal is rather to be called violent than natural.

The ſtrength diminiſheth not, where it is not imployed.

SIMP. They are the contrary motions wherewith the Earth is pretended to move, againſt which the Authour produceth his argument.

SAGR. It hath been ſaid already, that they are no wiſe contraries, and that herein the Authour is extreamly deceived, ſo that the whole ſtrength of the argument recoileth upon the Opponent

ponent himſelf, whilſt he will make the *Firſt Mover* to hurry along with it all the inferiour Spheres, contrary to the motion which they themſelves at the ſame time exerciſe. It belongs therefore to the *Primum Mobile* to grow weary, which beſides the moving of its ſelf is made to carry ſo many other Spheres, and which alſo ſtrive againſt it with a contrary motion. So that the ultimate concluſion that the Authour inferred, ſaying, that diſcourſing of the effects of Nature, a man alwayes meets with things that favour the opinion of *Ariſtotle* and *Ptolomy*, and never any one that doth not interfer with *Copernicus*, ſtands in need of great conſideration; and it is better to ſay, that one of theſe two *Hypotheſes* being true, and the other neceſſarily falſe, it is impoſſible that a man ſhould ever be able to finde any argument, experience, or right reaſon, in favour of that which is falſe, like as to the truth none of theſe things can be repugnant. Vaſt difference, therefore, muſt needs be found between the reaſons and arguments produced by the one and other party, for and againſt theſe two opinions, the force of which I leave you your ſelf to judge of, *Simplicius*.

The argument of Clarantius, *recoileth upon himſelf.*

True Propoſitions meet with many concluſive arguments, ſo do not the falſe.

SALV. But you, *Sagredus*, being tranſported by the velocity of your wit, have taken my words out of my mouth, whilſt I was about to ſay ſomething, touching this laſt argument of the Authour; and although you have more then ſufficiently refuted him, yet nevertheleſſe I will adde ſomewhat, which then ran in my minde. He propoſeth it as a thing very unlikely, that a body diſſipable and corruptible, as the Earth, ſhould perpetually move with a regular motion, eſpecially for that we ſee living creatures in the end to grow weary, and to ſtand in need of reſt: and the improbability is increaſed, in that the ſaid motion is required to be of velocity incomparable and immenſe, in reſpect to that of animals. Now, I cannot ſee why the velocity of the Earth ſhould, at preſent, trouble it; ſo long as that of the ſtarry Sphere ſo very much bigger doth not occaſion in it any diſturbance more conſiderable, than that which the velocity of a machine, that in 24 hours maketh but one ſole revolution, produceth in the ſame. If the being of the velocity of the Earths converſion, according to the model of that machine, inferreth things of no greater moment than that, let the Authour ceaſe to fear the Earths growing weary; for that not one of the moſt feeble and ſlow-pac't animals, no not a Chamæleon would tire in moving no more than * four or five yards in 24 hours; but if he pleaſe to conſider the velocity to be no longer, in relation to the model of the machine, but abſolutely, and inaſmuch as the moveable in 24 hours is to paſs a very great ſpace, he ought to ſhew himſelf ſo much more reſerved in granting it to the ſtarry Sphere, which with a velocity incomparably greater than that of the Earth

* Cinque ò ſei braccia Fiorentini.

Wearineſs more to be feared in the ſtarry Sphere than in the terreſtriall Globe.

Earth is to carry along with it a thouſand bodies, each much bigger than the Terreſtrial Globe.

Here it remains for us to ſee the proofs, whereby the Authour concludes the new ſtars *Anno* 1572. and *Anno* 1604. to be ſublunary, and not cœleſtial, as the *Aſtronomers* of thoſe times were generally perſwaded; an enterprize very great certainly; but I have conſidered, that it will be better, in regard the Book is new and long, by reaſon of its many calculations, that between this evening and to morrow morning I make them as plain as I can, and ſo meeting you again to morrow to continue our wonted conferences, give you a brief of what I ſhall obſerve therein; and if we have time left, we will ſay ſomething of the *Annual motion* aſcribed to the Earth. In the mean time, if either of you, and *Simplicius* in particular, hath any thing to ſay more, touching what relates to the *Diurnal motion*, at large examined by me, we have a little time ſtill left to treat thereof.

SIMP. I have no more to ſay, unleſſe it be this, that the diſcourſes that this day have falne under our debate, have appeared to me fraught with very acute and ingenious notions, alledged on *Copernicus* his ſide, in confirmation of the motion of the Earth, but yet I find not my ſelf perſwaded to believe it; for in ſhort, the things that have been ſaid conclude no more but this, that the reaſons for the ſtability of the Earth are not neceſſary; but all the while no demonſtration hath been produced on the other ſide, that doth neceſſarily convince and prove its mobility.

SALV. I never undertook, *Simplicius*, to remove you from that your opinion; much leſs dare I preſume to determine definitively in this controverſie: it onely was, and ſtill ſhall be in the enſuing diſputations my intent, to make it appear to you, that thoſe who have thought that moſt ſwift motion of 24. hours doth belong to the Earth alone, and not to the Univerſe, the Earth onely excluded, were not induced to believe, that ſo it might and ought to do out of any blind perſwaſion; but that they did very well ſee, try, and examine the reaſons on the contrary ſide, and alſo not ſlightly anſwer them. With the ſame intention, if it ſtand with your liking, and that of *Sagredus*, we may paſſe to the conſideration of that other motion; firſt, by *Ariſtarchus Samius*, and afterwards by *Nicholaus Copernicus* aſcribed to the ſaid Terreſtrial Globe, which is, as, I believe, you have heretofore heard, made under the Zodiack within the ſpace of a year about the Sun, immoveably placed in the centre of the ſaid Zodiack.

SIMP. The diſquiſition is ſo great, and ſo noble, that I ſhall gladly hearken to the diſcuſſion thereof, perſwading my ſelf that I ſhall hear what ever can be ſaid of that matter. And I will afterwards

wards by my ſelf, according to my uſual cuſtome, make more deliberate reflexions upon what hath been, and is to be ſpoken; and if I ſhould gain no more but this, it will be no ſmall benefit that I ſhall be able to diſcourſe more Logically.

SAGR. Therefore, that we may no further weary *Salviatus*, we will put a period to the diſputations of this day, and reaſſume our conference to morrow in the uſual manner, with hope to hear very pleaſing novelties.

SIMP. I will leave with you the Book *De ſtellis novis*, and carry back this of the Concluſions, to ſee what is written therein againſt the Annual motion, which are to be the arguments of our diſcourſe to morrow.

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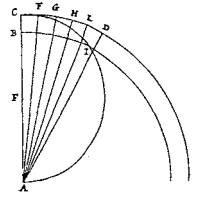

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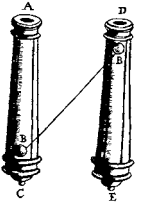

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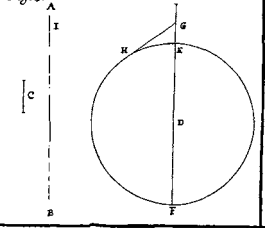

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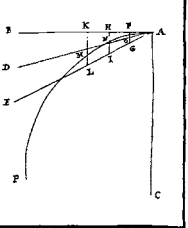

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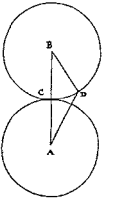
Fig: 6



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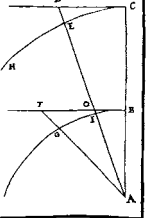

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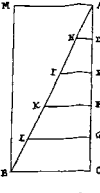

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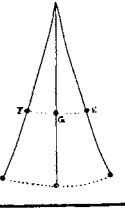


Place this Plate at the end of the Second

Dialogue.

GALILÆUS
Galilæus Lyncæus,
HIS
SYSTEME
OF THE
WORLD.

The Third Dialogue.

INTERLOCUTORS.

SALVIATUS, SAGREDUS, and SIMPLICIUS.

SAGR.

THE great desire wherewith I have expected your coming, that I might hear the novel conceits touching the annual conversion of this our Globe, hath made me think the houres of the last night, and those of this morning very tedious, although I spent them not idly, but lying awake I imployed a good part thereof in ruminating upon our yesterdayes discourses, weighing the reasons alledged by both parties, in favour of the two contrary Hypotheses, that of *Aristotle* and *Ptolomy*, and this of *Aristarchus*, and *Copernicus*. And really methinks, that which ever of these parties have been deceived, they are worthy of excuse, so specious and valid in appearance are the reasons that may have perswaded them either way; though nevertheless we

do for the moſt part cloſe with thoſe produced by the grave Authours firſt above mentioned. But albeit that the *Perrpatetick Hypotheſis*, by reaſon of its antiquity, hath had many followers and fautors, and the other very few; firſt, for its obſcurity, and next, for its novelty, yet methinks I diſcover amongſt thoſe many, and particularly amongſt the modernes ſome, who for the ſupport of the opinion by them eſteemed true, have introduced other reaſons ſufficiently childiſh, I could ſay ridiculous.

Some in arguing firſt fix in their minds the concluſion beleeved by them, and then adapt their reaſons to that.

SALV. I have met with the like, and ſo much worſe than yours, that I bluſh to rehearſe them, not ſo much to ſpare the fame of their Authours, the names of whom might be perpetually concealed, as becauſe I am aſhamed ſo much to ſtain the honour of mankinde. In obſerving of theſe men, I have found that ſome there are who prepoſterouſly reaſoning, firſt ſtabliſh the concluſion in their fancy, and (either becauſe it is their own, or elſe belongs to a perſon whom they much confide in) ſo firmly imprint it in their opinions, that it is altogether impoſſible ever wholly to efface it: and thoſe reaſons which they themſelves ſtumble upon, or which they hear others to alledge in confirmation of the conceit entertained, though never ſo ſimple and inſipid, inſtantly find credit and applauſe with them: but on the contrary, thoſe which are brought againſt their opinion, though ingenuous and concluding, they receive not only with nauſeating, but with diſdain and bitter indignation, yea, you ſhall have one of theſe ſo inraged, as that he will not be backward to try all wayes to ſuppreſs and ſilence their adverſaries: and of this I my ſelf have had ſome experience.

SAGR. Indeed theſe men deduce not the concluſion from the premiſes, nor confirme them with reaſons, but accomodate, or to ſay better, diſcommodate and diſtort the premiſes and arguments to make them ſpeak in favour of their pre-aſſumed and pertinacious concluſions. It is not good therefore to contract familiarity with theſe men; and the rather, for that their converſation is not only unpleaſant, but alſo dangerous. Yet let us continue our conference with *Simplicius* however, whom I have known this long while for a man of great ingenuity, and altogether void of malice: beſides he is well verſt in the Peripatetick Doctrine; ſo that I may aſſure my ſelf, that what ſhall not fall within the reach of his reaſon for the ſupport of the *Ariſtotelian* Hypotheſis, will not eaſily be found out by others. But ſee yonder he comes, quite out of winde, whoſe company we have ſo long deſired: we were juſt now ſpeaking againſt the ſmall haſt you made to come to us.

SIMP. You muſt not blame me, but *Neptune*, for this my long ſtay; which in the ebbe of this mornings tide hath in a manner drain'd away the waters, for the *Gondola* that brought me, being entered not far from hence into a certain Channel, wanting depth, where

where I was ſtranded, and forced to ſtay there more than a full hour, in expecting the return of the tide: and there waiting in this manner, without being able to get out of the boat, which on a ſudden ran a ground, I obſerved a certain accident, which to me ſeemed very ſtrange; and it was this, that in the waters ebbing I ſaw it retreat very faſt by ſeveral ſmall rivolets, the ouze being in many places diſcovered, and whilſt I ſtood looking upon this effect, I ſaw this motion in an inſtant to ceaſe, and without a minutes interval the ſame water to begin to return back again, and the tide from ebbing to become young flood, without ſtanding ſtill a moment: an effect that as long as I have dwelt in *Venice*, I never took notice of before.

The motion of the water in ebbing and flowing not interrupted by reſt.

SAGR. It is very much, that you ſhould be left thus on ground, amongſt ſmall Channels; in which rivolets, as having very little declivity, the riſing or falling of the main ſea, the thickneſs onely of a paper is ſufficient to make the water to ebbe and flow for good long ſpaces of time: like as in ſome creeks of the Sea, its flowing four or ſix * yards onely, maketh the water to overflow the adjacent Marſhes for ſome hundreds and thouſands of * acres.

* Pertiche venetiani.

SIMP. This I know very well, but I ſhould have thought, that between the ultimate terme of ebbing, and the firſt beginnng to flow, there ſhould have interpoſed ſome conſiderable interval of reſt.

SAGR. This will appear unto you, if you caſt your eye upon the bank or piles, where theſe mutations are made perpendicularly, but not that there is any real time of ceſſation.

SIMP. I did think, that becauſe theſe two motions were contrary, there ought to be in the midſt between them ſome kind of reſt; conformable to the Doctrine of *Ariſtotle*, which demonſtrates that *in puncto regreſſus mediat quies.*

SAGR. I very well remember this place: but I bear in minde alſo, that when I read Philoſophy, I was not thorowly ſatisfied with *Ariſtotles* demonſtration; but that I had many experiments on the contrary, which I could ſtill rehearſe unto you, but I am unwilling to ſally out into any other digreſſions, we being met here to diſcourſe of the propoſed mattes, if it be poſſible, without theſe excurſions wherewith we have interrupted our diſputes in thoſe dayes that are paſt.

SIMP. And yet we may with convenience, if not interrupt them, at leaſt prolong them very much, for returning yeſterday home, I ſet my ſelf to read the Tractate of Concluſions, where I find Demonſtrations againſt this annual motion aſcribed to the Earth, very ſolid; and becauſe I would not truſt my memory with the punctual relation of them, I have brought back the Book along with me.

SAGR. You have done very well; but if we would re-aſſume our Diſputations according to yeſterdayes appointment, it is requiſite that we firſt hear what account *Salviatus* hath to give us of the Book, *De ſtellis novis*, and then without interruption we may proceed to the Annual motion. Now what ſay you, *Salviatus* touching thoſe ſtars? Are they really pull'd down from Heaven to theſe lower regions, by vertue of that Authours calculations, whom *Simplicius* mentioneth?

SALV. I ſet my ſelf laſt night to peruſe his proceedings, and I have this morning had another view of him, to ſee whether that which he ſeemed over night to affirm, were really his ſenſe, or my dreams and phantaſtical nocturnal imaginations; and in the cloſe found to my great grief that thoſe things were really written and printed, which for the reputation-ſake of this Philoſopher I was unwilling to believe. It is in my judgment impoſſible, but that he ſhould perceive the vanity of his undertaking, aſwell becauſe it is too apert, as becauſe I remember, that I have heard him mentioned with applauſe by the *Academick our Friend*: it ſeemeth to me alſo to be a thing very unlikely, that in complacency to others, he ſhould be induced to ſet ſo low a value upon his reputation, as to give conſent to the publication of a work, for which he could expect no other than the cenſure of the Learned.

SAGR. Yea, but you know, that thoſe will be much fewer than one for an hundred, compared to thoſe that ſhall celebrate and extoll him above the greateſt wits that are, or ever have been in the world: He is one that hath mentioned the Peripatetick inalterability of Heaven againſt a troop of *Aſtronomers*, and that to their greater diſgrace hath foiled them at their own weapons: and what do you think four or five in a Countrey that diſcern his triflings, can do againſt the innumerable multitude, that, not being able to diſcover or comprehend them, ſuffer themſelves to be taken with words, and ſo much more applaud him, by how much the leſſe they underſtand him? You may adde alſo, that thoſe few who underſtand, ſcorn to give an anſwer to papers ſo trivial and unconcludent; and that upon very good reaſons, becauſe to the intelligent there is no need thereof, and to thoſe that do not underſtand, it is but labour loſt.

SALV. The moſt deſerved puniſhment of their demerits would certainly be ſilence, if there were not other reaſons, for which it is haply no leſſe than neceſſary to reſent their timerity: one of which is, that we *Italians* thereby incur the cenſure of Illiterates, and attract the laughter of Forreigners; and eſpecially to ſuch who are ſeparated from our Religion; and I could ſhew you many of thoſe of no ſmall eminency, who ſcoff at our *Academick*, and the many Mathematicians that are in *Italie*, for ſuffering the follies

follies of ſuch a * Fabler againſt *Aſtronomers* to come into the light, and to be openly maintained without contradiction; but this alſo might be diſpenſed with, in reſpect of the other greater occaſions of laughter, wherewith we may confront them depending on the diſſimulation of the intelligent, touching the follies of theſe opponents of the Doctrines that they well enough underſtand.

* Lorenzini.

SAGR. I deſire not a greater proof of thoſe mens petulancy, and the infelicity of a *Copernican*, ſubject to be oppoſed by ſuch as underſtand not ſo much as the very firſt poſitions, upon which he undertakes the quarrel.

SALV. You will be no leſſe aſtoniſhed at their method in confuting the *Aſtronomers*, who affirm the new Stars to be ſuperiour to the Orbs of the Planets; and peradventure in the † Firmament it ſelf.

† He taketh the Firmament for the Starry Sphere, and as we vulgarly receive the word.

SAGR. But how could you in ſo ſhort a time examine all this Book, which is ſo great a Volume, and muſt needs contain very many demonſtrations?

SALV. I have confined my ſelf to theſe his firſt confutations, in which with twelve demonſtrations founded upon the obſervations of twelve *Aſtronomers*, (who all held, that the Star, *Anno* 1572. which appeared in *Caſſiopeia*, was in the Firmament), he proveth it on the contrary, to be beneath the Moon, conferring, two by two, the meridian altitudes, proceeding in the method that you ſhall underſtand by and by. And becauſe, I think, that in the examination of this his firſt progreſſion, I have diſcovered in this Authour a great unlikelihood of his ability to conclude any thing againſt the *Aſtronomers*, in favour of the *Peripatetick Philoſophers*, and that their opinion is more and more concludently confirmed, I could not apply my ſelf with the like patience in examining his other methods, but have given a very ſlight glance upon them, and am certain, that the defect that is in theſe firſt impugnations, is likewiſe in the reſt. And as you ſhall ſee, by experience, very few words will ſuffice to confute this whole Book, though compiled with ſo great a number of laborious calculations, as here you ſee. Therefore obſerve my proceedings. This Authour undertaketh, as I ſay, to wound his adverſaries with their own weapons, *i.e.* a great number of obſervations made by themſelves, to wit, by twelve or thirteen Authours in number, and upon part of them he makes his ſupputations, and concludeth thoſe ſtars to have been below the Moon. Now becauſe the proceeding by interrogatories very much pleaſeth me, in regard the Authour himſelf is not here, let *Simplicius* anſwer me to the queſtions that I ſhall ask him, as he thinks he himſelf would, if he were preſent. And preſuppoſing that we ſpeak of the foreſaid Star, of *Anno* 1572. appearing

The method obſerved by Clar. *in confuting the Aſtronomers, and by* Salviatus *in confuting him.*

pearing in *Caſſiopeia*, tell me, *Simplicius*, whether you believe that it might be in the ſame time placed in divers places, that is, amongſt the Elements, aud alſo amongſt the planetary Orbs, and alſo above theſe amongſt the fixed Stars, and yet again infinitely more high.

SIMP. There is no doubt, but that it ought to be confeſſed that it is but in one only place, and at one ſole and determinate diſtance from the Earth.

SALV. Therefore if the obſervations made by the Aſtronomers were exact, and the calculations made by this Author were not erroneous, it were eaſie from all thoſe and all theſe to recollect the ſame diſtances alwayes to an hair, is not this true?

SIMP. My reaſon hitherto tells me that ſo it muſt needs be; nor do I believe that the Author would contradict it.

SALV. But when of many and many computations that have been made, there ſhould not be ſo much as two onely that prove true, what would you think of them?

SIMP. I would think that they were all falſe, either through the fault of the computiſt, or through the defect of the obſervators, and at the moſt that could be ſaid, I would ſay, that but onely one of them and no more was true; but as yet I know not which to chooſe.

SALV. Would you then from falſe fundamentals deduce and eſtabliſh a doubtful concluſion for true? Certainly no. Now the calculations of this Author are ſuch, that no one of them agrees with another, you may ſee then what credit is to be given to them.

SIMP. Indeed, if it be ſo, this is a notable failing.

SAGR. But by the way I have a mind to help *Simplicius*, and the Author by telling *Salviatus*, that his arguments would hold good if the Author had undertook to go about to find out exactly the diſtance of the Star from the Earth, which I do not think to be his intention; but onely to demonſtrate that from thoſe obſervations he collected that the Star was ſublunary. So that if from thoſe obſervations, and from all the computations made thereon, the height of the Star be alwayes collected to be leſſe than that of the Moon, it ſerves the Authors turn to convince all thoſe Aſtronomers of moſt impardonable ignorance, that through the defect either of Geometry or Arithmetick, have not known how to draw true concluſions from their own obſervations themſelves.

SALV. It will be convenient therefore that I turn my ſelf to you, *Sagredus*, who ſo cunningly aphold the Doctrine of this Author. And to ſee whether I can make *Simplicius*, though not very expert in calculations, and demonſtrations to apprehend the in-

inconcluſivenesſe at leaſt of the demonſtrations of this Author, firſt propoſed to conſideration, and how both he, and all the Aſtronomers with whom he contendeth, do agree that the new Star had not any motion of its own, and onely went round with the diurnal motion of the *primum mobile*; but diſſent about the placing of it, the one party putting it in the Celeſtial Region, that is above the Moon, and haply above the fixed Stars, and the other judging it to be neer to the Earth, that is, under the concave of the Lunar Orb. And becauſe the ſituation of the new ſtar, of which we ſpeak, was towards the North, and at no very great diſtance from the Pole, ſo that to us *Septentrionals*, it did never ſet, it was an eaſie matter with Aſtronomical inſtruments to have taken its ſeveral meridian altitudes, as well its ſmalleſt under the Pole, as its greateſt above the ſame; from the comparing of which altitudes, made in ſeveral places of the Earth, ſituate at different diſtances from the North, that is, different from one another in relation to polar altitudes, the ſtars diſtance might be inferred: For if it was in the Firmament amongſt the other fixed ſtars, its meridian altitudes taken in divers elevations of the pole, ought neceſſarily to differ from each other with the ſame variations that are found amongſt thoſe elevations themſelves; that is, for example, if the elevation of the ſtar above the horizon was 30 degrees, taken in the place where the polar altitude was *v. gr.* 45 degrees, the elevation of the ſame ſtar ought to have been encreaſed 4 or 5 degrees in thoſe more Northernly places where the pole was higher by the ſaid 4 or 5 degrees. But if the ſtars diſtance from the Earth was but very little, in compariſon of that of the Firmament; its meridian altitudes ought approaching to the North to encreaſe conſiderably more than the polar altitudes; and by that greater encreaſe, that is, by the exceſſe of the encreaſe of the ſtars elevation, above the encreaſe of the polar elevation (which is called the difference of Parallaxes) is readily calculated with a cleer and ſure method, the ſtars diſtance from the centre of the Earth. Now this Author taketh the obſervations made by thirteen Aſtronomers in ſundry elevations of the pole, and conferring a part of them at his pleaſure, he computeth by twelve collations the new ſtars height to have been alwayes beneath the Moon; but this he adventures to do in hopes to find ſo groſſe ignorance in all thoſe, into whoſe hands his book might come, that to ſpeak the truth, it hath turn'd my ſtomack; and I wait to ſee how thoſe other Aſtronomers, and particularly *Kepler*, againſt whom this Author principally inveigheth, can contein themſelves in ſilence, for he doth not uſe to hold his tongue on ſuch occaſions; unleſſe he did poſſibly think the enterprize too much below him. Now to give you to un-

The greateſt and leaſt elevations of the new ſtar differ not from each other more than the polar altitudes, the ſaid ſtar being in the Firmament.

underſtand the ſame, I have upon this paper tranſcribed the concluſions that he inferreth from his twelve indagations; the firſt of which is upon the two obſervations:

Of *Maurolicus* and *Hainzelius*, from which the Star is collected to have been diſtant from the centre leſſe than 3 ſemidiameters of the Earth, the difference of Parallaxes being 4 *gr.* 42 *m.* 30 *ſec.* ——— 3 *ſemid.*

2. And is calculated on the obſervations of *Hainzelius*, with Parall. of 8. *m.* 30 *ſec.* and its diſtance from the centre is computed to be more than ——— 25 *ſemid.*

3. And upon the obſervations of *Tycho* and *Hainzelius*, with Parall. of 10 *m.* and the diſtance of the centre is collected to be little leſſe than —— 19 *ſemid.*

4. And upon the obſervations of *Tycho* and the *Landgrave*, with Parall. of 14 *m.* the diſtance from the centre is made to be about ——— 10 *ſemid.*

5. And upon the obſervations of *Hainzelius* and *Gemma*, with Parall. of 42 *m.* 30 *ſec.* whereby the diſtance is gathered to be about ——— 4 *ſemid.*

6. And upon the obſervations of the *Landgrave* and *Camerarius*, with Parall. of 8 *m.* the diſtance is concluded to be about ——— 4 *ſemid.*

7. And upon the obſervations of *Tycho* and *Hagecius*, with Parall. of 6 *m.* and the diſtance is made ——— 31 *ſemid.*

8. And upon the obſervations of *Hagecius* and *Urſinus* with Parall. of 43 *m.* and the ſtars diſtance from the ſuperficies of the Earth is rendred —— $\frac{1}{2}$ *ſemid.*

9. And upon the obſervations of *Landgravius* and *Buſchius*, with Parall. of 15 *m.* and the diſtance from the ſuperficies of the Earth is by ſupputation ——— $\frac{1}{41}$ *ſemid.*

10. And upon the obſervations of *Maurolice* and *Munocius*, with Parall. of 4 *m.* 30 *ſec.* and the compnted diſtance from the Earths ſurface is —— $\frac{1}{2}$ *ſemid.*

11. And upon the obſervations of *Munocius* and *Gemma*, with Parall. of 55 *m.* and the diſtance from the centre is rendred ——— 13 *ſemid.*

12. And

12. And upon the obſervations of *Munoſius* and *Urſinus* with Parall. of 1 *gr.* 36 *m.* and the diſtance from the centre cometh forth leſſe than — 7 *ſemid.*

Theſe are twelve indagations made by the Author at his election, amongſt many which, as he ſaith, might be made by combining the obſervations of theſe thirteen obſervators. The which twelve we may believe to be the moſt favourable to prove his intention.

SAGR. I would know whether amongſt the ſo many other indagations pretermitted by the Author, there were not ſome that made againſt him, that is, from which calculating one might find the new ſtar to have been above the Moon, as at the very firſt ſight I think we may reaſonably queſtion; in regard I ſee theſe already produced to be ſo different from one another, that ſome of them give me the diſtance of the ſaid ſtar from the Earth, 4, 6, 10, 100, a thouſand, and an hundred thouſand times bigger one than another; ſo that I may well ſuſpect that amongſt thoſe that he did not calculate, there was ſome one in fauour of the adverſe party. And I gueſſe this to be the more probable, for that I cannot conceive that thoſe Aſtronomers the obſervators could want the knowledg and practice of theſe computations, which I think do not depend upon the abſtruceſt things in the World. And indeed it will ſeem to me a thing more than miraculous, if whilſt in theſe twelve inveſtigations onely, there are ſome that make the ſtar to be diſtant from the Earth but a few miles, and others that make it to be but a very ſmall matter below the Moon, there are none to be found that in favour of the contrary part do make it ſo much as twenty yards above the Lunar Orb. And that which ſhall be yet again more extravagant, that all thoſe Aſtronomers ſhould have been ſo blind as not to have diſcovered that their ſo apparent miſtake.

SALV. Begin now to prepare your ears to hear with infinite admiration to what exceſſes of confidence of ones own authority and others folly, the deſire of contradicting and ſhewing ones ſelf wiſer than others, tranſports a man. Amongſt the indagations omitted by the Author, there are ſuch to be found as make the new ſtar not onely above the Moon, but above the fixed ſtars alſo. And theſe are not a few, but the greater part, as you ſhall ſee in this other paper, where I have ſet them down.

SAGR. But what ſaith the Author to theſe? It may be he did not think of them?

SALV. He hath thought of them but too much: but ſaith, that the obſervations upon which the calculations make the ſtar to be infinitely remote, are erroneous, and that they cannot be combined to one another.

SIMP. But this ſeemeth to me a very lame evaſion; for the adverſe party may with as much reaſon reply, that thoſe are erroneous wherewith he collecteth the ſtar to have been in the Elementary Region.

SALV. Oh *Simplicius*, if I could but make you comprehend the craft, though no great craftineſſe of this Author, I ſhould make you to wonder, and alſo to be angry to ſee how that he palliating his ſagacity with the vail of the ſimplicity of your ſelf; and the reſt of meer Philoſophers, would inſinuate himſelf into your good opinion, by tickling your ears, and ſwelling your ambition, pretending to have convinced and ſilenced theſe petty Aſtronomers, who went about to aſſault the impregnable inalterability of the *Peripatetick* Heaven, and which is more, to have foild and conquered them with their own arms. I will try with all my ability to do the ſame; and in the mean time let *Sagredus* take it in good part, if *Simplicius* and I try his patience, perhaps a little too much, whilſt that with a ſuperfluous circumlocution (ſuperfluous I ſay to his moſt nimble apprehenſion) I go about to make out a thing, which it is not convenient ſhould be hid and unknown unto him.

SAGR. I ſhall not onely without wearineſſe, but alſo with much delight hearken to your diſcourſes; and ſo ought all *Peripatetick* Philoſophers, to the end they may know how much they are oblieged to this their Protector.

SALV. Tell me, *Simplicius*, whether you do well comprehend, how, the new ſtar being placed in the meridian circle yonder towards the North, the ſame to one that from the South ſhould go towards the North, would ſeem to riſe higher and higher above the Horizon, as much as the Pole, although it ſhould have been ſcituate amongſt the fixed ſtars; but, that in caſe it were conſiderably lower, that is nearer to the Earth, it would appear to aſcend more than the ſaid pole, and ſtill more by how much its vicinity was greater?

SIMP. I think that I do very well conceive the ſame; in token whereof I will try if I can make a mathematical Scheme of it, and in this great circle [*in Fig.* 1. *of this Dialogue.*] I will marke the pole P; and in theſe two lower circles I will note two ſtars beheld from one place on the Earth, which let be A; and let the two ſtars be theſe B and C, beheld in the ſame line A B C, which line I prolong till it meet with a fixed ſtar in D. And then walking along the Earth, till I come to the term E, the two ſtars will appear to me ſeparated from the fixed ſtar D, and advanced neerer to the pole P, and the lower ſtar B more, which will appear to me in G, and the ſtar C leſſe, which will appear to me in F, but the fixed ſtar D will have kept the ſame diſtance from the Pole.

SALV.

SALV. I ſee that you underſtand the buſineſſe very well. I believe that you do likewiſe comprehend, that, in regard the ſtar B is lower than C, the angle which is made by the rayes of the ſight, which departing from the two places A and E, meet in C, to wit, this angle A C E, is more narrow, or if we will ſay more acute than the angle conſtituted in B, by the rayes A B and E B.

SIMP. This I likewiſe underſtand very well.

SALV. And alſo, the Earth beine very little and almoſt inſenſible, in reſpect of the Firmament (*or Starry Sphere*;) and conſequently the ſpace A E, paced on the Earth, being very ſmall in compariſon of the immenſe length of the lines E G and E F, paſſing from the Earth unto the Firmament, you thereby collect that the ſtar C might riſe and aſcend ſo much and ſo much above the Earth, that the angle therein made by the rayes which depart from the ſaid ſtationary points A and E, might become moſt acute, and as it were abſolutely null and inſenſible.

SIMP. And this alſo is moſt manifeſt to ſenſe.

SALV. Now you know *Simplicius* that Aſtronomers and Mathematicians have found infallible rules by way of Geometry and Arithmetick, to be able by help of the quantity of theſe angles B and C, and of their differences, with the additional knowledg of the diſtance of the two places A and E, to find to a foot the remoteneſſe of ſublime bodies; provided alwayes that the aforeſaid diſtance, and angles be exactly taken.

SIMP. So that if the Rules dependent on *Geometry* and *Aſtronomy* be true, all the fallacies and errours that might be met with in attempting to inveſtigate thoſe altitudes of new Stars or Comets, or other things muſt of neceſſity depend on the diſtance A E, and on the angles B and C, not well meaſured. And thus all thoſe differences which are found in theſe twelve workings depend, not on the defects of the rules of the Calculations, but on the errours committed in finding out thoſe angles, and thoſe diſtances, by means of the Inſtrumental Obſervations.

SALV. True; and of this there is no doubt to be made. Now it is neceſſary that you obſerve intenſely, how in removing the Star from B to C, whereupon the angle alwayes grows more acute, the ray E B G goeth farther and farther off from the ray A B D in the part beneath the angle, as you may ſee in the line E C F, whoſe inferiour part E C is more remote from the part A C, than is the part E B, but it can never happen, that by any whatſoever immenſe receſſion, the lines A D and E F ſhould totally ſever from each other, they being finally to go and conjoyn in the Star: and onely this may be ſaid, that they would ſeparate, and reduce themſelves to parallels, if ſo be the receſſion ſhould be infinite, which

caſe is not to be ſuppoſed. But becauſe (obſerve well) the diſtance of the Firmament, in relation to the ſmallneſſe of the Earth, as hath been ſaid, is to be accounted, as if it were infinite; therefore the angle conteined betwixt the two rayes, that being drawn from the points A and E, go to determine in a fixed Star, is eſteemed nothing, and thoſe rayes held to be two parallel lines; and therefore it is concluded, that then only may the New Star be affirmed to have been in the Firmament, when from the collating of the Obſervations made in divers places, the ſaid angle is, by calculation, gathered to be inſenſible, and the lines, as it were, parallels. But if the angle be of a conſiderable quantity, the New Star muſt of neceſſity be lower than thoſe fixed; and alſo than the Moon, in caſe the angle A B E ſhould be greater than that which would be made in the Moons centre.

SIMP. Then the remoteneſſe of the Moon is not ſo great, that a like angle ſhould be *inſenſible in her?

* Imperceptible.

SALV. No Sir; nay it is ſenſible, not only in the Moon, but in the Sun alſo.

SIMP. But if this be ſo, it's poſſible that the ſaid angle may be obſerved in the New Star, without neceſſitating it to be inferiour to the Sun, aſwell as to the Moon.

SALV. This may very well be, yea, and is in the preſent caſe, as you ſhall ſee in due place; that is, when I ſhall have made plain the way, in ſuch manner that you alſo, though not very perfect in *Aſtronomical* calculations, may clearly ſee, and, as it were, with your hands feel how that this Authour had it more in his eye to write in complacency of the *Peripatetick*s, by palliating and diſſembling ſundry things, than to eſtabliſh the truth, by producing them with naked ſincerity: therefore let us proceed forwards. By the things hitherto ſpoken, I ſuppoſe that you comprehend very well how that the diſtance of the new Star can never be made ſo immenſe, that the angle ſo often named ſhall wholly diſappear, and that the two rayes of the Obſervators at the places A and E, ſhall become altogether parallels: and you may conſequently comprehend to the full, that if the calculations ſhould collect from the obſervations, that that angle was totally null, or that the lines were truly parallels, we ſhould be certain that the obſervations were at leaſt in ſome ſmall particular erroneous: But, if the calculations ſhould give us the ſaid lines to be ſeparated not only to equidiſtance, that is, ſo as to be parallel, but to have paſt beyond that terme, and to be dilated more above than below, then muſt it be reſolutely concluded, that the obſervations were made with leſſe accurateneſſe, and in a word, to be erroneous; as leading us to a manifeſt impoſſibility. In the next place, you muſt believe me, and ſuppoſe it for true, that two right lines which

which depart from two points marked upon another right line, are then wider above than below, when the angles included between them upon that right line are greater than two right angles; and if theſe angles ſhould be equal to two right angles, the lines would be parallels; but if they were leſs than two right angles, the lines would be concurrent, and being continued out would undoubtedly interſect the triangle.

SIMP. Without taking it upon truſt from you, I know the ſame; and am not ſo very naked of *Geometry*, as not to know a Propoſition, which I have had occaſion of reading very often in *Ariſtotle*, that is, that the three angles of all triangles are equall to two right angles: ſo that if I take in my Figure the triangle ABE, it being ſuppoſed that the line E A is right; I very well conceive, that its three angles A, E, B, are equal to two right angles; and that conſequently the two angles E and A are leſſe than two right angles, ſo much as is the angle B. Whereupon widening the lines A B and E B (ſtill keeping them from moving out of the points A and E) untill that the angle conteined by them towards the parts B, diſappear, the two angles beneath ſhall be equal to two right angles, and thoſe lines ſhall be reduced to parallels: and if one ſhould proceed to enlarge them yet more, the angles at the points E and A would become greater than two right angles.

SALV. You are an *Archimedes*, and have freed me from the expence of more words in declaring to you, that whenſoever the calculations make the two angles A and E to be greater than two right angles, the obſervations without more adoe will prove erroneous. This is that which I had a deſire that you ſhould perfectly underſtand, and which I doubted that I was not able ſo to make out, as that a meer *Peripatetick* Philoſopher might attain to the certain knowledg thereof. Now let us go on to what remains. And re-aſſuming that which even now you granted me, namely, that the new ſtar could not poſſibly be in many places, but in one alone, when ever the ſuppurations made upon the obſervations of theſe Aſtronomers do not aſſign it the ſame place, its neceſſary that it be an errour in the obſervations, that is, either in taking the altitudes of the pole, or in taking the elevations of the ſtar, or in the one or other working. Now for that in the many workings made with the combinations two by two, there are very few of the obſervations that do agree to place the ſtar in the ſame ſituation; therefore theſe few onely may happily be the non-erroneous, but the others are all abſolutely falſe.

SAGR. It will be neceſſary then to give more credit to theſe few alone, than to all the reſt together, and becauſe you ſay, that theſe which accord are very few, and I amongſt theſe 12, do find two that ſo accord, which both make the diſtance of the ſtar

ſtar from the centre of the Earth 4 ſemidiameters, which are theſe, the fifth and ſixth, therefore it is more probable that the new ſtar was elementary, than celeſtial.

SALV. You miſtake the point; for if you note well it was not written, that the diſtance was exactly 4 ſemidiameters, but about 4 ſemidiameters; and yet you ſhall ſee that thoſe two diſtances differed from each other many hundreds of miles. Here they are; you ſee that this fifth, which is 13389 *Italian* miles, exceeds the ſixth, which is 13100 miles, by almoſt 300 miles.

SAGR. Which then are thoſe few that agree in placing the ſtar in the ſame ſituation?

SALV. They are, to the diſgrace of this Author five workings, which all place it in the firmament, as you ſhall ſee in this note, where I have ſet down many other combinations. But I will grant the Author more than peradventure he would demand of me, which is in ſum, that in each combination of the obſervations there is ſome error; which I believe to be abſolutely neceſſary; for the obſervations being four in number that ſerve for one working, that is, two different altitudes of the Pole, and two different elevations of the ſtar, made by different obſervers, in different places, with different inſtruments, who ever hath any ſmall knowledg of this art, will ſay, that amongſt all the four, it is impoſſible but there will be ſome error; and eſpecially ſince we ſee that in taking but one onely altitude of the Pole, with the ſame inſtrument, in the ſame place, by the ſame obſerver, that hath repeated the obſervation a thouſand times, there will ſtill be a titubation of one, or ſometimes of many minutes, as in this ſame book you may ſee in ſeveral places. Theſe things preſuppoſed, I ask you *Simplicius* whether you believe that this Authour held theſe thirteen obſervators for wiſe, underſtanding and expert men in uſing thoſe inſtruments, or elſe for inexpert, and bunglers?

Aſtronomical Inſtruments are very ſubject to errour.

SIMP. It muſt needs be that he eſteemed them very acute and intelligent; for if he had thought them unskilful in the buſineſſe, he might have omitted his ſixth book as inconcluſive, as being founded upon ſuppoſitions very erroneous; and might take us for exceſſively ſimple, if he ſhould think he could with their inexpertneſſe perſwade us to believe a falſe poſition of his for truth.

SALV. Therefore theſe obſervators being ſuch, and that yet notwithſtanding they did erre, and ſo conſequently needed correction, that ſo one might from their obſervations infer the beſt hints that may be; it is convenient that we apply unto them the leaſt and neereſt emendations and corrections that may be; ſo that they do but ſuffice to reduce the obſervations from impoſſibility to poſſibility; ſo as *v. gr.* if one may but correct a manifeſt errour, and an apparent impoſſibility of one of their obſervations

vations by the addition or ſubſtraction of two or three minutes, and with that amendment to reduce it to poſſibility, a man ought not to eſſay to adjuſt it by the addition or ſubſtraction of fifteen, twenty, or fifty.

SIMP. I think the Authour would not deny this: for granting that they are expert and judicious men, it ought to be thought that they did rather erre little than much.

SALV. Obſerve again; The places where the new Star is placed, are ſome of them manifeſtly impoſſible, and others poſſible. Abſolutely impoſſible it is, that it ſhould be an infinite ſpace ſuperiour to the fixed Stars, for there is no ſuch place in the world; and if there were, the Star there ſcituate would have been imperceptible to us: it is alſo impoſſible that it ſhould go creeping along the ſuperficies of the Earth; and much leſſe that it ſhould be within the ſaid Terreſtrial Globe. Places poſſible are theſe that be in controverſie, it not interferring vvith our underſtanding, that a viſible object in the likeneſſe of a Star might be aſwell above the Moon, as below it. Now whilſt one goeth about to compute by the way of Obſervations and Calculations made with the utmoſt certainty that humane diligence can attain unto what its place was, it is found that the greateſt part of thoſe Calculations make it more than infinitely ſuperiour to the Firmament, others make it very neer to the ſurface of the Earth, and ſome alſo under the ſame; and of the reſt, which place it in ſituations not impoſſible, none of them agree with each other; inſomuch that it muſt be confeſſed, that all thoſe obſervations are neceſſarily falſe; ſo that if we would nevertheleſs collect ſome fruit from ſo many laborious calculations, we muſt have recourſe to the corrections, amending all the obſervations.

SIMP. But the Authour will ſay, that of the obſervations that aſſign to the Star impoſſible places, there ought no account to be made, as being extreamly erroneous and falſe; and thoſe onely ought to be accepted, that conſtitute it in places not impoſſible: and amongſt theſe a man ought to ſeek, by help of the moſt probable, and moſt numerous concurrences, not if the particular and exact ſituation, that is, its true diſtance from the centre of the Earth, at leaſt, whether it was amongſt the Elements, or elſe amongſt the Cœleſtial bodies.

SALV. The diſcourſe which you now make, is the ſelf ſame that the Author made, in favour of his cauſe, but with too unreaſonable a diſadvantage to his adverſaries; and this is that principal point that hath made me exceſſively to wonder at the too great confidence that he expreſſed to have, no leſs of his own authority, than of the blindneſs and inadvertency of the Aſtronomers; in favour of whom I will ſpeak, and you ſhall anſwer for the Author.

And

And firſt, I ask you, whether the Aſtronomers, in obſerving with their Inſtruments, and ſeeking *v.gr.* how great the elevation of a Star is above the Horizon, may deviate from the truth, aſwell in making it too great, as too little; that is, may erroneouſly compute, that it is ſometime higher than the truth, and ſometimes lower; or elſe whether the errour muſt needs be alwayes of one kinde, to wit, that erring they alwayes make it too much, and never too little, or alwayes too little, and never too much?

SIMP. I doubt not, but that it is as eaſie to commit an errour the one way, as the other.

SALV. I believe the Author would anſwer the ſame. Now of theſe two kinds of errours, which are contraries, and into which the obſervators of the new ſtar may equally have fallen, applied to calculations, one ſort will make the ſtar higher, and the other lower than really it is. And becauſe we have already agreed, that all the obſervations are falſe; upon what ground would this Author have us to accept thoſe for moſt congruous with the truth, that ſhew the ſtar to have been near at hand, than the others that ſhew it exceſſively remote?

SIMP. By what I have, as yet, collected of the Authors mind, I ſee not that he doth refuſe thoſe obſervations, and indagations that might make the ſtar more remote than the Moon, and alſo than the Sun, but only thoſe that make it remote (as you your ſelf have ſaid) more than an infinite diſtance; the which diſtance, becauſe you alſo do refuſe it as impoſſible, he alſo paſſeth over, as being convicted of infinite falſhood; as alſo thoſe obſervations are of impoſſibility. Methinks, therefore, that if you would convince the Author, you ought to produce ſupputations, more exact, or more in number, or of more diligent obſervers, which conſtitute the ſtar in ſuch and ſuch a diſtance above the Moon, or above the Sun, and to be brief, in a place poſſible for it to be in, like as he produceth theſe twelve, which all place the ſtar beneath the Moon in places that have a being in the world, and where it is poſſible for it to be.

SALV. But *Simplicius* yours and the Authors Equivocation lyeth in this, yours in one reſpect, and the Authors in another; I diſcover by your ſpeech that you have formed a conceit to your ſelf, that the exorbitancies that are commited in the eſtabliſhing the diſtance of the Star do encreaſe ſucceſſively, according to the proportion of the errors that are made by the Inſtrument, in taking the obſervations, and that by converſion, from the greatneſs of the exorbitancies, may be argued the greatneſſe of the error; and that thereforefore hearing it to be infered from ſuch an obſervation, that the diſtance of the ſtar is infinite, it is neceſſary, that the errour in obſerving was infinite, and therefore not to be amended,

ed, and as ſuch to be refuſed; but the buſineſſe doth not ſucceed in that manner, my *Simplicius*, and I excuſe you for not having comprehended the matter as it is, in regard of your ſmall experience in ſuch affairs; but yet cannot I under that cloak palliate the error of the Author, who diſſembling the knowledge of this which he did perſwade himſelf that we in good earneſt did not underſtand, hath hoped to make uſe of our ignorance, to gain the better credit to his Doctrine, among the multitude of illiterate men. Therefore for an advertiſement to thoſe who are more credulous then intelligent, and to recover you from error, know that its poſſible (and that for the moſt part it will come to paſſe) that an obſervation, that giveth you the ſtar *v. gr.* at the diſtance of *Saturn*, by the adition or ſubſtraction of but one ſole minute from the elevation taken with the inſtrument, ſhall make it to become infinitely diſtant; and therefore of poſſible, impoſſible, and by converſion, thoſe calculations which being grounded upon thoſe obſervations, make the ſtar infinitely remote, may poſſibly oftentimes with the addition or ſubduction of one ſole minute, reduce it to a poſſible ſcituation: and this which I ſay of a minute, may alſo happen in the correction of half a minute, a ſixth part, and leſs. Now fix it well in your mind, that in the higheſt diſtances, that is *v. g.* the height of *Saturn*, or that of the fixed Stars, very ſmall errors made by the Obſervator, with the inſtrument, render the ſcituation determinate and poſſible, infinite & impoſſible. This doth not ſo evene in the ſublunary diſtances, and near the earth, where it may happen that the obſervation by which the Star is collected to be remote *v. g.* 4. Semidiameters terreſtrial, may encreaſe or diminiſh, not onely one minute but ten, and an hundred, and many more, without being rendred by the calculation either infinitely remote, or ſo much as ſuperior to the Moon. You may hence comprehend that the greatneſſe of the error (to ſo ſpeak) inſtrumental, are not to be valued by the event of the calculation, but by the quantity it ſelf of degrees and minutes numbred upon the inſtrument; and theſe obſervations are to be called more juſt or leſs erroneous, which with the addition or ſubſtraction of fewer minutes, reſtore the ſtar to a poſſible ſituation; and amongſt the poſſible places, the true one may be believed to have been that, about which a greater number of diſtances concurre upon calculating the more exact obſervations.

SIMP. I do not very well apprehend this which you ſay: nor can I of my ſelf conceive how it can be, that in greater diſtances, greater exorbitancies can ariſe from the errour of one minute only, than in the ſmaller from ten or an hundred; and therefore would gladly underſtand the ſame.

SALV. You ſhall ſee it, if not Theorically, yet at leaſt Practically,

cally, by this ſhort aſſumption, that I have made of all the combinations, and of part of the workings pretermitted by the Author, which I have calculated upon this ſame paper.

SAGR. You muſt then from yeſterday, till now, which yet is not above eighteen hours, have done nothing but compute, without taking either food or ſleep.

SALV. I have refreſhed my ſelf both thoſe wayes; but truth is, make theſe ſupputations with great brevity; and, if I may ſpeak the truth, I have much admired, that this Author goeth ſo farre about, and introduceth ſo many computations no wiſe neceſsary to the queſtion in diſpute. And for a full knowledge of this, and alſo to the end it may ſoon be ſeen, how that from the obſervations of the Aſtronomers, whereof this Author makes uſe, it is more probably gathered, that the new ſtar might have been above the Moon, and alſo above all the Planets, yea amongſt the fixed ſtars, and yet higher ſtill than they, I have tranſcribed upon this paper all the obſervations ſet down by the ſaid Authour, which were made by thirteen Aſtronomers, wherein are noted the Polar altitude, and the altitudes of the ſtar in the meridian, aſwell the leſſer under the Pole, as the greater and higher, and they are theſe.

Tycho.

	gr.	*m.*	
Altitude of the Pole	55	58	
Altitude of the Star	84	00	the greateſt.
	27	57	the leaſt.
And theſe are, according to the firſt paper: but according to the ſecond, the greateſt is ————	27	45	

Hainzelius.

	gr.	*m.*	*ſec.*
Altitude of the Pole	48	22	
Altitude of the Star	76	34	
	76	33	45
	76	35	
	20	09	40
	20	09	30
	20	09	20

Peucerus

Peucerus and *Sculerus*.

	gr.	m.
Altitude of the pole	51	54
Altitude of the Star	79	56
	23	33

Landgravius.

	gr.	m.
Altitude of the pole	51	18
Altitude of the Star	79	30

Camerarius.

	gr.	m.
Altitude of the pole	52	24
Altitude of the Star	80	30
	80	27
	80	26
	24	28
	24	20
	24	17

Hagecius

	gr.	m.
Altitude of the pole	48	22
Altitude of the Star	20	15

Maurolycus.

	gr.	m.
Altitude of the pole	38	30
Altitude of the Star	62	00

Munocius.

	gr.	m.
Altitude of the pole	39	30
Altitude of the ſtar	67	30
	11	30

Urſinus.

	gr.	m.
Altitude of the pole	49	24
Altitude of the ſtar	79	00
	22	00

Reinholdus.

	gr.	m.
Altitude of the pole	51	18
Altitude of the ſtar	79	30
	23	02

Buchius.

	gr.	m.
Altitude of the pole	51	10
Altitude of the ſtar	79	20
	22	40

Gemma.

	gr.	m.
Altitude of the pole	50	50
Altitude of the ſtar	79	45

Now to ſee my whole proceeding, we may begin from theſe calculations, which are four, omitted by the Author, perhaps becauſe they make againſt him, in regard they place the ſtar above the moon by many ſemidiameters of the Earth. The firſt of which is this, computed upon the obſervations of the Landgrave of *Haſſia*, and *Tycho*; which are, even by the Authors conceſſion, two of the moſt exact obſervers: and in this firſt, I will declare the order that I hold in the working; which ſhall ſerve for all the reſt, in that they are all made by the ſame rule, not varying in any thing, ſave in the quantity of the given ſummes, that is, in the number of the degrees of the Poles altitude, and of the new Stars elevation above the Horizon, the diſtance of which from the centre of the Earth, in proportion to the ſemidiameter of the terreſtrial Globe is ſought, touching which it nothing imports in this caſe, to know how many miles that ſemidiameter conteineth; whereupon the reſolving that, and the diſtance of places where the obſervations were made, as this Author doth, is but time and labour loſt; nor do I know why he hath made the ſame, and eſpecially why at the laſt he goeth about to reduce the miles found, into ſemidiameters of the Terreſtrial Globe.

SIMP. Perhaps he doth this to finde with ſuch ſmall meaſures, and with their fractions the diſtance of the Star terminated to three or four inches; for we that do not underſtand your rules of Arithmetick, are ſtupified in hearing your concluſions; as for inſtance, whilſt we read; Therefore the new Star or Comet was diſtant from the Earths centre three hundred ſeventy and three thouſand eight hundred and ſeven miles; and moreover, two hundred and eleven, four thouſand ninety ſevenths $373807\frac{211}{4090}$, and upon theſe preciſe punctualities, wherein you take notice of ſuch ſmall matters, we do conceive it to be impoſſible, that you, who in our calculations keep an account of an inch, can at the cloſe deceive us ſo much as an hundred miles.

SALV. This your reaſon and excuſe would paſſe for currant, if in a diſtance of thouſands of miles, a yard over or under were of any great moment, and if the ſuppoſitions that we take for true, were ſo certain, as that they could aſſure us of producing an indubitable truth in the concluſion; but here you ſee in the twelve workings of the Author, the diſtances of the Star, which from them one may conclude to have been different from each other, (and therefore wide of the truth) for many hundreds and thouſands of miles: now whilſt that I am more than certain, that that which I ſeek muſt needs differ from the truth by hundreds of miles, to what purppſe is it to be ſo curious in our calculations, for fear of miſſing the quantity of an inch? But let us proceed, at laſt, to the working, which I reſolve in this manner. *Tycho*, as may be

ſeen in that ſame note obſerved the ſtar in the polar altitude of 55 degrees and 58 *mi. pri.* And the polar altitude of the *Landgrave* was 51 degrees and 18 *mi. pri.* The altitude of the ſtar in the Meridian taken by *Tycho* was 27 degrees 45 *mi. pri.* The *Landgrave* found its altitude 23 degrees 3 *mi. pri.* The which altitudes are theſe noted here, as you ſee.

	gr.	*m.*		*gr.*	*m.*
Tycho Pole	55	58	*	27	45
Landgr. Pole	51	18	*	23	3

This done, ſubſtract the leſſe from the greater, and there remains theſe differences here underneath.

	gr.	*m.*
	4	40
	4	42
Parall.		2

Where the difference of the poles altitudes 4 *gr.* 4 *mi. pr.* is leſſe than the difference of the altitudes of the Star 4 *gr.* 42 *mi. pr.* and therefore we have the difference of parallaxes, 0 *gr.* 2 *mi. pri.* Theſe things being found, take the Authours own figure [*Fig.* 2.] in which the point B is the ſtation of the *Landgrave*, D the ſtation of *Tycho*, C the place of the ſtar, A the centre of the Earth, A B E the vertical line of the *Landgrave*, A D F

	gr.	*m.*	
Ang. B A D	4	40	Its chord 8142 of thoſe parts, whereof the ſemid. A B is an 100000.
B D F	92	20	
B D C	154	45	Sines 42657
B C D	0	2	58

58 | 42657 | 8142

8142

85314
170628
42657
341256

58 | 59 | 13294
3473
571
5

of *Tycho*, and the angle B C D the difference of Parallaxes. And be-

becauſe the angle B A D, conteined between the vertical lines, is equal to the difference of the Polar altitudes, it ſhall be 4*gr.* 40*m.* which I note here apart; and I finde the chord of it by the Table of Arches and Chords, and ſet it down neer unto it, which is 8142 parts, of which the ſemidiameter A B is 100000. Next, I finde the angle B D C with eaſe, for the half of the angle B A D, which is 2 *gr.* 20 *m.* added to a right angle, giveth the angle B D F 92*gr.* 20 *m.* to which adding the angle C D F, which is the diſtance from the vertical point of the greateſt altitude of the Star, which here is 62 *gr.* 15 *m.* it giveth us the quantity of the angle B D C, 154 *grad.* 45 *min.* the which I ſet down together with its Sine, taken out of the Table, which is 42657, and under this I note the angle of the Parallax B C D 0 *gr.* 2 *m.* with its Sine 58. And becauſe in the Triangle B C D, the ſide D B is to the ſide B C; as the ſine of the oppoſite angle B C D, to the ſine of the oppoſite angle B D C: therefore, if the line B D were 58. B C would be 42657. And becauſe the Chord D B is 8142. of thoſe parts whereof the ſemidiameter B A is 100000. and we ſeek to know how many of thoſe parts is B C; therefore we will ſay, by the Golden Rule, if when B D is 58. B G is 42657. in caſe the ſaid D B were 8142. how much would B C be? I multiply the ſecond term by the third, and the product is 347313294. which ought to be divided by the firſt, namely, by 58. and the quotient ſhall be the number of the parts of the line B C, whereof the ſemidiameter A B is 100000. And to know how many ſemidiameters B A, the ſaid line B C doth contein, it will be neceſſary anew to divide the ſaid quotient ſo found by 100000. and we ſhall have the number of ſemidiameters conteined in B G. Now the number 347313294. divided by 58. giveth 5988160$\frac{4}{5}$. as here you may ſee.

5988160$\frac{4}{5}$

58 | 347313294

571794 1

543

And this divided by 100000. the product is 59$\frac{88160}{100000}$

100000 | 59 | 88160.

But we may much abbreviate the operation, dividing the firſt quotient found, that is, 347313294. by the product of the multiplication of the two numbers 58. and 100000. that is,

59
58,00000 | 3473 | 13294
571
5

And this way alſo there will come forth 59.

And ſo many ſemidiameters are contained in the line B C, to which one being added for the line A B, we ſhall have little leſſe than 61. ſemidiameters for the two lines A B C; and therefore the right diſtance from the centre A, to the Star C, ſhall be more than 60. ſemidiameters, and therefore it is ſuperiour to the Moon, according to *Ptolomy*, more than 27. ſemidiameters, and according to *Copernicus*, more than 8. ſuppoſing that the diſtance of the Moon from the centre of the Earth by *Copernicus* his account is what the Author maketh it, 52 ſemidiameters. With this ſame working, I find by the obſervations of *Camerarius*, and of *Munoſius*, that the Star was ſituate in that ſame diſtance, to wit, ſomewhat more than 60. ſemidiameters. Theſe are the obſervations, and theſe following next after them the calculations.

		gr.	m.			gr.	m.
Altitude of the Pole	*Camerar.*	52	24	Altitude of the Star	24	28	
	Munoſ.	39	30		11	30	
Differences of the Polar Altitudes		12	54	Differences of the alt. of *	12	58	
					12	54	

Difference of Parallaxes 00 04. ang. BCD.

		gr.	m.		
Angles	B A D	12	54	and its chord or ſubtenſe 22466.	
	B D C	161	59	Sines	30930
	B C D	00	04		116

The Golden Rule.

22466
116 30930 22466
673980
202194
67398

59
116 | 6948 | 73380 Diſtance B C 59. and almoſt 60. ſemidiameters.
1144
10

The

The next working is made upon two observations of *Tycho*, and of *Munosius*, from which the Star is calculated to be distant from the Centre of the Earth 478 Semidiameters and more.

		gr.	m.		gr.	m.
Altitudes of the Pole.	*Tycho.*	55	58	Altitude of the Star.	84	00
	Munos.	39	30		67	30
Differences of the Polar Altitudes.		16	28	Differ. of the Alt. of the *	16	30
					16	28
				Difference of Parallax.	0	2 and ang. BCD

		gr.	m.		
Angles	*B A D.*	16	28	its chord	28640
	B D C.	104	14	Sines	96930
	B C D.	0	2		58

The Golden Rule.

```
58   96930  28640
     28640
   ---------
    3877200
   58158
  77544
 19386
 ----------------
     478
58 | 27760 | 75200
     4506
      53
```

These workings following make the Star remote from the Centre, more than 358 Semidiameters.

		gr.	m.		gr.	m.
Altitudes of the Pole.	*Peucerus*	51	54	Altitude of the *	79	56
	Munosius	39	30		47	30
		12	24		12	26
					12	24
					0	2

		gr.	m.		
Angles	*B A D.*	12	24	its chord	21600
	B D C.	106	16	Sines	95996
	B C D.	0	2		58

The

The Golden Rule.

58 — 95996 — 21600
21600

57597600
95996
191992

357
58 | 20735 | 13600
3339
42

From this other working the ſtar is found to be diſtant from the centre more than 716. ſemidiameters.

		gr.	m.			gr.	m.	ſec.
Altitudes of the Pole	Landgr.	51	18	Altitude of the Star	79	30	00	
	Hainzel.	48	22		76	33	45	
		2	56			2	56	15
						2	56	
						0	00	15

		gr.	m.	ſec.		
Angles	BAD	2	56	00	its Chord	5120
	BDC	101	58	00	Sines	97845
	BCD	0	00	15		7

The Golden Rule.

7 — 97845 — 5120
5120

1956900
57845
489225

715
7 | 5009 | 66400
4

Theſe as you ſee are five workings which place the ſtar very much above the Moon. And here I deſire you to conſider upon that particular, which even now I told you, namely, that in great

diſtances, the mutations, or if you pleaſe corrections, of a very few minutes, removeth the ſtar a very great way farther off. As for example, in the firſt of theſe workings, where the calculation made the ſtar 60. ſemidiameters remote from the centre, with the Parallax of 2. minutes; he that would maintain that it was in the Firmament, is to correct in the obſervations but onely two minutes, nay leſſe, for then the Parallax ceaſeth, or becommeth ſo ſmall, that it removeth the ſtar to an immenſe diſtance, which by all is received to be the Firmament. In the ſecond indagation, or working, the correction of leſſe than 4 *m. prim.* doth the ſame. In the third, and fourth, like as in the firſt, two minutes onely mount the ſtar even above the Firmament. In the laſt preceding, a quarter of a minute, that is 15. ſeconds, gives us the ſame. But it doth not ſo occur in the ſublunary altitudes; for if you fancy to your ſelf what diſtance you moſt like, and go about to correct the workings made by the Authour, and adjuſt them ſo as that they all anſwer in the ſame determinate diſtance, you will find how much greater corrections they do require.

SAGR. It cannot but help us in our fuller underſtanding of things, to ſee ſome examples of this which you ſpeak of.

SALV. Do you aſſign any whatſoever determinate ſublunary diſtance at pleaſure in which to conſtitute the ſtar, for with ſmall ado we may aſſertain our ſelves whether corrections like to theſe, which we ſee do ſuffice to reduce it amongſt the fixed ſtars, will reduce it to the place by you aſſigned.

SAGR. To take a diſtance that may favour the Authour, we will ſuppoſe it to be that which is the greateſt of all thoſe found by him in his 12 workings; for whilſt it is in controverſie between him and Aſtronomers, and that they affirm the ſtar to have been ſuperiour to the Moon, and he that it was inferiour, very ſmall ſpace that he proveth it to have been lower, giveth him the victory.

SALV. Let us therefore take the ſeventh working wrought upon the obſervations of *Tycho* and *Thaddæus Hagecius*, by which the Authour found the ſtar to have been diſtant from the centre 32. ſemidiameters, which ſituation is moſt favourable to his purpoſe; and to give him all advantages, let us moreover place it in the diſtance moſt diſfavouring the *Aſtronomers*, which is to ſituate it above the Firmament. That therefore being ſuppoſed, let us ſeek in the next place what corrections it would be neceſſary to apply to his other 11 workings. And let us begin at the firſt calculated upon the obſervations of *Hainzelius* and *Maurolce*; in which the Authour findeth the diſtance from the centre about 3. ſemidiameters with the Parallax of 4 *gr.* 42 *m.* 30. *ſec.* Let

us

us see whether by withdrawing it 20. minutes onely, it will rise to the height of 32. semidiameters: See the short and true operation. Multiply the sine of the angle B D C, by the sine of the

		gr.	m.		gr.	m.	sec.
Hainzelius	Pole	48	32 —— *		76	34	30
Maurolicus	Pole	38	30 —— *		62	00	00
		9	52		14	34	30
					9	52	00
				Parallax	4	42	30

		gr.	m.	sec.		
Angles	B A D	9	52	00	Chord	17200
	B D C	108	21	30	Sine	94910
	B C D	0	20	00	Sine	582

94910
17200
18982000
66437
9491
28
582 | 16324 | 52000
4688
2

chord B D, and divide the product, the five last figures being cut off by the line of the Parallax, and the quotient will be 28. semidiameters, and an half, so that though you make a correction of 4 *gr.* 22 *min.* 30 *sec.* taken from 4 *gr.* 42 *min.* 30 *sec.* it shall not elevate the star to the altitude of 32. semidiameters, which correction for *Simplicius* his understanding it, is of 262. minutes, and an half.

In the second operation made upon the observations of *Hainzelius*, and *Sculerus*, with the Parallax of 0 *gr.* 8 *min.* 30 *sec.* the star is found in the height of 25. semidiameters or thereabouts, as may be seen in the subsequent working.

B D	Chord		6166
B D C	Sines		97987
B C D			247

97987

97987
6166

587922
587922
97987
587922

24
247|6041|87842
1103
11

And bringing back the Parallax 0 *gr.* 8 *m.* 30 *ſec.* to 7 *gr.* 7 *m.* whoſe ſine is 204, the ſtar elevateth to 30 ſemidiameters or thereabouts; therefore the correction of 0 *gr.* 1 *mi.* 30 *ſec.* doth not ſuffice.

20
204|6041|87342
1965
12

Now let us ſee what correction is requiſite for the third working made upon the obſervations of *Hainzelius* and *Tycho*, which rendereth the ſtar about 19 ſemidiameters high, with the Parallax of 10 *m. pri.* The uſual angles and their ſines, and chord found by the Authour, are theſe next following; and they remove the ſtar (as alſo in the Authours working) 19 ſemidiameters from the centre of the Earth. It is neceſſary therefore for the raiſing of it, to diminiſh the Parallax according to the Rule which he likewiſe obſerveth in the ninth working. Let us therefore ſuppoſe the Parallax to be 6 *m. prim.* whoſe ſine is 175, and the diviſion being made, there is found likewiſe leſſe than 31 ſemidiameters for the ſtars diſtance. And therefore the correction of 4 *min. prim.* is too little to ſerve the Authours purpoſe.

Angles	B A D	7	36.	Chord	13254
	B D C	155	52	Sine	40886
	B C D	0	10	Sine	291

13254

13254
40886

79524
106032
106032
53016

18 30
291 | 5419 | 03044 | 175 | 5419
250 16
181

Let us come to the fourth working, and the reſt with the ſame rule, and with the chords and ſines found out by the Authour himſelf; in this the Parallax is 14 *m. prim.* and the height found leſſe than 10 ſemidiameters, and diminiſhing the Parallax from 14 *min.* to 4 *min.* yet nevertheleſſe you ſee that the ſtar doth not elevate full 31 ſemidiameters. Therefore 10 *min.* in 14 *min.* doth not ſuffice.

Angles	BAD	Chord	8142
	BDC	Sine	43235
	BCD	Sine	407

43235
8142

86470
172940
43235
345880

30
116 | 3520 | 19370
4

In the fifth operation of the Authour we have the ſines and the chord as you ſee, and the Parallax is 0 *gr.* 42 *m.* 30 *ſec.* which rendereth the height of the ſtar about 4 ſemidiameters, and correcting the Parallax, with reducing it from 0 *gr.* 42 *m.* 30 *ſec.* to 0 *gr.* 5 *m.* onely, doth not ſuffice to raiſe it to ſo much as 28 ſemidiameters, the correction therefore of 0 *gr.* 37 *m.* 30 *ſec.* is too little.

Angles	BAD	Chord	4034
	BDC	Sine	97998
	BGD		1236

97998
4034
391992
293994
391992
27
145|3953|23932
1058
3

In the ſixth operation the chord, the ſines and Parallax are as followeth, and the ſtar is found to be about 4. ſemidiameters; let us ſee whether it will be reduced, abating the Parallax from 8 *m.* to 1 *m.* onely; Here is the operation, and the ſtar raiſed but to 27. ſemidiameters or thereabout; therefore the correction of 7 *m.* in 8 *m.* doth not ſuffice.

BD	Chord	1920
BDC	Sine	40248
BCD 8 *gr.*	Sine	233

40248
1920
804960
362232
40248
26
29|772|76160
198
1

In the eighth operation the chord, the ſines, and the Parallax, as you ſee, are theſe enſuing, and hence the Authour calculates the height of the ſtar to be 1. ſemidiameter and an half, with the Parallax of 43. *min.* which reduced to 1 *min.* yet notwithſtanding giveth the ſtar leſſe remote than 24. ſemidiameters, the correction therefore of 42. *min.* is not enough.

BD	Chord	1804
BDC	Sine	36643
BCD	Sine	29

36643

36643
1804
146572
293144
36643
22
29|661|03972
83
2

Let us now ſee the ninth. Here is the chord, the ſines and the Parallax which is 15 *m*. From whence the Authour calculates the diſtance of the ſtar from the ſuperficies of the Earth to be leſſe than a* ſeven and fortieth part of a ſemidiameter, but this is an errour in the calcultaion, for it cometh forth truly, as we ſhall ſee here below, more than a fifth : See here the quotient is $\frac{232}{436}$, which is more than one fifth.

*Here the Latine verſion is erroneous, making it a fortieth part of, &c.

B D	Chord	232
B D C	Sine	39046
B C D	Sine	436

39046
232
78092
117138
78092
436|90|58672

That which the Authour preſently after ſubjoyns in way of amending the obſervations, that is, that it ſufficeth not to reduce the difference of Parallax, neither to a minute, nor yet to the eighth part of a minute is true. But I ſay, that neither will the tenth part of a minute reduce the height of the ſtar to 32. ſemidiameters ; for the ſine of the tenth part of a minute, that is of ſix ſeconds, is 3 ; by which if we according to our Rule ſhould divide 90. or we may ſay, if we ſhould divide 9058672. by 300000. the quotient will be $30\frac{58672}{300000}$, that is little more than 30. ſemidiameters and an half.

The tenth giveth the altitude of the ſtar one fifth of a ſemidiameter, with theſe angles, ſines, and Parallax, that is, 4 *gr.* 30

30 *m.* which I ſee that being reduced from 4 *gr.* 30 *min.* to 2 *min.* yet nevertheleſſe it elevates not the ſtar to 29. ſemidiameters.

B D	Chord	1746
B D C	Sine	92050
B C D 4 *gr.* 30 *m.*	Sine	7846

92050
17460

552300
36820
64435
9205

27
58 | 1607 | 19300
441
4

The eleventh rendereth the ſtar to the Authour remote about 13. ſemidiameters, with the Parallax of 55. *min.* let us ſee, reducing it to 20 *min.* whether it will exalt the ſtar: See here the calculation elevates it to little leſſe than 33. ſemidiameters, the correction therefore is little leſſe than 35. *min.* in 55. *min.*

B D	Chord	19748
B D C	Sine	96166
B C D 0 *gr.* 55 *m.*	Sine	1600

96166
19748

639328
384664
673162
865494
96166

32
582 | 18990 | 56168
1536
56

The twelfth with the Parallax of 1. *gr.* 36. *min.* maketh the ſtar leſſe high than 6. ſemidiameters, reducing the Parallax to 20 *min.* it carrieth the ſtar to leſſe than 30. ſemidiameters diſtance, therefore the correction of 1 *gr.* 16. *min.* ſufficeth not.

BD

BD		Chord	17258
BDC		Sine	96150
BCD	1 *gr.* 36 *m.*	Sine	2792

```
      17258
      96150
     862900
    17258
   103548
  155322
          28
  582 | 16593 | 56700
      4957
        29
```

These are the Corrections of the Parallaxes of the ten workings of the Author, to reduce the Star to the altitude of 32 Semidiameters.

gr.	*m.*	*sec.*		*gr.*	*m.*	*sec.*
04	22	30	in	04	42	30
00	04	00	in	00	10	00
00	10	00	in	00	14	00
00	37	00	in	00	42	30
00	07	00	in	00	18	00
00	42	00	in	00	43	00
00	14	50	in	00	15	00
04	28	00	in	04	30	00
00	35	00	in	00	55	00
01	16	00	in	01	36	00
	216				296.60	
	540				240. 9	
	765				836.540	

From hence we see, that to reduce the Star to 32. Semidiameters in altitude, it is requisite from the sum of the Parallaxes 836. to subtract 756. and to reduce them to 80. nor yet doth that correction suffice.

 Here

Here we ſee alſo, (as I have noted even now) that ſhould the Authour conſent to aſſign the diſtance of 32. Semidiameters for the true height of the Star, the correction of thoſe his 10. workings, (I ſay 10. becauſe the ſecond being very high, is reduced to the height of 32. Semidiameters, with 2. minutes correction) to make them all to reſtore the ſaid Star to that diſtance, would require ſuch a reduction of Parallaxes, that amongſt the whole number of ſubſtractions they ſhould make more than 756 *m. pr.* whereas in the 5. calculated by me, which do place the Star above the Moon, to correct them in ſuch ſort, as to conſtitute it in the Firmament, the correction onely of 10. minutes, and one fourth ſufficeth.

Now adde to theſe, other 5. workings, that place the Star preciſely in the Firmament, without need of any correction at all, and we ſhall have ten workings or indagations that agree to place it in the Firmament, with the correction onely of 5. of them (as hath been ſeen) but 10. *m.* and 15 *ſec.* Whereas for the correction of thoſe 10. of the Authour, to reduce them to the altitude of 32. ſemidiameters, there will need the emendations of 756 minutes in 836. that is, there muſt from the ſumme 836 be ſubſtracted 756. if you would have the Star elevated to the altitude of 32. ſemidiameters, and yet that correction doth not fully ſerve.

The workings that immediately without any correction free the Star from Parallaxes, and therefore place it in the Firmament, and that alſo in the remoteſt parts of it, and in a word, as high as the Pole it ſelf, are theſe 5. noted here.

		gr.	*m.*		*gr.*	*m.*
Camerar. *Peucerus*	Polar altit.	52	24	Altit. of the Star	80	26
		51	54		79	56
		0	30		0	30

		gr.	*m.*		*gr.*	*m.*
Landgrav. *Hainzel.*	Polar altit.	51	18	Altit. of the Star	79	30
		48	22		76	34
		2	56		2	56

		gr.	*m.*		*gr.*	*m.*
Tycho *Peucerus*	Polar altit.	55	58	Altit. of the Star	84	00
		51	54		79	56
		4	4		4	4

Reinold.

		gr.	m.		gr.	m.
Reinhold. *Hainzel.*	Polar altit.	51	18	Altit. of the Star	79	30
		48	22		36	34
		2	56		2	56

		gr.	m.		gr.	m.
Camerar. *Hagecius*	Polar altit.	52	24	Altit. of the Star	24	17
		48	22		20	15
		4	2		4	2

Of the remaining combinations that might be made of the Obſervations of all theſe Aſtronomers, thoſe that make the Stars ſublime to an infinite diſtance, are many in number, namely, about 30. more than thoſe who give the Star, by calculation, to be below the Moon; and becauſe (as it was agreed npon between us) it is to be believed that the Obſervators have erred rather little than much, it is a manifeſt thing that the corrections to be applied to the Obſervaations, which make the ſtar of an infinite altitude, to reduce it lower, do ſooner, and with leſſer amendment place it in the Firmament, than beneath the Moon; ſo that all theſe applaud the opinion of thoſe who put it amongſt the fixed Stars. You may adde, that the corrections required for thoſe emendations, are much leſſer than thoſe, by which the Star from an unlikely proximity may be removed to the height more favourable for this Authour, as by the foregoing examples hath been ſeen; amongſt which impoſſible proximities, there are three that ſeem to remove the Star from the Earths centre, a leſſe diſtance than one Semidiameter, making it, as it were, to turn round under ground, and theſe are thoſe combinations, wherein the Polar altitude of one of the Obſervators being greater than the Polar altitude of the other, the elevation of the Star taken by the firſt, is leſſer than the elation of the Star taken by the latter.

The firſt of theſe is this of the *Landgrave* with *Gemma*, where the Polar altitude of the *Landgrave* 51 *gr.* 18 *min.* is greater than the Polar altitude of *Gemma*, which is 50 *gr.* 50 *m.* But the altitude of the Star of the *Landgrave* 79 *gr.* 30 *min.* is leſſer than that of the Star, of *Gemma* 79 *gr.* 45 *min.*

		gr.	m.		gr.	m.
Landgrave *Gemma*	Polar altit.	51	18	Altit. of the Star	79	30
		50	50		79	45

The other two are theſe below.

		gr. m.		gr. m.
Buſchius. *Gemma.*	Polar Altitude	51 10 / 50 50	Altit. of the Star	79 20 / 79 45

Reinholdus. *Gemma.*	Polar Altitude	51 18 / 50 50	Altit. of the Star	79 30 / 79 45

From what I have hitherto demonſtrated, you may gueſſe how much this firſt way of finding out the diſtance of the Star, and proving it ſublunary introduced by the Authour, maketh againſt himſelf, and how much more probably and clearly the diſtance thereof is collected to have been amongſt the more remote fixed Stars.

SIMP. As to this particular, I think that the inefficacy of the Authors demonſtrations is very plainly diſcovered; But I ſee that all this was compriſed in but a few leaves of his Book, and it may be, that ſome other of his Arguments are more concluſive then theſe firſt.

SALV. Rather they muſt needs be leſſe valid, if we will take thoſe that lead the way for a proof of the reſt: For (as it is clear) the uncertainty and inconcluſiveneſſe of thoſe, is manifeſtly obſerved to derive it ſelf from the errours committed in the inſtrumental obſervations, upon which the Polar Altitude, and height of the Star was thought to have been juſtly taken, all in effect having eaſily erred; And yet to find the Altitude of the Pole, Aſtronomers have had Ages of time to apply themſelves to it, at their leaſure: and the Meridian Altitudes of the Star are eaſier to be obſerved, as being moſt terminate, and yielding the Obſervator ſome time to continue the ſame, in regard they change not ſenſibly, in a ſhort time, as thoſe do that are remote from the Meridian. And if this be ſo, as it is moſt certain, what credit ſhall we give to Calculations founded upon Obſervations more numerous, more difficult to be wrought, more momentary in variation, and we may add, with Inſtruments more incommodious and erroneous? Upon a ſlight peruſal of the enſuing demonſtrations, I ſee that the Computations are made upon Altitudes of the Star taken in different Vertical Circles, which are called by the Arabick name, *Azimuths*; in which obſervations moveable inſtruments are made uſe of, not only in the Vertical Circles, but in the Horizon alſo, at the ſame time; inſomuch that it is requiſite in the ſame moment that the altitude is taken, to have obſerved, in the Horizon, the diſtance of the Vir-

tical

tical point in which the Star is, from the Meridian; Moreover, after a conſiderable interval of time, the operation muſt be repeated, and exact account kept of the time that paſſed, truſting either to Dials, or to other obſervations of the Stars. Such an *Olio* of Obſervations doth he ſet before you, comparing them with ſuch another made by another obſerver in another place with another different inſtrument, and at another time; and from this the Authour ſeeks to collect what would have been, the Elevations of the Star, and Horizontal Latitudes happened in the time and hour of the other firſt obſervations, and upon ſuch a coæquation he in the end grounds his account. Now I refer it to you, what credit is to be given to that which is deduced from ſuch like workings. Moreover, I doubt not in the leaſt, but that if any one would torture himſelf with ſuch tedious computations, he would find, as in thoſe aforegoing, that there were more that would favour the adverſe party, than the Authour: But I think it not worth the while to take ſo much pains in a thing, which is not, amongſt thoſe primary ones, by us underſtood.

SAGR. I am of your Opinion in this particular: But this buſineſſe being environed with ſo many intricacies, uncertainties, and errours, upon what confidence have ſo many Aſtronomers poſitively pronounced the new Star to have been ſo high?

SALV. Upon two ſorts of obſervations moſt plain, moſt eaſie, and moſt certain; one only of which is more than ſufficient to aſſure us, that it was ſcituate in the Firmament, or at leaſt by a great diſtance ſuperiour to the Moon. One of which is taken from the equality, or little differing inequality of its diſtances from the Pole, aſwell whilſt it was in the loweſt part of the Meridian, as when it was in the uppermoſt: The other is its having perpetually kept the ſame diſtances from certain of the fixed Stars adjacent to it, and particularly from the eleventh of *Caſſiopea*, no more remote from it than one degree and an half; from which two particulars is undoubtedly inferred, either the abſolute want of Parallax, or ſuch a ſmalneſſe thereof, that it doth aſſure us with very expeditious Calculations of its great diſtance from the Earth.

SAGR. But theſe things, were they not known to this Authour? and if he ſaw them, what doth he ſay unto them?

SALV. We are wont to ſay, of one that having no reply that is able to cover his fault, produceth frivolous excuſes, *cerca di attaccarſi alle funi del cielo*; [He ſtrives to take hold of the Cords of Heaven;] but this Authour runs, not to the Cords, but to the Spiders Web of Heaven; as you ſhall plainly ſee in our examination of theſe two particulars even now hinted. And firſt, that which ſheweth us the Polar diſtances of the Obſervators one by one, I have noted down in theſe brief Calculations. For a full underſtand-

ſtanding of which, I ought firſt to advertiſe you, that when ever the new Star, or other Phænomenon is near to the earth, turning with a Diurnal motion about the Pole, it will ſeem to be farther off from the ſaid Pole, whilſt it is in the lower part of the Meridian, then whilſt it is above, as in this Figure [*being fig. third of this Dial.*] may be ſeen. In which the point T. denotes the centre of the Earth; O. the place of the Obſervator; the Arch VPC the Firmament; P. the Pole. The *Phænomenon*, [*or appearance*] moving along the Circle F S. is ſeen one while under the Pole by the Ray O F C. and another while above, according to the Ray O S D. ſo that the places ſeen in the Firmament are D. and C. but the true places in reſpect of the Centre T, are B, and A, equidiſtant from the Pole. Where it is manifeſt that the apparent place of the *Phænomenon* S, that is the point D, is nearer to the Pole than the other apparent place C, ſeen along the Line or Ray O F C, which is the firſt thing to be noted. In the ſecond place you muſt note that the exces of the apparent inferiour diſtance from the Pole, over and above the apparent ſuperiour diſtance from the ſaid Pole, is greater than the Inferiour Parallax of the *Phænomenon*, that is, I ſay, that the exceſſe of the Arch C P, (the apparent inferior diſtance) over and above the Arch P D, (the apparent ſuperior diſtance) is greater then the Arch C A, (that is the inferiour Paralax.) Which is eaſily proved; for the Arch C P. more exceedeth P D, then P B; P B, being bigger than P D, but P B. is equal to P A, and the exceſſe of C P, above P A, is the arch, C A, therefore the exceſſe of the arch C P above the arch P D, is greater than the arch C A, which is the parallax of the Phænomenon placed in F, which was to be demonſtrated. And to give all advantages to the Author, let us ſuppoſe that the parallax of the ſtar in F, is the whole exceſſe of the arch C P (that is of the inferiour diſtance from the pole) above the arch P D (the inferiour diſtance.) I proceed in the next place to examine that which the obſervations of all Aſtronomers cited by the Authour giveth us, amongſt which, there is not one that maketh not againſt himſelf and his purpoſe. And let us begin with theſe of *Buſchius*, who findeth the ſtars diſtance from the pole, when it was ſuperiour, to be 28 *gr.* 10 *m.* and the inferiour to be 28 *gr.* 30 *m.* ſo that the exceſſe is 0 *gr.* 20 *m.* which let us take (in favour of the Author) as if it all were the parallax of the ſtar in F, that is the angle T F O. Then the diſtance from the *Vertex* [or Zenith] that is the arch C V, is 67 *gr.* 20 *m.* Theſe two things being found; prolong the line C O, and from it let fall the perpendicular T I., and let us conſider the triangle T O I, of which the angle I is right angle, and the angle I O T known, as being vertical to the angle V O C, the diſtance of the ſtar from the *Vertex*, Moreover in the triangle T I F,

TIF, which is alſo rectangular, there is known the angle F, taken by the paralla x. Then note in ſome place apart the two angles IOT and IFT, and of them take the ſines, which are here ſet down to them, as you ſeen. And becauſe in the triangle IOT, the ſine TI is 92276. of thoſe parts, whereof the whole ſine TO is 100000; and moreover in the triangle IFT, the ſine TI is 582. of thoſe parts, whereof the whole ſine TF is 100000, to find how many TF is of thoſe parts, whereof TO is 100000; we will ſay by the Rule of three: If TI be 582. TF is an 100000. but if TI were 92276. how much would TF be. Let us multiply 92276. by 100000. and the product will be 9227600000. and this muſt be divided by 582. and the quotient will be 15854982. and ſo many ſhall there be in T.F of thoſe parts, of which there are in TO an 100000. So that if it were required to know how many lines TO, are in TF, we would divide 15854982 by 100000. and there will come forth 158. and very near an half; and ſo many diameters ſhall be the diſtance of the ſtar F, from the centre T, and to abreviate the operation, we ſeeing, that the product of the multiplication of 92276. by 100000, ought to be divided firſt by 582, and then the quotient of that diviſion by 100000. we may without multiplying 92276. by 100000. and with one onely diviſion of the ſine 92276. by the ſine 582. ſoon obtain the ſame ſolution, as may be ſeen there below; where 92276. divided by 582. giveth us the ſaid $158\frac{1}{2}$, or thereabouts. Let us bear in mind therefore, that the onely diviſion of the ſine TI, as the ſine of the angle TOI by the ſine TI, as the ſine of the angle IFT, giveth us the diſtance ſought TF, in ſo many diameters TO.

		gr.	m.		
Angles	IOT	67	20	Sines	92276
	IFT	0	20		582

TI	TF	TI	TF
582	10000	92276	0

15854982
582 | 9227600000
3407002746
49297867
325414

100000 | 158 | 54982

158
582 | 92276
34070
492
3

See

See next that which the obſervations of *Peucerus* giveth us, in which the inferiour diſtance from the Pole is 28 *gr.* 21 *m.* and the ſuperiour 28 *gr.* 2 *m.* the difference 0 *gr.* 19 *m.* and the diſtance from the vertical point 66 *gr.* 27 *m.* from which particulars is gathered the ſtars diſtance from the centre almoſt 166 ſemediameters.

		gr.	*m.*		
Angles	I A C	66	27	Sines	91672
	I E C	0	19		553

$$165\tfrac{417}{553}$$

553 | 91672
36397
312
4

Here take what *Tycho* his obſervation holdeth forth to us, interpreted with greateſt favour to the adverſary; to wit, the inferiour diſtance from the pole is 28 *gr.* 13 *m.* and the ſuperiour 28 *gr.* 2 *m.* omitting the difference which is 0 *gr.* 11 *m.* as if all were one Parallax; the diſtance from the vertical point 62 *gr.* 15 *m.* Behold here below the operation, and the diſtance of the ſtar from the centre found to be $976\frac{2}{11}$ ſemidiameters.

		gr.	*m.*		
Angles	I A C	62	15	Sines	88500
	I E C	0	11		320

$$276\tfrac{2}{11}$$

320 | 88500
2418
1

The obſervation of *Reinholdus*, which is the next enſuing, giveth us the diſtance of the Star from the Centre 793. Semidiameters.

		gr.	*m.*		
Angles	I A C	66	58	Sines	92026
	I E C	0	4		116

$$793\tfrac{31}{116}$$

116 | 92026
10888
33

From

From the following obſervation of the *Landgrave*, the diſtance of the Star from the Centre is made to be 1057, Semidiameters.

		gr.	*m.*		
Angles	I A C	66	57	Sines	92012
	I E C	0	3		87

$1057\frac{11}{17}$

87 | 92012

5663

5

Two of the moſt favourable obſervations for the Authour being taken from *Camerarius*, the diſtance of the Star from the Centre is found to be 3143 Semidiameters.

		gr.	*m.*		
Angles	I A C	65	43	Sines	91152
	I E C	0	1		29

3143

29 | 91152

4295

The Obſervation of *Munoſius* giveth no *Parallax*, and therefore rendreth the new Star amongſt the higheſt of the fixed. That of *Hainzelius* makes it infinitely remote, but with the correction of an half *min. prim.* placeth it amongſt the fixed Stars. And the ſame is collected from *Urſinus*, with the correction of 12. *min. prim.* The other Aſtronomers have not given us the diſtance above and below the Pole, ſo that nothing can be concluded from them. By this time you ſee, that all the obſervations of all theſe men conſpire againſt the Author, in placing the Star in the Heavenly and higheſt Regions.

SAGR. But what defence hath he for himſelf againſt ſo manifeſt contradictions?

SALV. He betakes himſelf to one of thoſe weak threads which I ſpeak of, ſaying that the *Parallaxes* come to be leſſened by means of the refractions, which opperating contrarily ſublimate the *Phænomenon*, whereas the *Parallaxes* abaſe it. Now of what little ſtead this lamentable refuge is, judge by this, that in caſe that effect of the refractions were of ſuch an efficacy, as that which not long time ſince ſome Aſtronomers have introduced, the moſt that they could work touching the elevating a *Phænomenon* above the Horizon

more than truth, when it is before hand 23. or 24. Degrees high, would be the leſſening its *Parallax* about 3. minutes, the which abatement is too ſmall to pull down the Star below the Moon, and in ſome caſes is leſſe than the advantage given him by us in admitting that the exceſſe of the inferiour diſtance from the Pole above the Superiour, is all *Parallax*, the which advantage is far more clear and palpable than the effect of Refraction, of the greatneſſe of which I ſtand in doubt, and not without reaſon. But beſides, I demand of the Author, whether he thinks that thoſe Aſtronomers, of whoſe obſervations he maketh uſe, had knowledge of theſe effects of Refractions, and conſidered the ſame, or no; if they did know and conſider them, it is reaſonable to think that the, kept account of them in aſſigning the true Elevation of the Star, making in thoſe degrees of Altitude diſcovered with the Inſtruments, ſuch abatements as were convenient on the account of the alterations made by the Refractions; inſomuch that the diſtances by them delivered, were in the end thoſe corrected and exact, and not the apparent and falſe ones. But if he think that thoſe Authors made no reflection upon the ſaid Refractions, it muſt be confeſſed, that they had in like manner erred in determining all thoſe things which cannot be perfectly adjuſted without allowance for the Refractions; amongſt which things one is the preciſe inveſtigation of the Polar Altitudes, which are commonly taken from the two Meridian Altitudes of ſome of the fixed Stars that are conſtantly viſible, which Altitudes will come to be altered by Refraction in the ſame manner, juſt as thoſe of the new Star; ſo that the Polar Altitude that is deduced from them, will prove to be defective, and to partake of the ſelf ſame want which this Author aſſigns to the Altitudes aſcribed to the new Star, to wit, both that and theſe will be with equal falſhood placed higher than really they are. But any ſuch errour, as far as concerns our preſent buſineſſe, doth no prejudce at all: For we not needing to know any more, but onely the difference between the two diſtances of the new Star from the Pole at ſuch time as it was inferiour and ſuperiour, it is evident that ſuch diſtances would be the ſame, taking the alteration of Refraction commonly for the Star and for the Pole, or for them when commonly amended. The Authors Argument would indeed have had ſome ſtrength, though very ſmall, if he had aſſured us that the Altitude of the Pole had been once preciſely aſſigned, and corrected from the errour depending on refraction, from which again the Aſtronomers had not kept themſelves in aſſigning the altitudes of the new Star; but he hath not aſcertained us of that, nor perhaps could he have done, nor haply, (and this is more probable) was that caution wanting in the Obſervators.

SAGR. This argument is in my judgment ſufficiently anſwered;

ed; therefore tell me how he diſ-ingageth himſelf in the next place from that particular of the Stars having conſtantly kept the ſame diſtance from the fixed Stars circumjacent to it.

SALV. He betakes himſelf, in like manner, to two threads, yet more unable to uphold him than the former: one of which is likewiſe faſtened to refraction, but ſo much leſs firmly, in that he ſaith, that refraction operating upon the new Star, and ſublimating it higher than its true ſituation, maketh the ſeeming diſtances untain to be diſtinguiſhed from the true, when compared to the circumpoſed fixed Stars that environ it. Nor can I ſufficiently admire how he can diſſemble his knowing how that the ſame refraction will work alike upon the new Star, as upon the antient one its neighbour, elevating both equally, ſo as that ſuch a like accident altereth not the ſpace betwixt them. His other ſubterfuge is yet more unhappy, and carryeth with it much of ridiculous, it being founded upon the errour that may ariſe in the inſtrumen taloperation it ſelf; whilſt that the Obſervator not being able to conſtitute the centre of the eyes pupil in the centre of the Sextant (an Inſtrument imployed in obſerving the diſtance between two Stars) but holding it elevated above that centre, as much as the ſaid pupil is diſtant from I know not what bone of the cheek, againſt which the end of the Inſtrument reſteth, there is formed in the eye an angle more acute than that which is made by the ſides of the Inſtrument; which angle of rayes differeth alſo from it ſelf, at ſuch time as a man looketh upon Stars, not much elevated above the Horizon, and the ſame being afterwards placed at a great height; that angle, ſaith he, is made different, while the Inſtrument goeth aſcending, the head ſtanding ſtill: but if in mounting the Inſtrument, the neck ſhould bend backwards, and the head go riſing, together with the Inſtrument, the angle would then continue the ſame. So that the Authours anſwer ſuppoſeth that the Obſervators in uſing the Inſtrument have not raiſed the head, as they ought to have done; a thing which hath nothing of likelihood in it. But granting that ſo it had been, I leave you to judge what difference can be between two acute angles of two equicrural triangles, the ſides of one of which triangles are each four [*Italian*] *Braces* [*i.e.* about three Engliſh yards] and thoſe of the other, four braces within the quantity of the diameter of a Pea; for the differences cannot be abſolutely greater between the length of the two viſive rayes, whilſt the line is drawn perpendicularly from the centre of the pupil, upon the plain of the Rule of the Sextant (which line is no bigger than the breath of the thumb) and the length of the ſame rayes, whilſt elevating the Sextant, without raiſing the head together with it, that ſame line no longer falleth perpendicularly upon the ſaid plane, but inclineth, making

the angle towards the circumference ſomething acute. But wholly to free this Authour from theſe unhappy lies, let him know, (in regard it appears that he is not very skilful in the uſe of Aſtronomicall Inſtruments) that in the ſides of the Sextant or Quadrant there are placed two * Sights, one in the centre, and the other at the other at the oppoſite end, which are raiſed an inch or more above the plane of the Rule; and through the tops of thoſe ſights the ray of the eye is made to paſſe, which eye likewiſe is held an hands breadth or two, or it may be more, from the Inſtrument; ſo that neither the pupil, nor any bone of the cheek, nor of the whole body toucheth or ſtayeth it ſelf upon the Inſtrument, nor much leſſe is the Inſtrument upheld or mounted in the armes, eſpecially if it be one of thoſe great ones, as is uſual, which weighing tens, hundreds, and alſo thouſands of pounds, are placed upon very ſtrong feet or frames: ſo that the whole objection vaniſheth. Theſe are the ſubterfuges of this Authour, which, though they were all of ſteel, would not ſecure him the hundredth part of a minute; and with theſe he conceits to make us believe, that he hath compenſated that difference, which importeth more than an hundred minutes; I mean, that of the not obſerving a notable difference in the diſtances between one of the fixed ſtars, and the new ſtar in in any of their circulations; which, had it been neer to the Moon, it ought to have been very conſpicuous to the meer ſight, without any Inſtrument, eſpecially comparing it with the eleventh of *Caſſiopeia*, its neighbour, within 1 *gr.* 30 *m.* which ought to have varied from it more than two diameters of the moon, as the more intelligent Aſtronomers of thoſe times do well note.

* Tragnardi.

SAGR. Methinks I ſee that unfortunate Husbandman, who after all his expected crops, have been beaten down and deſtroyed by a ſtorm, goeth up and down with a languiſhing and down-caſt look, gleaning up every ſmall ear that would not ſuffice to keep a chicken alive one ſole day.

SALV. Truly, this Authour came out too ſlenderly provided with armes againſt the aſſailants of the Heavens inalterability, and with too brittle a chain attempted to pull down the new ſtar of *Caſſiopeia* from the higheſt Regions, to theſe ſo low and elementary. And for that I think that we have ſufficiently demonſtrated the vaſt difference that is between the arguments of thoſe Aſtronomers, and of this their Antagoniſt, it will be convenient that we leave this particular, and return to our principal matter; in which there preſents it ſelf to our conſideration the annual motion commonly aſcribed to the Sun, but by *Ariſtarchus Samius* firſt of all, and after by *Copernicus* taken from the Sun, and transferred upon the Earth; againſt which Hypotheſis, methinks I ſee *Simplicius* to come ſtrongly provided, and particularly with the ſword and buckler

buckler of the little Treatiſe of *Concluſions*, or Diſquiſitions Mathematical, the oppugnations of which it would be good to begin to produce.

SIMP. I will, if you ſo pleaſe, reſerve them to the laſt, as thoſe that are of lateſt invention.

SALV. It will therefore be neceſſary, that in conformity to the method hitherto obſerved, you do orderly, one by one, propound the arguments, on the contrary, aſwell of *Ariſtotle*, as of the other ancients, which ſhall be my task alſo, that ſo nothing may eſcape our ſtrict conſideration and examination; and likewiſe *Sagredus*, with the vivacity of his wit, ſhall interpoſe his thoughts, as he ſhall finde himſelf inclined.

SAGR. I will do it with my wonted freedome; and your commands ſhall oblige you to excuſe me in ſo doing.

SALV. The favour will challenge thanks, and not an excuſe. But now let *Simplicius* begin to propoſe thoſe doubts which diſſwade him from believing that the Earth, in like manner, as the other planets, may move round about a fixed centre.

SIMP. The firſt and greateſt difficulty is the repugnance and incompatibility that is between being in the centre, and being far from it; for if the Terreſtrial Globe were to move in a year by the circumference of a circle, that is, under the Zodiack, it is impoſſible that it ſhould, at the ſame time, be in the centre of the Zodiack; but that the Earth is in the ſaid centre *Ariſtotle*, *Ptolomy*, and others have many wayes proved.

SALV. You very well argue, and there is no queſtion but that one that would make the Earth to move in the circumference of a circle, muſt firſt of neceſſity prove, that it is not in the centre of that ſame circle; it now followeth, that we enquire, whether the Earth be, or be not in that centre, about which, I ſay, that it turneth, and you ſay that it is fixed; and before we ſpeak of this, it is likewiſe neceſſary that we declare our ſelves, whether you and I have both the ſame conceit of this centre, or no. Therefore tell me, what and where is this your intended centre?

SIMP. When I ſpeak of the centre, I mean that of the Univerſe, that of the World, that of the Starry Sphere.

SALV. Although I might very rationally put it in diſpute, whether there be any ſuch centre in nature, or no; being that neither you nor any one elſe hath ever proved, whether the World be finite and figurate, or elſe infinite and interminate; yet nevertheleſs granting you, for the preſent, that it is finite, and of a terminate Spherical Figure, and that thereupon it hath its centre; it will be requiſite to ſee how credible it is that the Earth, and not rather ſome other body, doth poſſeſſe the ſaid centre.

It hath not been hitherto proved by any, whether the World be finite or infinite.

SIMP. That the world is finite, terminate, and ſpherical, *Ariſtotle*

ſtotle proveth with an hundred demonſtrations.

The Demonſtrations of Ariſtotle *to prove that the Univerſe is finite, are all nullified by denying it to be moveable.*

SALV. All which in the end are reduced to one alone, and that one to none at all; for if I deny his aſſumption, to wit, that the Univerſe is moveable, all his demonſtrations come to nothing, for he onely proveth the Univerſe to be finite and terminate, for that it is moveable. But that we may not multiply diſputes, let it be granted for once, that the World is finite, ſpherical, and hath its centre. And ſeeing that that centre and figure is argued from its mobility, it will, without doubt, be very reaſonable, if from the circular motions of mundane bodies we proceed to the particular inveſtigation of that centres proper place: Nay *Ariſtotle* himſelf hath argued and determined in the ſame manner, making that ſame to be the centre of the Univerſe about which all the Cœleſtial Spheres revolve, and in which he beleived the Terreſtrial Globe to have been placed. Now tell me *Simplicius*, if *Ariſtotle* ſhould be conſtrained by evident experience to alter in part this his diſpoſure and order of the Univerſe, and confeſſe himſelf to have been deceived in one of theſe two propoſitions, namely, either in placing the Earth in the centre, or in ſaying, that the Cœleſtial Spheres do move about that centre, which of the two confeſſions think you would he chooſe?

Ariſtotle *makes that point to be the centre of the Univerſe about which all the Celeſtial Spheres do revolve.*

A queſtion is put, in caſe that if Ariſtotle *were forced to receive one of two propoſitions that make againſt his doctrine, which he would admit.*

SIMP. I believe, that if it ſhould ſo fall out, the *Peripateticks*.

SALV. I do not ask the *Peripateticks*, I demand of *Ariſtotle*, for as to thoſe, I know very well what they would reply; they, as obſervant and humble vaſſals of *Ariſtotle*, would deny all the experiments and all the obſervations in the World, nay, would alſo refuſe to ſee them, that they might not be forced to acknowledg them, and would ſay that the World ſtands as *Ariſtotle* writeth, and not as nature will have it, for depriving them of the ſhield of his Authority, with what do you think they would appear in the field? Tell me therefore what you are perſwaded *Ariſtotle* himſelf would do in the caſe.

SIMP. To tell you the truth, I know not how to reſolve which of the two inconveniences is to be eſteemed the leſſer.

SALV. Apply not I pray you this term of inconvenience to a thing which poſſibly may of neceſſity be ſo. It was an inconvenience to place the Earth in the centre of the Cœleſtial revolutions; but ſeeing you know not to which part he would incline, I eſteeming him to be a man of great judgment, let us examine which of the two choices is the more rational, and that we will hold that *Ariſtotle* would have received. Reaſſuming therefore our diſcourſe from the beginning, we ſuppoſe with the good liking of *Ariſtotle*, that the World (of the magnitude of which we have no ſenſible notice beyond the fixed ſtars) as being of a ſpherical figure;

figure; and moveth circularly, hath neceſſarily, and in reſpect of its figure a centre; and we being moreover certain, that within the ſtarry Sphere there are many Orbs, the one within another, with their ſtars, which likewiſe do move circulary, it is in diſpute whether it is moſt reaſonable to believe and to ſay that theſe conteined Orbs do move round the ſaid centre of the World, or elſe about ſome other centre far remote from that? Tell me now *Simplicius* what you think concerning this particular.

SIMP. If we could ſtay upon this onely ſuppoſition, and that we were ſure that we might encounter nothing elſe that might diſturb us, I would ſay that it were much more reaſonable to affirm that the Orb containing., and the parts contained, do all move about one common centre, than about divers.

Its more rationall that the Orb containing, and the parts contained, do move all about one centre, than upon divers.

SALV. Now if it were true that the centre of the World is the ſame about which the Orbs of mundane bodies, that is to ſay, of the Planets, move, it is moſt certain that it is not the Earth, but the Sun rather that is fixed in the centre of the World. So that as to this firſt ſimple and general apprehenſion, the middle place belongeth to the Sun, and the Earth is as far remote from the centre, as it is from that ſame Sun.

If the centre of the World be the ſame with that about which the planets move, the Sun and not the Earth is placed in it.

SIMP. But from whence do you argue that not the Earth, but the Sun is in the centre of the Planetary revolutions?

SALV. I infer the ſame from moſt evident, and therefore neceſſarily concludent obſervations, of which the moſt palpable to exclude the Earth from the ſaid centre, and to place the Sun therein, are, the ſeeing all the Planets one while neerer and another while farther off from the Earth with ſo great differences, that for example, *Venus* when it is at the fartheſt, is ſix times more remote from us, than when it is neereſt, and *Mars* riſeth almoſt eight times as high at one time as at another. See therefore whether *Ariſtotle* was not ſomewhat miſtaken in thinking that it was at all times equidiſtant from us.

Obſervations from whence it is collected that the Sun and not the Earth is in the centre of the Celeſtial revolutions.

SIMP. What in the next place are the tokens. that their motions are about the Sun?

SALV. It is argued in the three ſuperiour planets *Mars*, *Jupiter*, and *Saturn*, in that we find them alwayes neereſt to the Earth when they are in oppoſition to the Sun, and fartheſt off when they are towards the conjunction, and this approximation and receſſion importeth thus much that *Mars* neer at hand, appeareth very neer 60 times greater than when it is remote. As to *Venus* in the next place, and to *Mercury*, we are certain that they revolve about the Sun, in that they never move far from him, and in that we ſee them one while above and another while below it, as the mutations of figure in *Venus* neceſſarily argueth. Touching the Moon it is certain, that ſhe cannot in any way ſe-

The mutation of figure in Venus argueth its motion to be about the Sun.

The Moon cannot ſeperate from the Earth.

ſeperate from the Earth, for the reaſons that ſhall be more diſtinctly alledged hereafter.

SAGR. I expect that I ſhall hear more admirable things that depend upon this annual motion of the Earth, than were thoſe dependant upon the diurnal revolution.

The annual motion of the Earth mixing with the motions of the other Planets produce extravagant appearances.

SALV. You do not therein erre: For as to the operation of the diurnal motion upon the Celeſtial bodies, it neither was, nor can be other, than to make the Univerſe ſeem to run precipitately the contrary way; but this annual motion intermixing with the particular motions of all the planets, produceth very many extravagancies, which have diſarmed and non-pluſt all the greateſt Scholars in the World. But returning to our firſt general apprehenſions, I reply that the centre of the Celeſtial converſions of the five planets *Saturn*, *Jupiter*, *Mars*, *Venus* and *Mercury*, is the Sun; and ſhall be likewiſe the centre of the motion of the Earth, if we do but ſucceed in our attempt of placing it in Heaven. And as for the Moon, this hath a circular motion about the Earth, from which (as I ſaid before) it can by no means alienate it ſelf, but yet doth it not ceaſe to go about the Sun together with the Earth in an annual motion.

SIMP. I do not as yet very well apprehend this ſtructure, but it may be, that with making a few draughts thereof, one may better and more eaſily diſcourſe concerning the ſame.

SALV. Tis very true: yea for your greater ſatisfaction and admiration together, I deſire you, that you would take the pains to draw the ſame; and to ſee that although you think you do not apprehend it, yet you very perfectly underſtand it; And onely by anſwering to my interrogations you ſhall deſigne it punctually.

The Syſteme of the Univerſe deſigned from the appearances.

Take therefore a ſheet of paper and Compaſſes; And let this white paper be the immenſe expanſion of the Univerſe; in which you are to diſtribute and diſpoſe its parts in order, according as reaſon ſhall direct you. And firſt, in regard that without my inſtruction you verily believe that the Earth is placed in this Univerſe, therefore note a point at pleaſure, about which you intend it to to be placed, and mark it with ſome characters.

SIMP. Let this mark A be the place of the Terreſtrial Globe.

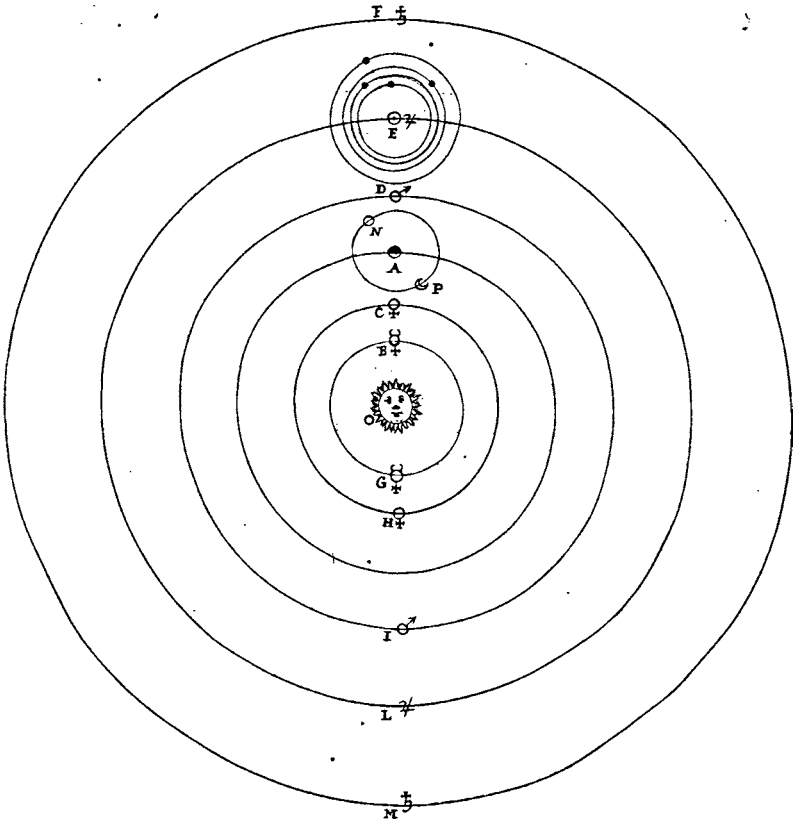
SALV. Very well. I know ſecondly, that you underſtand perfectly that the ſaid Earth is not within the body of the Sun, nor ſo much as contiguous to it, but diſtant for ſome ſpace from the ſame, and therefore aſſign to the Sun what other place you beſt like, as remote from the Earth as you pleaſe, and mark this in like manner.

SIMP. Here it is done: Let the place of the Solar body be O.

SALV. Theſe two being conſtituted, I deſire that we may think

think of accomodating the body of *Venus* in ſuch a manner that its ſtate and motion may agree with what ſenſible experiments do ſhew us; and therefore recall to mind that which either by the paſt diſcourſes, or your own obſervations you have learnt to befal that ſtar, and afterwards aſſign unto it that ſtate which you think agreeth with the ſame.

SIMP. Suppoſing thoſe *Phænomena* expreſſed by you, and which I have likewiſe read in the little treatiſe of Concluſions, to



be true, namely, that that ſtar never recedes from the Sun beyond ſuch a determinate ſpace of 40 degrees or thereabouts, ſo as that it never cometh either to appoſition with the Sun, or ſo much as to quadrature, or yet to the ſextile aſpect; and more than that, ſuppoſing that it ſheweth at one time almoſt 40 times greater than at another; namely, very great, when being retrograde, it goeth to the veſpertine conjunction of the Sun, and very ſmall when with a motion

Venus *very great towards the reſpective conjunction and very ſmall towards the matutine.*

motion ſtraight forwards, it goeth to the matutine conjunction; and moreover it being true, that when it appeareth bigge it ſhews with a corniculate figure, and when it appeareth little, it ſeems perfectly round, theſe appearances, I ſay, being true, I do not ſee how one can chooſe but affirm the ſaid ſtar to revolve in a circle about the Sun, for that the ſaid circle cannot in any wiſe be ſaid to encompaſſe or to contain the Earth within it, nor to be inferiour to the Sun, that is between it and the Earth, nor yet ſuperiour to the Sun. That circle cannot incompaſſe the Earth, becauſe *Venus* would then ſometimes come to oppoſition with the Sun; it cannot be inferiour, for then *Venus* in both its conjunctions with the Sun would ſeem horned; nor can it be ſuperiour, for then it would alwayes appear round, and never cornicular; and therefore for receit of it I will draw the circle C H, about the Sun, without encompaſſing the Earth.

Venus neceſſarily proved to move about the Sun.

SALV. Having placed *Venus*, it is requiſite that you think of *Mercury*, which, as you know, alwayes keeping about the Sun, doth recede leſſe diſtance from it than *Venus*; therefore conſider with your ſelf, what place is moſt convenient to aſſign it.

SIMP. It is not to be queſtioned, but that this Planet imitating *Venus*, the moſt commodious place for it will be, a leſſer circle within this of *Venus*, in like manner about the Sun, being that of its greateſt vicinity to the Sun, an argument, an evidence ſufficiently proving the vigour of its illumination, above that of *Venus*, and of the other Planets, we may therefore upon theſe conſiderations draw its Circle, marking it with the Characters B G.

The revolution of Mercury *concluded to be about the Sun, within the Orb of* Venus.

SALV. But *Mars*, Where ſhall we place it?

Mars neceſſarily includeth within its Orb the Earth, and alſo the Sun.

SIMP. *Mars*, Becauſe it comes to an oppoſition with the Sun, its Circle muſt of neceſſity encompaſs the Earth; But I ſee that it muſt neceſſarily encompaſs the Sun alſo, for coming to conjunction with the Sun, if it did not move over it, but were below it, it would appear horned, as *Venus* and the Moon; but it ſhews alwayes round, and therefore it is neceſſary, that it no leſs includeth the Sun within its circle than the Earth. And becauſe I remember that you did ſay, that when it is in oppoſition with the Sun, it ſeems 60 times bigger than when it is in the conjunction, me thinks that a Circle about the Centre of the Sun, and that taketh in the earth, will very well agree with theſe *Phænomena*, which I do note and mark D I, where *Mars* in the point D, is near to the earth, and oppoſite to the Sun; but when it is in the point I, it is at Conjuction with the Sun, but very far from the Earth. And becauſe the ſame appearances are obſerved in *Jupiter* and *Saturn*, although with much leſſer difference in *Jupiter* than in *Mars*, and with yet leſſe in *Saturn* than in *Jupiter*; me thinks I

Mars at its oppoſition to the Sun ſhews to be ſixty times bigger than towards the conjunction.

Jupiter and Saturn do likewiſe encompaſſe the Earth, and the Sun.

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underſtand that we ſhould very commodiouſly ſalve all the *Phænomena* of theſe two Planets, with two Circles, in like manner, drawn about the Sun, and this firſt for *Jupiter*, marking it E L, and another above that for *Saturn* marked F M.

The approximation and receſſion of the three ſuperiour Planets, importeth double the Suns diſtance.

SALV. You have behaved your ſelf bravely hitherto. And becauſe (as you ſee) the approach and receſſion of the three Superiour Planets is meaſured with double the diſtance between the Earth and Sun, this maketh greater difference in *Mars* than in *Jupiter*, the Circle D I, of *Mars*, being leſſer than the Circle E L, of *Jupiter*, and likewiſe becauſe this E L, is leſſe than this Circle F M, of *Saturn*, the ſaid difference is alſo yet leſſer in *Saturn* than in *Jupiter*, and that punctually anſwereth the *Phænomena*. It remains now that you aſſign a place to the Moon.

The difference of the apparent magnitude leſſe in Saturn, than in Jupiter, and in Jupiter than in Mars, and why.

SIMP. Following the ſame Method (which ſeems to me very concluſive) in regard we ſee that the Moon cometh to conjunction and oppoſition with the Sun, it is neceſſary to ſay, that its circle encompaſſeth the Earth, but yet doth it not follow, that it muſt environ the Sun, for then at that time towards its conjunction, it would not ſeem horned, but alwayes round and full of Light. Moreover it could never make, as it often doth, the Eclipſe of the Sun, by interpoſing betwixt it and us; It is neceſſary therefore to aſſign it a circle about the Earth, which ſhould be this N P, ſo that being conſtituted in P, it will appear from the Earth A, to be in conjunction with the Sun, and placed in N, it appeareth oppoſite to the Sun, and in that poſition it may fall under the Earths ſhadow, and be obſcured.

The Moons Orb invironeth the Earth, but not the Sun.

SALV. Now, *Simplicius*, what ſhall we do with the fixed ſtars? Shall we ſuppoſe them ſcattered through the immenſe abiſſes of the Univerſe, at different diſtances, from any one determinate point; or elſe placed in a ſuperficies ſpherically diſtended about a centre of its own, ſo that each of them may be equidiſtant from the ſaid centre?

The probable ſituation of the fixed ſtars.

SIMP. I would rather take a middle way; and would aſſign them an Orb deſcribed about a determinate centre and comprized within two ſpherical ſuperficies, to wit, one very high, and concave, and the other lower, and convex, betwixt which I would conſtitute the innumerable multitude of ſtars, but yet at divers altitudes, and this might be called the Sphere of the Univerſe, containing within it the Orbs of the planets already by us deſcribed.

Which ought to be accounted the ſphere of the Univerſe.

SALV. But now we have all this while, *Simplicius*, diſpoſed the mundane bodies exactly, according to the order of *Copernicus*, and we have done it with your hand; and moreover to each of them you have aſſigned peculiar motions of their own, except to the Sun, the Earth, and ſtarry Sphere; and to *Mercury* with *Venus*, you have aſcribed the circular motion about the Sun,

without encompaſſing the Earth; about the ſame Sun you make the three ſuperiour Planets *Mars*, *Jupiter*, and *Saturn*, to move, comprehending the Earth within their circles. The Moon in the next place can move in no other manner than about the Earth, without taking in the Sun, and in all theſe motions you agree alſo with the ſame *Copernicus*. There remains now three things to be decided between the Sun, the Earth, and fixed ſtars, namely, Reſt, which ſeemeth to belong to the Earth; the annual motion under the Zodiack, which appeareth to pertain to the Sun; and the diurnal motion, which ſeems to belong to the Starry Sphere, and to be by that imparted to all the reſt of the Univerſe, the Earth excepted. And it being true that all the Orbs of the Planets, I mean of *Mercury*, *Venus*, *Mars*, *Jupiter*, and *Saturn*, do move about the Sun as their centre; reſt ſeemeth with ſo much more reaſon to belong to the ſaid Sun, than to the Earth, in as much as in a moveable Sphere, it is more reaſonable that the centre ſtand ſtill, than any other place remote from the ſaid centre; to the Earth therefore, which is conſtituted in the midſt of moveable parts of the Univerſe, I mean between *Venus* and *Mars*, one of which maketh its revolution in nine moneths, and the other in two years, may the motion of a year very commodiouſly be aſſigned, leaving reſt to the Sun. And if that be ſo, it followeth of neceſſary conſequence, that likewiſe the diurnal motion belongeth to the Earth; for, if the Sun ſtanding ſtill, the Earth ſhould not revolve about its ſelf, but have onely the annual motion about the Sun, our year would be no other than one day and one night, that is ſix moneths of day, and ſix moneths of night, as hath already been ſaid. You may conſider withal how commodiouſly the precipitate motion of 24 hours is taken away from the Univerſe, and the fixed ſtars that are ſo many Suns, are made in conformity to our Sun to enjoy a perpetual reſt. You ſee moreover what facility one meets with in this rough draught to render the reaſon of ſo great appearances in the Celeſtial bodies.

Reſt, the annual motion and the diurnal ought to be diſtributed betwixt the Sun, Earth, and Firmament.

In a moveable ſphere, it ſeemeth more reaſonable that its centre be ſtable, than any other of its parts.

Granting to the Earth the annual, it muſt of neceſſity alſo have the diurnal motion aſſigned to it.

SAGR. I very well perceive that facility, but as you from this ſimplicity collect great probabilities for the truth of that Syſtem, others haply could make thence contrary deductions; doubting, not without reaſon, why that ſame being the ancient Syſteme of *Pythagoreans*, and ſo well accommodated to the *Phænomena*, hath in the ſucceſſion of ſo many thouſand years had ſo few followers, and hath been even by *Ariſtotle* himſelf refuted, and ſince that *Copernicus* himſelf hath had no better fortune.

SALV. If you had at any time been aſſaulted, as I have been, many and many a time, with the relation of ſuch kind of frivolous reaſons, as ſerve to make the vulgar contumacious, and difficult to be perſwaded to hearken, (I will not ſay to conſent) to this novelty,

ty, I believe that you wonder at the paucity of thoſe who are followers of that opinion would be much diminiſhed. But ſmall regard in my judgement, ought to be had of ſuch thick ſculs, as think it a moſt convincing proof to confirm, and ſteadfaſtly ſettle them in the belief of the earths immobility, to ſee that if this day they cannot Dine at *Conſtantinople*, nor Sup in *Jappan*, that then the Earth as being a moſt grave body cannot clamber above the Sun, and then ſlide headlong down again; Of ſuch as theſe I ſay, whoſe number is infinite, we need not make any reckoning, nor need we to record their foolieries, or to ſtrive to gain to our ſide as our partakers in ſubtil and ſublime opinions, men in whoſe definition the kind onely is concerned, and the difference is wanting. Moreover, what ground do you think you could be able to gain, with all the demonſtrations of the World upon brains ſo ſtupid, as are not able of themſelves to know their down right follies? But my admiration, *Sagredus*, is very different from yours, you wonder that ſo few are followers of the *Pythagorean* Opinion; and I am amazed how there could be any yet left till now that do embrace and follow it: Nor can I ſufficiently admire the eminencie of thoſe mens wits that have received and held it to be true, and with the ſprightlineſſe of their judgements offered ſuch violence to their own ſences, as that they have been able to prefer that which their reaſon dictated to them, to that which ſenſible experiments repreſented moſt manifeſtly on the contrary. That the reaſons againſt the Diurnal virtiginous revolution of the Earth by you already examined, do carry great probability with them, we have already ſeen; as alſo that the *Ptolomaicks*, and *Ariſtotelicks*, with all their Sectators did receive them for true, is indeed a very great argument of their efficacie; but thoſe experiments which apertly contradict the annual motion, are of yet ſo much more manifeſtly repugnant, that (I ſay it again) I cannot find any bounds for my admiration, how that reaſon was able in *Ariſtarchus* and *Copernicus*, to commit ſuch a rape upon their Sences, as in deſpight thereof, to make her ſelf miſtreſs of their credulity.

Diſcourſes more than childiſh, ſerve to keep fools in the opinion of the Earths ſtability.

A declaration of the improbability of Copernicus *his opinion.*

Reaſons and diſcourſe in Ariſtarcus *and* Copernicus *prevailed over manifeſt ſence.*

SAGR. Are we then to have ſtill more of theſe ſtrong oppoſitions againſt this annual motion?

SALV. We are, and they be ſo evident and ſenſible, that if a ſence more ſublime and excellent than thoſe common and vulgar, did not take part with reaſon, I much fear, that I alſo ſhould have been much more averſe to the *Copernican* Syſteem than I have been ſince the time that a clearer lamp than ordinary hath enlightned me.

SAGR. Now therefore *Salviatus*, let us come to joyn battail for every word that is ſpent on any thing elſe, I take to be caſt away.

SALV.

SALV. I am ready to serve you. You have already seen me draw the form of the *Copernican* Systeme; against the truth of which *Mars* himself, in the first place, makes an hot charge; who, in case it were true, that its distances from the earth should so much vary, as that from the least distance to the greatest, there were twice as much difference, as from the earth to the Sun; it would be necessary, that when it is neareſt unto us, its *discus* would shew more than 60. times bigger than it seems, when it is farthest from us; nevertheless that diversity of apparent magnitude is not to be seen, nay in its opposition with the Sun, when its neareſt to the Earth, it doth not shew so much as quadruple and quintuple in bigness, to what it is, when towards the conjunction it cometh to be occulted under the Suns rayes. Another and greater difficulty doth *Venus* exhibit; For if revolving about the Sun, as *Copernicus* affirmeth, it were one whileabove, & another while below the same, receding and approaching to us so much as the Diameter of the circle described would be, at such time as it should be below the Sun, and neareſt to us, its *discus* would shew little less than 40 times bigger than when it is above the Sun, near to its other conjunction; yet nevertheleſſe, the difference is almoſt imperceptible Let us add another difficulty, that in case the body of *Venus* be of it self dark, and onely shineth as the Moon, by the illumination of the Sun, which seemeth most reasonable; it would shew forked or horned at such time as it is under the Sun, as the Moon doth when she is in like manner near the Sun; an accident that is not to be discovered in her. Whereupon *Copernicus* affirmeth, that either she is light of her self, or else that her substance is of such a nature, that it can imbue the Solar light, and transmit the same through all its whole depth, so as to be able to appear to us alwayes shining; and in this manner *Copernicus* excuseth the not changing figure in *Venus*: but of her small variation of Magnitude, he maketh no mention at all; and much less of *Mars* than was needful; I believe as being unable so well as he desired to salve a *Phænomenon* so contrary to his Hypotheſis, and yet being convinced by so many other occurrences and reasons he maintained, and held the same Hypotheſis to be true. Besides these things, to make the Planets, together with the Earth, to move above the Sun as the Centre of their conversions, and the Moon onely to break that order, and to have a motion by it self about the earth; and to make both her, the Earth, and the whole Elementary *Sphere*, to move all together about the Sun in a year, this seemeth to pervert the order of this Systeme, which rendreth it unlikely and false. These are those difficulties that make me wonder how *Aristarchus* and *Copernicus*, who must needs have observed them, not having been able for all that to salve them, have yet notwithstanding by other admirable occurrences been induced

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Mars makes an hot assault upon the Copernican *Systeme.*

The Phænomena *of* Venus *appear contrary to the Systeme of* Copernicus.

Another difficulty raised by Venus *against* Copernicus.

Venus, *according to* Copernicus, *either lucid in it self, or else of a transparent substance.*

Copernicus *speaketh nothing of the small variation of bigness in* Venus *and in* Mars.

The moon much disturbeth the order of the other Planets.

to confide ſo much in that which reaſon dictated to them, as that they have confidently affirmed that the ſtructure of the Univerſe could have no other figure than that which they deſigned to themſelves. There are alſo ſeveral other very ſerious and curious doubts, not ſo eaſie to be reſolved by the middle ſort of wits, but yet penetrated and declared by *Copernicus*, which we ſhall defer till by and by, after we have anſwered to other objections that ſeem to make againſt this opinion. Now coming to the declarations and anſwers to thoſe three before named grand Objections, I ſay, that the two firſt not onely contradict not the *Copernican* Syſteme, but greatly and abſolutely favour it; For both *Mars* and *Venus* ſeems unequal to themſelves, according to the proportions aſſigned; and *Venus* under the Sun ſeemeth horned, and goeth changing figures in it ſelf exactly like the Moon.

Anſwers to the three firſt objections againſt the Copernican *Syſteme.*

SAGR. But how came this to be concealed from *Copernicus*, and revealed to you?

SALV. Theſe things cannot be comprehended, ſave onely by the ſenſe of ſeeing, the which by nature was not granted to man ſo perfect, as that it was able to attain to the diſcovery of ſuch differences; nay even the very inſtrument of ſight is an impediment to it ſelf: But ſince that it hath pleaſed God in our age to vouchſafe to humane ingenuity, ſo admirable an invention of perfecting our ſight, by multiplying it four, ſix, ten, twenty, thirty, and fourty times, infinite objects, that either by reaſon of their diſtance, or for their extream ſmallneſſe were inviſible unto us, have by help of the Teleſcope been rendered viſible.

SAGR. But *Venus* and *Mars* are none of the objects inviſible for their diſtance or ſmallneſſe, yea, we do diſcern them with our bare natural ſight; why then do we not diſtinguiſh the differences of their magnitudes and figures?

SALV. In this, the impediment of our very eye it ſelf hath a great ſhare, as but even now I hinted, by which the reſplendent and remote objects are not repreſented to us ſimple and pure; but gives them us fringed with ſtrange and adventitious rayes, ſo long and denſe, that their naked body ſheweth to us agrandized ten, twenty, an hundred, yea a thouſand times more than it would appear, if the capillitious rayes were taken away.

The reaſon whence it happens that Venus *and* Mars *do not appear to vary magnitude ſo much as is requiſite.*

SAGR. Now I remember that I have read ſomething on this ſubject, I know not whether in the Solar Letters, or in the *Saggiatore* of our common Friend, but it would be very good, aſwell for recalling it into my memory, as for the information of *Simplicius*, who it may be never ſaw thoſe writings, that you would declare unto us more diſtinctly how this buſineſſe ſtands, the knowledge whereof I think to be very neceſſary for the aſſiſting of us to underſtand that of which we now ſpeak.

SIMP.

SIMP. I muſt confeſſe that all that which *Salviatus* hath ſpoken is new unto me, for truth is, I never have had the curioſity to read thoſe Books, nor have I hitherto given any great credit to the Teleſcope newly introduced; rather treading in the ſteps of other *Peripatetick* Philoſophers my companions, I have thought thoſe things to be fallacies and deluſions of the Chryſtals, which others have ſo much admired for ſtupendious operations: and therefore if I have hitherto been in an errour, I ſhall be glad to be freed from it, and allured by theſe novelties already heard from you, I ſhall the more attentively hearken to the reſt.

The operations of the Teleſcope accounted fallacies by the Peripateticks.

SALV. The confidence that theſe men have in their own apprehenſiveneſſe, is no leſs unreaſonable than the ſmall eſteem they have of the judgment of others: yet its much that they ſhould eſteem themſelves able to judge better of ſuch an inſtrument, without ever having made trial of it, than thoſe who have made, and daily do make a thouſand experiments of the ſame: But I pray you, let us leave this kind of pertinacious men, whom we cannot ſo much as tax without doing them too great honour. And returning to our purpoſe, I ſay, that reſplendent objects, whether it is that their light doth refract on the humidity that is upon the pupils, or that it doth reflect on the edges of the eye-browes, diffuſing its reflex rayes upon the ſaid pupils, or whether it is for ſome other reaſon, they do appear to our eye, as if they were environ'd with new rayes, and therefore much bigger than their bodies would repreſent themſelves to us, were they diveſted of thoſe irradiations. And this aggrandizement is made with a greater and greater proportion, by how much thoſe lucid objects are leſſer and leſſer; in the ſame manner for all the world, as if we ſhould ſuppoſe that the augmentation of ſhining locks were *v.g.* four inches, which addition being made about a circle that hath four inches diameter would increaſe its appearance to nine times its former bigneſſe: but———

Shining objects ſeem environed with adventitious rayes.

The reaſon why luminous bodies appear enlarged much the more, by how much they are leſſer.

SIMP. I believe you would have ſaid three times; for adding four inches to this ſide, and four inches to that ſide of the diameter of a circle, which is likewiſe four inches, its quantity is thereby tripled, and not made nine times bigger.

SALV. A little more *Geometry* would do well, *Simplicius*. True it is, that the diameter is tripled, but the ſuperficies, which is that of which we ſpeak, increaſeth nine times: for you muſt know, *Simplicius*, that the ſuperficies of circles are to one another, as the ſquares of their diameters; and a circle that hath four inches diameter is to another that hath twelve, as the ſquare of four to the ſquare of twelve; that is, as 16. is to 144. and therefore it ſhall be increaſed nine times, and not three; this, by way of advertiſement to *Simplicius*. And proceeding forwards, if we ſhould add the

Superficial figures encreaſing proportion double to their lines.

the ſaid irradiation of four inches to a circle that hath but two inches of diameter onely, the diameter of the irradiation or Garland would be ten inches, and the ſuperficial content of the circle would be to the *area* of the naked body, as 100. to 4. for thoſe are the ſquares of 10. and of 2. the agrandizement would therefore be 25. times ſo much; and laſtly, the four inches of hair or fringe, added to a ſmall circle of an inch in diameter, the ſame would be increaſed 81. times; and ſo continually the augmentations are made with a proportion greater and greater, according as the real objects that increaſe, are leſſer and leſſer.

SAGR. The doubt which puzzled *Simplicius* never troubled me, but certain other things indeed there are, of which I deſire a more diſtinct underſtanding; and in particular, I would know upon what ground you affirm that the ſaid agrandizement is alwayes equal in all viſible objects.

Objects the more vigorous they are in light, the more they do ſeem to increaſe.

SALV. I have already declared the ſame in part, when I ſaid, that onely lucid objects ſo increaſed, and not the obſcure; now I adde what remaines, that of the reſplendent objects thoſe that are of a more bright light, make the reflection greater and more reſplendent upon our pupil; whereupon they ſeem to augment much more than the leſſe lucid: and that I may no more inlarge my ſelf upon this particular, come we to that which the true Miſtris of *Aſtronomy*, Experience, teacheth us. Let us this evening, when the air is very obſcure, obſerve the ſtar of *Jupiter*; we ſhall ſee it very glittering, and very great; let us afterwards look through a tube, or elſe through a ſmall trunk, which clutching the hand cloſe, and accoſting it to the eye, we lean between the palm of the hands and the fingers, or elſe by an hole made with a ſmall needle in a paper; and we ſhall ſee the ſaid ſtar diveſted of its beams, but ſo ſmall, that we ſhall judge it leſſe, even than a ſixtieth part of its great glittering light ſeen with the eye at liberty: we may afterwards behold the *Dog-ſtars* beautiful and bigger than any of the other fixed ſtars, which ſeemeth to the bare eye no great matter leſſe than *Jupiter*; but taking from it, as before, the irradiation, its *Diſcus* will ſhew ſo little, that it will not be thought the twentieth part of that of *Jupiter*, nay, he that hath not very good eyes, will very hardly diſcern it; from whence it may be rationally inferred, that the ſaid ſtar, as having a much more lively light than *Jupiter*, maketh its irradiation greater than *Jupiter* doth his. In the next place, as to the irradiation of the Sun and Moon, it is as nothing, by means of their magnitude, which poſſeſſeth of it ſelf alone ſo great a ſpace in our eye, that it leaveth no place for the adventitious rayes; ſo that their faces ſeem cloſe clipt, and terminate. We may aſſure our ſelves of the ſame truth by another experiment which I have often made triall of;

An eaſie experiment that ſheweth the increaſe in the ſtars, by means of the adventitious rays.

Jupiter *augments leſſe than the* Dog-ſtar.

The Sun *and* Moon *increaſe little.*

It is ſeen by manifeſt experience, that the more ſplendid bodies do much more irradiate than the leſſe lucid.

we may aſſure our ſelves, I ſay, that bodies ſhining with moſt lively light do irradiate, or beam forth rayes more by far than thoſe that are of a more languiſhing light. I have many times ſeen *Jupiter* and *Venus* together twenty, or thirty degrees diſtant from the Sun, and the air being very dark, *Venus* appeared eight or ten times bigger than *Jupiter*, being both beheld by the eye at liberty; but being beheld afterwards with the Teleſcope, the *Diſcus* of *Jupiter* diſcovered it ſelf to be four or more times greater than that of *Venus*, but the vivacity of the ſplendour of *Venus* was incomparably bigger than the languiſhing light of *Jupiter*; which was only becauſe of *Jupiters* being far from the Sun, and from us; and *Venus* neer to us, and to the Sun. Theſe things premiſed, it will not be difficult to comprehend, how Mars, when it is in oppoſition to the Sun, and therefore neerer to the Earth by ſeven times, and more, than it is towards the conjunction, cometh to appear ſcarce four or five times bigger in that ſtate than in this, when as it ſhould appear more than fifty times ſo much; of which the only irradiation is the cauſe; for if we diveſt it of the adventitious rayes, we ſhall find it exactly augmented with the due proportion: but to take away the capillitious border, the Teleſcope is the beſt and only means, which inlarging its *Diſcus* nine hundred or a thouſand times, makes it to be ſeen naked and terminate, as that of the Moon, and different from it ſelf in the two poſitions, according to its due proportions to an hair. Again, as to *Venus*, that in its veſpertine conjunction, when it is below the Sun, ought to ſhew almoſt fourty times bigger than in the other matutine conjunction, and yet doth not appear ſo much as doubled; it happeneth, beſides the effect of the irradiation, that it is horned; and its creſcents, beſides that they are ſharp, they do receive the Suns light obliquely, and therefore emit but a faint ſplendour; ſo that as being little and weak, its irradiation becometh the leſſe ample and vivacious, than when it appeareth to us with its Hemiſphere all ſhining: but now the Teleſcope manifeſtly ſhews its hornes to have been as terminate and diſtinct as thoſe of the Moon, and appear, as it were, with a great circle, and in a proportion thoſe well neer fourty times greater than its ſame *Diſcus*, at ſuch time as it is ſuperiour to the Sun in its ultimate matutine apparition.

The Teleſcope *is the beſt means to take away the irradiations of the Stars.*

Another ſecond reaſon of the ſmall apparent increaſe of Venus.

SAGR. Oh, *Nicholas Copernicus*, how great would have been thy joy to have ſeen this part of thy Syſteme, confirmed with ſo manifeſt experiments!

Copernicus *perſwaded by reaſons contrary to ſenſible experiments.*

SALV. Tis true. But how much leſſe the fame of his ſublime wit amongſt the intelligent? when as it is ſeen, as I alſo ſaid before, that he did conſtantly continue to affirm (being perſwaded thereto by reaſon) that which ſenſible experiments ſeemed to contradict; for I cannot ceaſe to wonder that he ſhould conſtantly perſiſt in ſaying, that *Venus* revolveth about the Sun, and is more than ſix

times farther from us at one time, than at another; and also seemeth to be always of an equal bigness, although it ought to shew forty times bigger when neareſt to us, than when fartheſt off.

SAGR. But in *Jupiter*, *Saturn* and *Mercury*, I believe that the differences of their apparent magnitudes, should seem punctually to answer to their different distances.

SALV. In the two Superiour ones, I have made precise observations yearly for this twenty two years last past: In *Mercury* there can be no observation of moment made, by reason it suffers not it self to be seen, save onely in its greateſt digreſſions from the Sun, in which its distances from the earth are insensibly unequal, and those differences consequently not to be observed; as also its mutations of figures which must absolutely happen in it, as in *Venus*. And if we do see it, it must of necessity appear in form of a Semicircle, as *Venus* likewise doth in her greateſt digreſſions; but its *discens* is so very small, and its splendor so very great, by reason of its vicinity to the Sun, that the virtue of the Teleſcope doth not suffice to clip its treſſes or adventitious rayes, so as to make them appear shaved round about. It remains, that we remove that which seemed a great inconvenience in the motion of the Earth, namely that all the Planets moving about the Sun, it alone, not solitary as the reſt, but in company with the Moon, and the whole Elementary Sphear, should move round about the Sun in a year; and that the said Moon withal should move every moneth about the earth. Here it is neceſſary once again to exclaim and extol the admirable perſpicacity of *Copernicus*, and withal to condole his misfortune, in that he is not now alive in our dayes, when for removing of the seeming absurdity of the Earth and Moons motion in consort we see *Jupiter*, as if it were another Earth, not in consort with the Moon, but accompanied by four Moons to rovolve about the Sun in 12. years together, with what ever things the Orbs of the four Mediceæan Stars can contain within them.

Mercury admitteth not of clear observations.

The difficulties removed that arise from the Earths moving about the Sun, not solitarily, but in consort with the Moon.

SALV. Why do you call the four jovial Planets, Moons?

SAGR. Such they would seem to be to one that standing in *Jupiter* should behold them; for they are of themselves dark, and receive their light from the Sun, which is manifeſt from their being eclipsed, when they enter into the cone of *Jupiters* shadow: and because onely those their Hemiſpheres, that look towards the Sun are illuminated, to us that are without their Orbs, and nearer to the Sun, they seem always *lucid*, but to one that should be in *Jupiter*, they would shew all illuminated, at such time as they were in the upper parts of their circles; but in the parts inferiour, that is between *Jupiter* and the Sun, they would from *Jupiter* be observed to be horned; and in a word they would, to

The Medicean *Stars are as it were four* Moons *about* Jupiter.

the obſervators ſtanding in *Jupiter*, make the ſelf ſame changes of Figure, that to us upon the Earth, the Moon doth make. You ſee now how theſe three things, which at firſt ſeemed diſſonant, do admirably accord with the *Copernican* Syſteme. Here alſo by the way may *Simplicius* ſee, with what probability one may conclude, that the Sun and not the Earth, is in the Centre of the *Planetary* converſions. And ſince the Earth is now placed amongſt mundane Bodies, that undoubtedly move about the Sun, to wit, above *Mercury* and *Venus*, and below *Saturn*, *Jupiter*, and *Mars*; ſhall it not be in like manner probable, and perhaps neceſſary to grant, that it alſo moveth round?

SIMP. Theſe accidents are ſo notable and conſpicuous, that it is not poſſible, but that *Ptolomy* and others his Sectators, ſhould have had knowledge of them, and having ſo, it is likewiſe neceſſary, that they have found a way to render reaſons of ſuch, and ſo ſenſible appearances that were ſufficient, and alſo congruous and probable, ſeeing that they have for ſo long a time been received by ſuch numbers of learned men.

The Principal ſcope of Aſtronomers, is to give a reaſon of appearances.

SALV. You argue very well; but you know that the principal ſcope of *Aſtronomers*, is to render only reaſon for the appearances in the Cæleſtial Bodies, and to them, and to the motions of the Stars, to accomodate ſuch ſtructures and compoſitions of Circles, that the motions following thoſe calculations, anſwer to the ſaid appearances, little ſcrupling to admit of ſome exorbitances, that indeed upon other accounts they would much ſtick at. And *Copernicus* himſelf writes, that he had in his firſt ſtudies reſtored the Science of *Aſtronomy* upon the very ſuppoſitions of *Ptolomy*, and in ſuch manner corrected the motions of the Planets, that the computations did very exactly agree with the *Phænomena*, and the *Phænomena* with the ſupputations, in caſe that he took the Planets ſeverally one by one. But he addeth, that in going about to put together all the ſtructures of the particular Fabricks, there reſulted thence a Monſter and *Chimæra*, compoſed of members moſt diſproportionate to one another, and altogether incompatible; So that although it ſatisfied an *Aſtronomer* meerly *Arithmetical*, yet did it not afford ſatisfaction or content to the *Aſtronomer Phyloſophical*. And becauſe he very well underſtood, that if one might ſalve the Cæleſtial appearances with falſe aſſumptions in nature, it might with much more eaſe be done by true ſuppoſitions, he ſet himſelf diligently to ſearch whether any amongſt the antient men of fame, had aſcribed to the World any other ſtructure, than that commonly received by *Ptolomy*; and finding that ſome *Pythagoreans* had in particular aſſigned the Diurnal converſion to the Earth, and others the annual motion alſo, he began to compare the appearances, and particulari-

Copernicus *reſtored Aſtronomy upon the ſuppoſitions of* Ptolomy.

What moved Copernicus *to eſtabliſh his Syſteme.*

ties

ties of the Planets motions, with these two new suppositions, all which things jumpt exactly with his purpose; and seeing the whole correspond, with admirable facility to its parts, he imbraced this new Systeme, and it took up his rest.

SIMP. But what great exorbitancies are there in the *Ptolomaick* Systeme, for which there are not greater to be found in this of *Copernicus*?

Inconveniencies that are in the Systeme of Ptolomy.

SALV. In the *Ptolomaick Hypothesis* there are diseases, and in the *Copernican* their cures. And first will not all the Sects of *Physosophers*, account it a great inconvenience, that a body naturally moveable in circumgyration, should move irregularly upon its own Centre, and regularly upon another point? And yet there are such deformed motions as these in the *Ptolomæan* Hypothesis, but in the *Copernican* all move evenly about their own Centres. In the *Ptolomaick*, it is necessary to assign to the Cœlestial bodies, contrary motions, and to make them all to move, from East to West, and at the same time, from West to East; But in the *Copernican*, all the Cœlestial revolutions are towards one onely way, from West to East. But what shall we say of the apparent motion of the Planets, so irregular, that they not only go one while swift, and another while slow, but sometimes wholly seace to move; and then after a long time return backa gain? To salve which appearances *Ptolomie* introduceth very great *Epicicles*, accommodating them one by one to each Planet, with some rules of incongruous motions, which are all with one single motion of the Earth taken away. And would not you, *Simplicius*, call it a great absurditie, if in the *Ptolomaick* Hypothesis, in which the particular Planets, have their peculiar Orbs assigned them one above another, one must be frequently forced to say, that *Mars*, constituted above the Sphære of the Sun, doth so descend, that breaking the Solar Orb, it goeth under it, and approacheth nearer to the Earth, than to the Body of the Sun, and by and by immeasurably ascendeth above the same? And yet this, and other exorbitancies are remedied by the sole and single annual motion of the Earth.

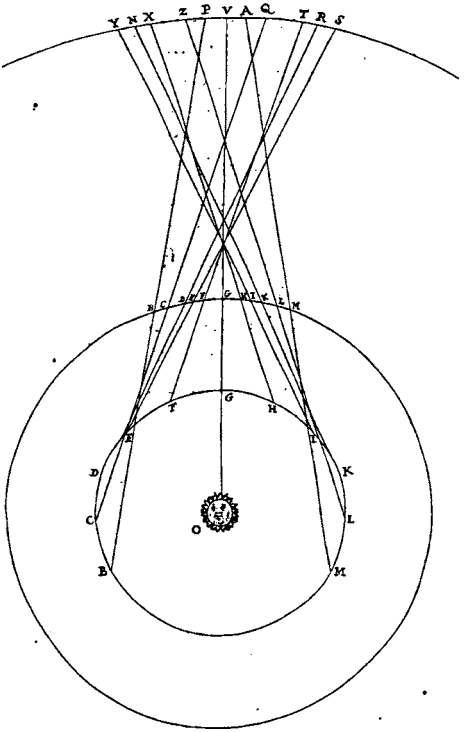
SAGR. I would gladly be bettter informed how these stations, and retrograde and direct motions, which did ever seem to me great improbalities, do accord in this *Copernican* Systeme.

It a great Argument in favour of Copernicus, *that he obviates the stations & retrogradations of the motions of the Planets.*

SALV. You shall see them so to accord, *Sagredus*, that this onely conjecture ought to be sufficient to make one that is not more than pertinacious or stupid, yield, assent to all the rest of this Doctrine. I tell you therefore, that nothing being altered in the motion of *Saturn*, which is 30 years, in that of *Jupiter*, which is 12, in that of *Mars*, which is 2, in that of *Venus*, which is 9. moneths; in that of *Mercury*, which is 80. dayes,

The ſole annual motion of the Earth cauſeth great inequality of motions in the five Planets.

dayes, or thereabouts, the ſole annual motion of the Earth between *Mars* and *Venus*, cauſeth the apparent inequalities in all the five ſtars before named. And for a facile and full underſtanding of the whole, I will deſcribe this figure of it. Therefore ſuppoſe the Sun to be placed in the centre O, about which we will draw the Orb deſcribed by the Earth, with the annual motion B G M, and let the circle deſcribed, *v. gr.* by *Jupiter* about the Sun in 12. years, be this B G M, and in the



A demonſtration of the inequalities of the three ſuperiour Planets dependent on the annual motion of the Earth.

ſtarry ſphere let us imagine the Zodiack Y V S. Again, in the annual Orb of the Earth let us take certain equal arches, B C, C D, E F, F G, G H, H I, I K, K L, L M, and in the Sphere of *Jupiter* let us make certain other arches, paſſed in the ſame times in which the Earth paſſeth hers, which let be B C, C D, D E, E F, F G, G H, H I, I K, K L, L M, which ſhall each be proportionally leſſe than theſe marked in the Earths Orb, like as the motion of *Jupiter* under the Zodiack is ſlower than the annual. Suppoſing now, that when the Earth is in B, *Jupiter* is in B, it ſhall appear to us in the Zodiack to be in P, deſcribing the

the right line B ʙ P. Next ſuppoſe the Earth to be moved from B to C, and *Jupiter* from ʙ to ᴄ, in the ſame time; *Jupiter* ſhall appear to have paſſed in the Zodiack to Q, and to have moved ſtraight forwards, according to the order of the ſignes P Q. In the next place, the Earth paſſing to D, and *Jupiter* to ᴅ, it ſhall be ſeen in the Zodiack in R, and from E; *Jupiter* being come to ᴇ; will appear in the Zodiack in S, having all this while moved right forwards. But the Earth afterwards beginning to interpoſe more directly between *Jupiter* and the Sun, ſhe being come to F, and *Jupiter* to ꜰ, he will appear in T, to have already begun to return apparently back again under the Zodiack, and in that time that the Earth ſhall have paſſed the arch E F, *Jupiter* ſhall have entertained himſelf between the points S T, and ſhall have appeared to us almoſt motionleſſe and ſtationary. The Earth being afterwards come to G, and *Jupiter* to G, in oppoſition to the Sun, it ſhall be viſible in the Zodiack at V, and much returned backwards by all the arch of the Zodiack T V; howbeit that all the way purſuing its even courſe it hath really gone forwards not onely in its own circle, but in the Zodiack alſo in reſpect to the centre of the ſaid Zodiack, and to the Sun placed in the ſame. The Earth and *Jupiter* again continuing their motions, when the Earth is come to H, and *Jupiter* to ʜ, it ſhall ſeem very much gone backward in the Zodiack by all the arch V X. The Earth being come to I, and *Jupiter* to ɪ, it ſhall be apparently moved in the Zodiack by the little ſpace X Y, and there it will ſeem ſtationary. When afterwards the Earth ſhall be come to K, and *Jupiter* to ᴋ; in the Zodiack he ſhall have paſſed the arch Y N in a direct motion; and the Earth purſuing its courſe to L, ſhall ſee *Jupiter* in L, in the point Z. And laſtly *Jupiter* in ᴍ ſhall be ſeen from the Earth M, to have paſſed to A, with a motion ſtill right forwards; and its whole apparent retrogadation in the Zodiack ſhall anſwer to the arch S Y, made by *Jupiter*, whilſt that he in his own circle paſſeth the arch ᴇ ɪ, and the Earth in hers the arch E I. And this which hath been ſaid, is intended of *Saturn* and of *Mars* alſo; and in *Saturn* thoſe retrogradations are ſomewhat more frequent than in *Jupiter*, by reaſon that its motion is a little ſlower than that of *Jupiter*, ſo that the Earth overtaketh it it in a ſhorter ſpace of time; in *Mars* again they are more rare, for that its motion is more ſwift than that of *Jupiter*. Whereupon the Earth conſumeth more time in recovering it. Next as to *Venus* and *Mercury*, whoſe Circles are comprehended by that of the Earth, their ſtations and regreſſions appear to be occaſioned, not by their motions that really are ſuch, but by the anual motion of the ſaid Earth, as *Copernicus* exellently demonſtrateth, to-

Retrogradations more frequent in Saturn, *leſſe in* Jupiter, *and yet leſſe in* Mars, *and why.*

The Retrogradation of Venus *and* Mercury *demonſtrated by* Apollonius *and* Copernicus,

together with *Appollonius Pergæus* in *lib.* 5. of his Revolutions, *Chap.* 35.

The annual motion of the Earth moſt apt to render a reaſon of the exorbitances of the five Planets.

You ſee, Gentlemen, with what facility and ſimplicity the annual motion, were it appertaining to the Earth, is accommodated to render a reaſon of the apparent exorbitances, that are obſerved in the motions of the five Planets, *Saturn*, *Jupiter*, *Mars*, *Venus* and *Mercury*, taking them all away, and reducing them to equal and regular motions. And of this admirable effect, *Nicholas Copernicus*, hath been the firſt that hath made the reaſon plain unto us. But of another effect, no leſſe admirable than this, and that with a knot, perhaps more difficult to unknit, bindeth the wit of man, to admit this annual converſion, and to leave it to our Terreſtrial Globe; a new and unthought of conjecture ariſeth from the Sun it ſelf, which ſheweth that it is unwilling to be ſingular in ſhifting, of this atteſtation of ſo eminent a concluſion, rather as a teſtimony beyond all exception, it hath deſired to be heard apart. Hearken then to this great and new wonder.

The Sun it ſelf teſtifieth the annual motion to belong to the Earth.

The Lyncæan Academick the firſt diſcoverer of the Solar ſpots, and all the other celeſtial novelties.

The hiſtory of the proceedings of the Academian for a long time about the obſervation of the Solar ſpots.

The firſt diſcoverer and obſerver of the *Solar* ſpots, as alſo of all the other Cœleſtial novelties, was our *Academick Lincæus*; and he diſcovered them *anno* 1610. being at that time Reader of the *Mathematicks*, in the Colledge of *Padua*, and there, and in *Venice*, he diſcourſed thereof with ſeveral perſons, of which ſome are yet living: And the year following, he ſhewed them in *Rome* to many great perſonages, as he relates in the firſt of his Letters to *Marcus Velſerus*, * Sheriffe of *Auguſta*. He was the firſt that againſt the opinions of the too timorous and too jealous aſſertors of the Heavens inalterability, affirmed thoſe ſpots to be matters, that in ſhort times were produced and diſſolved: for as to place, they were contiguous to the body of the Sun, and revolved about the ſame; or elſe being carried about by the ſaid Solar body, which revolveth in it ſelfe about its own Centre, in the ſpace almoſt of a moneth, do finiſh their courſe in that time; which motion he judged at firſt to have been made by the Sun about an Axis erected upon the plane of the Ecliptick; in regard that the arches deſcribed by the ſaid ſpots upon the *Diſcus* of the Sun appear unto our eye right lines, and parallels to the plane of the Ecliptick: which therefore come to be altered, in part, with ſome accidental, wandring, and irregular motions, to which they are ſubject, and whereby tumultuarily, and without any order they ſucceſſively change ſituations amongſt themſelves, one while crouding cloſe together, another while diſſevering, and ſome dividing themſelves into many and very much changing figures, which, for the moſt part, are very unuſual. And albeit thoſe ſo inconſtant mutations did ſomewhat alter the primary periodick

* Duumviro.

riodick courſe of the ſaid ſpots, yet did they not alter the opinion of our friend, ſo as to make him believe, that they were any eſſential and fixed cauſe of thoſe deviations, but he continued to hold, that all the apparent alterations derived themſelves from thoſe accidental mutations: in like manner, juſt as it would happen to one that ſhould from far diſtant Regions obſerve the motion of our Clouds; which would be diſcovered to move with a moſt ſwift, great, and conſtant motion, carried round by the diurnal *Vertigo* of the Earth (if haply that motion belong to the ſame) in twenty four hours, by circles parallel to the Equinoctial, but yet altered, in part, by the accidental motions cauſed by the winds, which drive them, at all adventures, towards different quarters of the World. While this was in agitation, it came to paſs that *Velſerus* ſent him two Letters, written by a certain perſon, under the feigned name of * *Apelles*, upon the ſubject of theſe Spots, requeſting him, with importunity, to declare his thoughts freely upon thoſe Letters, and withall to let him know what his opinion was touching the eſſence of thoſe ſpots; which his requeſt he ſatisfied in 3 Letters, ſhewing firſt of all howvain the conjectures of *Apelles* were; & diſcovering, ſecondly, his own opinions; withal foretelling to him, that *Apelles* would undoubtedly be better adviſed in time, and turn to his opinion, as it afterwards came to paſs. And becauſe that our Academian (as it was alſo the judgment of many others that were intelligent in Natures ſecrets) thought he had in thoſe three Letters inveſtigated and demonſtrated, if not all that could be deſired, or required by humane curioſity, at leaſt all that could be attained by humane reaſon in ſuch a matter, he, for ſome time (being buſied in other ſtudies) intermitted his continual obſervations, and onely in complacency to ſome friend, joyned with him, in making now and then an abrupt obſervation: till that he, and after ſome years, we, being then at my * Country-ſeat, met with one of the ſolitary Solar ſpots very big, and thick, invited withal by a clear and conſtant ſerenity of the Heavens, he, at my requeſt, made obſervations of the whole progreſſe of the ſaid ſpot, carefully marking upon a ſheet of paper the places that it was in every day at the time of the Suns coming into the Meridian; and we having found that its courſe was not in a right line, but ſomewhat incurvated, we came to reſolve, at laſt, to make other obſervations from time to time; to which undertaking we were ſtrongly induced by a conceit, that accidentally came into the minde of my Gueſt, which he imparted to me in theſe or the like words.

In my opinion, *Philip*, there is a way opened to a buſineſs of very great conſequence. For if the Axis about which the Sun turneth be not erect perpendicularly to the plane of the Ecliptick,

* This Authors true name is *Chriſtopher Scheiner* a Jeſuit, and his Book here meant is intituled, *Apelles poſt tabulam.*

* La mia villa delle Selue.

A conceipt that came ſuddenly into the minde of the Academian Lyncæus *concerning the great conſequence that followed upon the motion of the Solar ſpots.*

tick, but is inclined upon the ſame, as its crooked courſe, but even now obſerved, makes me believe, we ſhall be able to make ſuch conjectures of the ſtates of the Sun and Earth, as neither ſo ſolid or ſo rational have been hitherto deduced from any other accident whatſoever. I being awakened at ſo great a promiſe, importun'd him to make a free diſcovery of his conceit unto me. And he continued his diſcourſe to this purpoſe. If the Earths motion were along the Ecliptique about the Sun; and the Sun were conſtituted in the centre of the ſaid Ecliptick, and therein revolved in its ſelf, not about the Axis of the ſaid Ecliptique (which would be the Axis of the Earths annual motion) but upon one inclined, it muſt needs follow, that ſtrange changes will repreſent themſelves to us in the apparent motions of the Solar ſpots, although the ſaid Axis of the Sun ſhould be ſuppoſed to perſiſt perpetually and immutably in the ſame inclination, and in one and the ſame direction towards the ſelf-ſame point of the Univerſe. Therefore the Terreſtrial Globe in the annual motion moving round it, it will firſt follow, that to us, carried about by the ſame, the courſes of the ſpots ſhall ſometimes ſeem to be made in right lines, but this only twice a year, and at all other times ſhall appear to be made by arches inſenſibly incurvated. Secondly, the cuvity of thoſe arches for one half of the year, will ſhew inclined the contrary way to what they will appear in the other half; that is, for ſix moneths the convexity of the arches ſhall be towards the upper part of the Solar *Diſcus*, and for the other ſix moneths towards the inferiour. Thirdly, the ſpots beginning to appear, and (if I may ſo ſpeak) to riſe to our eye from the left ſide of the Solar *Diſcus*, and going to hide themſelves and to ſet in the right ſide, the Oriental termes, that is, of their firſt appearings for ſix moneths, ſhall be lower than the oppoſite termes of their occultations; and for other ſix moneths it ſhall happen contrarily, to wit, that the ſaid ſpots riſing from more elevated points, and from them deſcending, they ſhall, in their courſes, go and hide themſelves in lower points; and onely for two dayes in all the year ſhall thoſe termes of riſings and ſettings be equilibrated: after which freely beginning by ſmall degrees the inclination of the courſes of the ſpots, and day by day growing bigger, in three moneths, it ſhall arrive at its greateſt obliquity, and from thence beginning to diminiſh, in ſuch another time it ſhall reduce it ſelf to the other *Æquilibrium*. It ſhall happen, for a fourth wonder, that the courſe of the greateſt obliquity ſhall be the ſame with the courſe made by the right line, and in the day of the Libration the arch of the courſe ſhall ſeem more than ever incurvated. Again, in the other times, according as the pendency ſhall ſucceſſively diminiſh, and make its approach

Extravagant mutations to be obſerved in the motions of the ſpots, foreſeen by the Academick, in caſe the Earth had the annual motion.

proach towards the *Æquilibrium*, the incurvation of the arches of the courſes on the contrary ſhall, by degrees, increaſe.

SAGR. I confeſſe, *Salviatus*, that to interrupt you in your Diſcourſe is ill manners, but I eſteem it no leſſe rudeneſs to permit you to run on any farther in words, whilſt they are, as the ſaying is, caſt into the air: for, to ſpeak freely, I know not how to form any diſtinct conceit of ſo much as one of theſe concluſions, that you have pronounced; but becauſe, as I thus generally and confuſedly apprehend them, they hold forth things of admirable conſequence, I would gladly, ſome way or other, be made to underſtand the ſame.

SALV. The ſame that befalls you, befell me alſo, whilſt my Gueſt tranſported me with bare words; who afterwards aſſiſted my capacity, by deſcribing the buſineſſe upon a material Inſtrument, which was no other than a ſimple Sphere, making uſe of ſome of its circles, but to a different purpoſe from that, to which they are commonly applied. Now I will ſupply the defect of the Sphere, by drawing the ſame upon a piece of paper, as need ſhall require. And to repreſent the firſt accident by me propounded, which was, that the courſes or journeys of the ſpots, twice a year, and no more, might be ſeen to be made in right lines, let us ſuppoſe this point O [*in Fig.* 4.] to be the centre of the grand Orb, or, if you will, of the Ecliptick, and likewiſe alſo of the Globe of the Sun it ſelf; of which, by reaſon of the great diſtance that is between it and the Earth, we that live upon the Earth, may ſuppoſe that we ſee the one half: we will therefore deſcribe this circle A B C D about the ſaid centre O, which repreſenteth unto us the extream term that divideth and ſeparates the Hemiſphere of the Sun that is apparent to us, from the other that is occult. And becauſe that our eye, no leſſe than the centre of the Earth, is underſtood to be in the plane of the Ecliptick, in which is likewiſe the centre of the Sun, therefore, if we ſhould fancy to our ſelves the body of the Sun to be cut thorow by the ſaid plane, the ſection will appear to our eye a right line, which let be B O D, and upon that a perpendicular being let fall A O C, it ſhall be the Axis of the ſaid Ecliptick, and of the annual motion of the Terreſtrial Globe. Let us next ſuppoſe the Solar body (without changing centre) to revolve in it ſelf, not about the Axis A O C. (which is the erect Axis upon the plane of the Ecliptick) but about one ſomewhat inclined, which let be this E O I, the which fixed and unchangeable Axis maintaineth it ſelf perpetually in the ſame inclination and direction towards the ſame points of the Firmament, and of the Univerſe. And becauſe, in the revolutions of the Solar Globe, each point of its ſuperficies (the Poles excepted) deſcribeth the circumference of a

The firſt Accident to be obſerved in the motion of the Solar ſpots; and conſequently all the reſt explained.

circle, either bigger or leſſer, according as it is more or leſſe remote from the ſaid Poles, let us take the point F, equally diſtant from them, and draw the diameter F O G, which ſhall be perpendicular to the Axis E I, and ſhall be the diameter of the grand circle deſcribed about the Poles E I. Suppoſing not that the Earth, and we with her be in ſuch a place of the Ecliptick, that the Hemiſphere of the Sun to us apparent is determin'd or bounded by the circle A B C D, which paſſing (as it alwayes doth) by the Poles A C, paſſeth alſo by E I. It is manifeſt, that the grand circle, whoſe diameter is F G, ſhall be erect to the circle A B C D, to which the ray that from our eye falleth upon the centre O, is perpendicular; ſo that the ſaid ray falleth upon the plane of the circle, whoſe diameter is F G, and therefore its circumference will appear to us a right line, and the ſelf ſame with F G, whereupon if there ſhould be in the point F, a ſpot, it comming afterwards to be carried about by the Solar converſion, would, upon the ſurface of the Sun, trace out the circumference of that circle, which ſeems to us a right line. Its courſe or paſſage will therefore ſeem ſtraight. And ſtraight alſo will the motion of the other ſpots appear, which in the ſaid revolution ſhall deſcribe leſſer circles, as being all parallel to the greater, and to our eye placed at an immenſe diſtance from them. Now, if you do but conſider, how that after the Earth ſhall in ſix moneths have run thorow half the grand Orb, and ſhall be ſituate oppoſite to that Hemiſphere of the Sun, which is now occult unto us, ſo as that the boundary of the part that then ſhall be ſeen, may be the ſelf ſame A B C D, which alſo ſhall paſſe by the Poles E I; you ſhall underſtand that the ſame will evene in the courſes of the ſpots, as before, to wit, that all will appear to be made by right lines. But becauſe that that accident takes not place, ſave onely when the terminator or boundary paſſeth by the Poles E I, and the ſaid terminator from moment to moment, by meanes of the Earths annual motion, continually altereth, therefore its paſſage by the fixed Poles E I, ſhall be momentary, and conſequently momentary ſhall be the time, in which the motions of thoſe ſpots ſhall appear ſtraight. From what hath been hitherto ſpoken one may comprehend alſo how that the apparition and beginning of the motion of the ſpots from the part F, proceeding towards G, their paſſages or courſes are from the left hand, aſcending towards the right; but the Earth being placed in the part diametrically oppoſite the appearance of the ſpots about G, ſhall ſtill be to the left hand of the beholder, but the paſſage ſhall be deſcending towards the right hand F. Let us now deſcribe the Earth te be ſituate one fourth part farther diſtant from its preſent ſtate, and let us draw, as in the other figure, the terminator A B C D,

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[*as in Fig.* 5.] and the Axis, as before A C, by which the plane of our Meridian would paſſe, in which plane ſhould alſo be the Axis of the Suns revolution, with its Poles, one towards us, that is, in the apparent Hemiſphere, which Pole we will repreſent by the point E, and the other ſhall fall in the occult Hemiſphere, and I mark it I. Inclining therefore the Axis E I, with the ſuperiour part E, towards us, the great circle deſcribed by the Suns converſion, ſhall be this B F D G, whoſe half by us ſeen, namely B F D, ſhall no longer ſeem unto us a right line, by reaſon the Poles E I are not in the circumference A B C D, but ſhall appear incurvated, and with its convexity towards the inferiour part C. And it is manifeſt, that the ſame will appear in all the leſſer circles parallel to the ſame B F D. It is to be underſtood alſo, that when the Earth ſhall be diametrically oppoſite to this ſtate, ſo that it ſeeth the other Hemiſphere of the Sun, which now is hid, it ſhall of the ſaid great circle behold the part D G B incurved, with its convexity towards the ſuperiour part A; and the courſes of the ſpots in theſe conſtitutions ſhall be firſt, by the arch B F D, and afterwards by the other D G B, and the firſt apparitions and ultimate occultations made about the points B and D, ſhall be equilibrated, and not thoſe that are more or leſſe elevated than theſe. But if we conſtitute the Earth in ſuch a place of the Ecliptick, that neither the boundary A B C D, nor the Meridian AC, paſſeth by the Poles of the Axis E I, as I will ſhew you anon, drawing this other Figure [*viz. Fig.* 6.] wherein the apparent or viſible Pole E falleth between the arch of the terminator A B, and the ſection of the Meridian A C; the diameter of the great circle ſhall be F O G, and the apparent ſemicircle F N G, and the occult ſemicircle G S F, the one incurvated with its convexity N towards the inferiour part, and the other alſo bending with its convexity S towards the upper part of the Sun. The ingreſſions and exitions of the ſpots, that is, the termes F and G ſhall not be librated, as the two others B and D; but F ſhall be lower, and G higher: but yet with leſſer difference than in the firſt Figure. The arch alſo F N G ſhall be incurvated, but not ſo much as the precedent B F D; ſo that in this poſition the paſſages or motions of the ſpots ſhall be aſcendent from the left ſide F, towards the right G, and ſhall be made by curved lines. And imagining the Earth to be conſtituted in the poſition diametrically oppoſite; ſo that the Hemiſphere of the Sun, which was before the occult, may be the apparent, and terminated by the ſame boundary A B C D, it will be manifeſtly diſcerned, that the courſe of the ſpots ſhall be by the arch G S F, beginning from the upper point G, which ſhall then be likewiſe from the left hand of the beholder, and going to determine, deſcending

ſcending towards the right, in the point F. What I have hitherto ſaid, being underſtood, I believe that there remains no difficulty in conceiving how from the paſſing of the terminator of the Solar Hemiſpheres by the Poles of the Suns converſion, or neer or far from the ſame, do ariſe all the differences in the apparent courſes of the ſpots; ſo that by how much the more thoſe Poles ſhall be remote from the ſaid terminator, by ſo much the more ſhall thoſe courſes be incurvated, and leſſe oblique; whereupon at the ſame diſtance, that is, when thoſe Poles are in the ſection of the Meridian, the incurvation is reduced to the greateſt, but the obliquity to the leaſt, that is to *Æquilibrium*, as the ſecond of theſe three laſt figures [*viz. Fig.* 5.] demonſtrateth. On the contrary, when the Poles are in the terminator, as the firſt of theſe three figures [*viz. Fig.* 4.] ſheweth the inclination is at the greateſt, but the incurvation at the leaſt, and reduced to rectitude. The terminator departing from the Poles, the curvity begins to grow ſenſible, the obliquity all the way encreaſing, and the inclination growing leſſer.

Theſe are thoſe admirable and extravagant mutations, that my Gueſt told me would from time to time appear in the progreſſes of the Solar ſpots, if ſo be it ſhould be true that the annual motion belonged to the Earth, and that the Sun being conſtituted in the centre of the Ecliptick, were revolved in it ſelf upon an Axis, not erect, but inclined to the Plane of the ſaid Ecliptick.

SAGR. I do now very well apprehend theſe conſequences, and believe that they will be better imprinted in my fancy, when I ſhall come to reflect upon them, accommodating a Globe to thoſe inclinations, and then beholding them from ſeveral places. It now remains that you tell us what followed afterwards touching the event of theſe imaginary conſequences.

The events being obſerved, were anſwerable to the predictions.

SALV. It came to paſſe thereupon, that continuing many ſeveral moneths to make moſt accurate obſervations, noting down with great exactneſſe the courſes or tranſitions of ſundry ſpots at divers times of the year, we found the events punctually to correſpond to the predictions.

SAGR. *Simplicius*, if this which *Salviatus* ſaith be true; (nor can we diſtruſt him upon his word) the *Ptolomeans* and *Ariſtoteleans*, had need of ſolid arguments, ſtrong conjectures, and well grounded experiments to counterpoiſe an objection of ſo much weight, and to ſupport their opinion from its final overthrow.

SIMP. Fair and ſoftly good Sir, for haply you may not yet be got ſo far as you perſwade your ſelf you are gone. And though I am not an abſolute maſter of the ſubject of that narration

tion given us by *Salviatus*; yet do I not find that my Logick, whilſt I have a regard to form, teacheth me, that that kind of argumentation affords me any neceſſary reaſon to conclude in favour of the *Copernican* Hypotheſis, that is, of the ſtability of the Sun in the centre of the Zodiack, and of the mobility of the Earth under its circumference. For although it be true, that the ſaid converſion of the Sun, and cirnition of the Earth being granted, there be a neceſſity of diſcerning ſuch and ſuch ſtrange extravagancies as theſe in the ſpots of the Sun, yet doth it not follow that arguing *per converſum*, from finding ſuch like unuſual accidents in the Sun, one muſt of neceſſity conclude the Earth to move by the circumference, and the Sun to be placed in the centre of the Zodiack. For who ſhall aſſertain me that the like irregularities may not as well be viſible in the Sun, it being moveable by the Ecliptick, to the inhabitants of the Earth, it being alſo immoveable in the centre of the ſame? Unleſſe you demonſtrate to me, that there can be no reaſon given for that appearance, when the Sun is made moveable, and the Earth ſtable, I will not alter my opinion and belief that the Sun moveth, and the Earth ſtandeth ſtill.

Though the annual motion aſſigned to the Earth anſwereth to the Phænomena *of the ſolar ſpots, yet doth it not follow by converſion that from the* Phænomena *of the ſpots one may infer the annual motion to belong to the Earth.*

SAGR. *Simplicius* behaveth himſelf very bravely, and argueth very ſubtilly in defence of the cauſe of *Ariſtotle* and *Ptolomy*; and if I may ſpeak the truth, mythinks that the converſation of *Salviatus*, though it have been but of ſmall continuance, hath much farthered him in diſcourſing ſilogiſtically. An effect which I know to be wrought in others as well as him. But as to finding and judging whether competent reaſon may be rendered of the apparent exorbitancies and irregularities in the motions of the ſpots, ſuppoſing the Earth to be immoveable, and the Sun moveable, I ſhall expect that *Salviatus* manifeſt his opinion to us, for it is very probable that he he hath conſidered of the ſame, and collected together whatever may be ſaid upon the point.

SALV. I have often thought thereon, and alſo diſcourſed thereof with my Friend and Gueſt afore-named; and touching what is to be produced by Philoſophers and Aſtronomers, in defence of the ancient Syſteme, we are on one hand certain, certain I ſay, that the true and pure *Peripateticks* laughing at ſuch as employ themſelves in ſuch, to their thinking, inſipid fooleries, will cenſure all theſe *Phænomena* to be vain illuſions of the Chriſtals; and in this manner will with little trouble free themſelves from the obligation of ſtudying any more upon the ſame. Again, as to the Aſtronomical Philoſophers, after we have with ſome diligence weighed that which may be alledged as a mean between thoſe two others, we have not been able to find out an anſwer

The Pure Peripatetick *Philoſophers will laugh at the ſpots and their* Phænomena, *as illuſions of the Chryſtals in the Teleſcope.*

anſwer that ſufficeth to ſatisfie at once the courſe of the ſpots, and the diſcourſe of the Mind. I will explain unto you ſo much as I remember thereof, that ſo you may judge thereon as ſeems beſt unto you.

Suppoſing that the apparent motions of the Solar ſpots are the ſame with thoſe that have been above declared, and ſuppoſing the Earth to be immoveable in the centre of the Ecliptick, in whoſe circumference let the center of the Sun be placed; it is neceſſary that of all the differences that are ſeen in thoſe motions, the cauſes do reſide in the motions that are in the body of the Sun: Which in the firſt place muſt neceſſarily revolve in it ſelf (*i. e.* about its own axis) carrying the ſpots along therewith; which ſpots have been ſuppoſed, yea and proved to adhere to the Solar ſuperficies. It muſt ſecondly be confeſt, that the Axis of the Solar converſion is not parallel to the Axis of the Ecliptick, that is as much as to ſay, that it is not perpendicularly erected upon the Plane of the Ecliptick, becauſe if it were ſo, the courſes and exitions of thoſe ſpots would ſeem to be made by right lines parallel to the Ecliptick. The ſaid Axis therefore is inclining, in regard the ſaid courſes are for the moſt part made by curve *lines*. It will be neceſſary in the third place to grant that the inclination of this Axis is not fixed, and continually extended towards one and the ſame point of the Univerſe, but rather that it doth alwayes from moment to moment go changing its direction; for if the pendency ſhould always look towards the ſelf ſame point, the courſes of the ſpots would never change appearance; but appearing at one time either right or curved, bending upwards or downwards, aſcending or deſcending, they would appear the ſame at all times. It is therefore neceſſary to ſay, that the ſaid Axis is convertible; and is ſometimes found to be in the Plane of the circle that is extreme, terminate, or of the viſible Hemiſphere, I mean at ſuch time as the courſes of the ſpots ſeem to be made in right lines, and more than ever pendent, which happeneth twice a year; and at other times found to be in the Plane of the Meridian of the Obſervator, in ſuch ſort that one of its Poles falleth in the viſible Hemiſphere of the Sun, and the other in the occult; and both of them remote from the extreme points, or we may ſay, from the poles of another Axis of the Sun, which is parallel to the Axis of the Ecliptick; (which ſecond Axis muſt neceſſarily be aſſigned to the Solar Globe) remote, I ſay, as far as the inclination of the Axis of the revolution of the ſpots doth import; and moreover that the Pole falling in the apparent Hemiſphere, is one while in the ſuperiour, another while in the inferiour part thereof; for that it muſt be ſo, the courſes themſelves do manifeſtly evince at ſuch time as they are equi-

If the Earth be immoveable in the centre of the Zodiack, there muſt be aſcribed to the Sun four ſeveral motions, as is declared at length.

equilibrated, and in their greateſt curvity, one while with their convexity towards the upper part, and another while towards the lower part of the Solar *Diſcus*. And becauſe thoſe poſitions are in continuall alteration, making the inclinations and incurvations now greater, now leſſer, and ſometimes reduce themſelves, the firſt ſort to perfect libration, and the ſecond to perfect perpendicularity, it is neceſſary to aſſert that the ſelf ſame Axis of the monethly revolution of the ſpots hath a particular revolution of its own, whereby its Poles deſcribe two circles about the Poles of another Axis, which for that reaſon ought (as I have ſaid) to be aſſigned to the Sun, the ſemidiameter of which circles anſwereth to the quantity of the inclination of the ſaid Axis. And it is neceſſary, that the time of its Period be a year; for that ſuch is the time in which all the appearances and differences in the courſes of the ſpots do return. And that the revolution of this Axis, is made about the Poles of the other Axis parallel to that of the Ecliptick, & not about other points, the greateſt inclinations and greateſt incurvations, which are always of the ſame bigneſs, do clearly prove. So that finally, to maintain the Earth fixed in the centre, it will be neceſſary to aſſign to the Sun, two motions about its own centre, upon two ſeveral Axes, one of which finiſheth its converſion in a year, and the other in leſſe than a moneth; which aſſumption ſeemeth, to my underſtanding, very hard, and almoſt impoſſible; and this dependeth on the neceſſity of aſcribing to the ſaid Solar body two other motions about the Earth upon different Axes, deſcribing with one the Ecliptick in a year, and with the other forming ſpirals, or circles parallel to the Equinoctial one every day: whereupon that third motion which ought to be aſſigned to the Solar Clobe about its own centre (I mean not that almoſt monethly, which carrieth the ſpots about, but I ſpeak of that other which ought to paſſe thorow the Axis and Poles of this monethly one) ought not, for any reaſon that I ſee, to finiſh its Period rather in a year, as depending on the annual motion by the Ecliptick, than in twenty four hours, as depending on the diurnal motion upon the Poles of the Equinoctial. I know, that what I now ſpeak is very obſcure, but I ſhall make it plain unto you, when we come to ſpeak of the third motion annual, aſſigned by *Copernicus*, to the Earth. Now if theſe four motions, ſo incongruous with each other, (all which it would be neceſſary to aſſign to the ſelf ſame body of the Sun) may be reduced to one ſole and ſimple motion, aſſigned the Sun upon an Axis that never changeth poſition, and that without innovating any thing in the motions for ſo many other cauſes aſſigned to the Terreſtrial Globe, may ſo eaſily ſalve ſo many extravagant appearances in

the motions of the Solar ſpots, it ſeemeth really that ſuch an Hypotheſis ought not to be rejected.

This, *Simplicius*, is all that came into the minds of our friend, and my ſelf, that could be alledged in explanation of this *Phænomenon* by the *Copernicans*, and by the *Ptolomæans*, in defence of their opinions. Do you inferre from thence what your judgment perſwades you.

SIMP. I acknowledge my ſelf unable to interpoſe in ſo important a deciſion: And, as to my particular thoughts, I will ſtand neutral; and yet nevertheleſſe I hope that a time will come, when our minds being illumin'd by more lofty contemplations than theſe our humane reaſonings, we ſhall be awakened and freed from that miſt which now is ſo great an hinderance to our ſight.

SAGR. Excellent and pious is the counſel taken by *Simplicius*, and worthy to be entertained and followed by all, as that which being derived from the higheſt wiſdome and ſupreameſt authority, may onely, with ſecurity be received. But yet ſo far as humane reaſon is permitted to penetrate, confining my ſelf within the bounds of conjectures, and probable reaſons, I will ſay a little more reſolutely than *Simplicius* doth, that amongſt all the ingenuous ſubtilties I ever heard, I have never met with any thing of greater admiration to my intellect, nor that hath more abſolutely captivated my judgment, (alwayes excepting pure Geometrical and Arithmetical Demonſtrations) than theſe two conjectures taken, the one from the ſtations and retrogradations of the five Planets, and the other from theſe irregularities of the motions of the Solar ſpots: and becauſe they ſeem to me ſo eaſily and clearly to aſſign the true reaſon of ſo extravagant appearances, ſhewing as if they were but one ſole ſimple motion, mixed with ſo many others, ſimple likewiſe, but different from each other, without introducing any difficulty, rather with obviating thoſe that accompany the other Hypotheſis; I am thinking that I may rationally conclude, that thoſe who contumaciouſly withſtand this Doctrine, either never heard, or never underſtood, theſe ſo convincing arguments.

SALV. I will not aſcribe unto them the title either of convincing, or non-convincing; in regard my intention is not, as I have ſeveral times told you, to reſolve any thing upon ſo high a queſtion, but onely to propoſe thoſe natural and Aſtronomicall reaſons, which, for the one and other Syſteme, may be produced by me, leaving the determination to others; which determination cannot at laſt, but be very manifeſt: for one of the two poſitions being of neceſſity to be true, and the other of neceſſity to be falſe, it is a thing impoſſible that (alwayes confining our ſelves within

within the limits of humane doctrine) the reasons alledged for the true Hypothesis should not manifest themselves as concludent as those for the contrary vain and ineffectual.

SAGR. It will be time therefore, that we hear the objections of the little Book of * *Conclusions*, or Disquisitions which *Simplicius* did bring with him.

* I should have told you, that the true name of this concealed Authour is *Christopher Scheinerus*, and its title *Disquisitiones Mathematica.*

SIMP. Here is the Book, and this is the place where the Authour first briefly describeth the Systeme of the world, according to the Hypothesis of *Copernicus*, saying, *Terram igitur unà cum Luna, totoque hoc elementari mundo* Copernicus, &c.

SALV. Forbear a little, *Simplicius*, for methinks that this Authour, in this first entrance, shews himself to be but very ill verst in the Hypothesis which he goeth about to confute, in regard, he saith that *Copernicus* maketh the Earth, together with the Moon, to describe the * grand Orb in a year moving from East to West; a thing that as it is false and impossible, so was it never affirmed by *Copernicus*, who rather maketh it to move the contrary way, I mean from West to East, that is, according to the order of the Signes; whereupon we come to think the same to be the annual motion of the Sun, constituted immoveable in the centre of the Zodiack. See the too adventurous confidence of this man; to undertake the confutation of anothers Doctrine, and yet to be ignorant of the primary fundamentals; upon which his adversary layeth the greatest and most important part of all the Fabrick. This is a bad beginning to gain himself credit with his Reader; but let us go on.

* *i.e.* the Ecliptick

SIMP. Having explained the Universal Systeme, he beginneth to propound his objections against this annual motion: and the first are these, which he citeth Ironically, and in derision of *Copernicus*, and of his followers, writing that in this phantastical Hypothesis of the World one must necessarily maintain very grosse absurdities; namely, that the Sun, *Venus*, and *Mercury* are below the Earth; and that grave matters go naturally upwards, and the light downwards; and that *Christ*, our Lord, and Redeemer, ascended into Hell, and descended into Heaven, when he approached towards the Sun, and that when *Joshuah* commanded the Sun to stand still, the Earth stood still, or the Sun moved a contrary way to that of the Earth; and that when the Sun is in *Cancer*, the Earth runneth through *Capricorn*; and that the *Hyemal* (or Winter) Signes make the Summer, and the *Æstival* Winter; and that the Stars do not rise and set to the Earth, but the Earth to the Stars; and that the East beginneth in the West, and the West in the East; and, in a word, that almost the whole course of the World is inverted.

Instances of a certain Book Ironically propounded against Copernicus.

SALV. Every thing pleaseth me, except it be his having inter-

mixed places out of the ſacred Scriptures (alwayes venerable, and to be reverd) amongſt theſe, but two ſcurrilous fooleries, and attempting to wound with holy Weapons, thoſe who Philoſophating in jeſt, and for divertiſement, neither affirm nor deny, but, ſome preſuppoſals and poſitions being aſſumed, do familiarly argue.

SIMP. Truth is, he hath diſpleaſed me alſo, and that not a little; and eſpecially, by adding preſently after that, howbeit, the *Copernichiſts* anſwer, though but very impertinently to theſe and ſuch like other reaſons, yet can they not reconcile nor anſwer thoſe things that follow.

SALV. This is worſe than all the reſt; for he pretendeth to have things more efficacious and concludent than the Authorities of the ſacred Leaves; But I pray you, let us reverence them, and paſſe on to natural and humane reaſons: and yet if he give us amongſt his natural arguments, things of no more ſolidity, than thoſe hitherto alleadged, we may wholly decline this undertaking, for I as to my own parricular, do not think it fit to ſpend words in anſwering ſuch trifling impertinencies. And as to what he ſaith, that the *Copernicans* anſwer to theſe objections, *it is* moſt falſe, nor may it be thought, that any man ſhould ſet him ſelf to waſt his time ſo unprofitably.

Suppoſing the annual motion to belong to the Earth, it followeth, that one fixed Star, is bigger than the whole grand Orb.

SIMP. I concur with you in the ſame judgement; therefore let us hear the other inſtances that he brings, as much ſtronger. And obſerve here, how he with very exact computations concludeth, that if the grand Orb of the Earth, or the ecliptick, in which *Copernicus* maketh it to run in a year round the Sun, ſhould be as it were, inſenſible, in reſpect of the immenſitie of the Starry Sphære; according as the ſaid *Copernicus*, ſaith it is to be ſuppoſed, it would be neceſſary to grant and confirm, that the fixed Stars were remote from us, an unconceivable diſtance, and that the leſſer of them, were bigger than the whole grand Orb aforeſaid, and ſome other much bigger than the whole Sphære of *Saturn*; Maſſes certainly too exceſſively vaſt, unimaginable, and incredible.

Tycho his Argument grounded upon a falſe Hypotheſis.

Litigious Lawyers that are entertained in an ill cauſe, keep cloſe to ſome expreſſion fallen from the adverſe party at unawares.

SALV. I have heretofore ſeen ſuch another objection brought by *Tycho* againſt *Copernicus*, and this is not the firſt time that I have diſcovered the fallacy; or, to ſay better, the fallacies of this Argumentation; founded upon a moſt falſe Hypotheſis, and upon a Propoſition of the ſaid *Copernicus*, underſtood by his adverſaries, with too punctual a nicity, according to the practiſe of thoſe pleaders, who finding the flaw to be in the very merit of their cauſe, keep to ſome one word, fallen unawares from the contrary partie, and fly out into loud and tedious deſcants upon that. But for your better information; *Copernicus* having declared

thoſe

thoſe admirable conſequences which are derived from the Earths annual motion, to the other Planets, that is to ſay, of the * directions and retrogradations of the three uppermoſt in particular; he ſubjoyneth, that this apparent mutation (which is diſcerned more in *Mars* than in *Jupiter*, by reaſon *Jupiter* is more remote, and yet leſſe in *Saturn*, by reaſon it is more remote than *Jupiter*) in the fixed Stars, did remain imperceptible, by reaſon of their immenſe remoteneſſe from us, in compariſon of the diſtances of *Jupiter* or *Saturn*. Here the Adverſaries of this opinion riſe up, and ſuppoſing that fore-named imperceptibility of *Copernicus*, as if it had been taken by him, for a real and abſolute thing of nothing, and adding, that a fixed Star of one of the leſſer magnitudes, is notwithſtanding perceptible, ſeeing that it cometh under the ſence of ſeeing, they go on to calculate with the intervention of other falſe aſſumptions, and concluding that it is neceſſary by the *Copernican* Doctrine, to admit, that a fixed Star is much bigger than the whole grand Orb. Now to diſcover the vanity of this their whole proceeding, I ſhall ſhew that a fixed Star of the ſixth magnitude, being ſuppoſed to be no bigger than the Sun, one may thence conclude with true demonſtrations, that the diſtance of the ſaid fixed Stars from us, cometh to be ſo great, that the annual motion of the Earth, which cauſeth ſo great and notable variations in the Planets, appears ſcarce obſervable in them; and at the ſame time, I will diſtinctly ſhew the groſs fallacies, in the aſſumptions of *Copernicus* his Adverſaries.

* Or progreſſions.

The apparent diverſity of motion in the Planets, is inſenſible in the fixed Stars.

Suppoſing that a fixed Star of the ſixth magnitude is no bigger than the Sun, the diverſitie which is ſo great in the Planets, in the fixed Stars is almoſt inſenſible.

And firſt of all, I ſuppoſe with the ſaid *Copernicus*, and alſo with his oppoſers, that the Semidiameter of the grand Orb, which is the diſtance of the Earth from the Sun, containeth 1208 Semidiameters of the ſaid Earth. Secondly, I premiſe with the allowance aforeſaid, and of truth, that the * apparent diameter of the Sun in its mean diſtance, to be about half a degree, that is, 30. *min. prim.* which are 1800. ſeconds, that is, 108000. thirds. And becauſe the apparent Diameter of a fixed Star of the firſt magnitude, is no more than 5. ſeconds, that is, 300. thirds, and the Diameter of a fixed Star of the ſixth magnitude, 50. thirds, (and herein is the greateſt errour of the *Anti-Copernicans*) Therefore the Diameter of the Sun, containeth the Diameter of a fixed Star of the ſixth magnitude 2160 times. And therefore if a fixed Star of the ſixth magnitude, were ſuppoſed to be really equal to the Sun, and not bigger, which is the ſame as to ſay, if the Sun were ſo far removed, that its Diameter ſhould ſeem to be one of the 2160. parts of what it now appeareth, its diſtance ought of neceſſity to be 2160. times greater than now in effect it is, which is as much as to ſay, that the diſtance of the fixed Stars of the ſixth magnitude, is 2160. Semidiameters of the grand Orb.

The diſtance of the Sun, containeth 1208 Semid. of the Earth.

* The Diameter of the Sun, half a degree.

The Diameter of a fixed Star, of the firſt magnitude, and of one of the ſixth.

The apparent Diameter of the Sun, how much it is bigger than that of a fixed ſtar.

The distance of a fixed star of the sixth magnitude, how much it is, the star being supposed to be equal to the Sun.

Orb. And because the distance of the Sun from the Earth, contains by common consent 1208. Semidiameters of the said Earth, and the distance of the fixed Stars (as hath been said) 2160. Semediameters of the grand Orb, therefore the Semediameter of the Earth is much greater (that is almost double) in comparison of the grand Orb, than the Semediameter of the grand Orb, in relation to the distance of the Starry Sphære; and therefore the variation of aspect in the fixed Stars, caused by the Diameter of the grand Orb, can be but little more observable, than that which is observed in the Sun, occasioned by the Semediameter of the Earth.

In the fixed stars the diversitie of aspect, caused by the grand Orb, is little more then that caused by the Earth in the Sun.

SAGR. This is a great fall for the first step.

A star of the sixth magnitude, supposed by Tycho *and the Authour of the Book of Conclusions, an hundred and six millions of times bigger than needs.*

SALV. It is doubtlesse an errour; for a fixed Star of the sixth magnitude, which by the computation of this Authour, ought, for the upholding the proposition of *Copernicus*, to be as big as the whole grand Orb, onely by supposing it equal to the Sun, which Sun is lesse by far, than the hundred and six milionth part of the said grand Orb, maketh the starry Sphære so great and high as sufficeth to overthrow the instance brought against the said *Copernicus*.

SAGR. Favour me with this computation.

The computation of the magnitude of the fixed Stars, in respect to the grand Orb.

SALV. The supputation is easie and short. The Diameter of the Sun, is eleven semediameters of the Earth, and the Diameter of the grand Orb, contains 2416. of those same semediameters, by the ascent of both parties; so that the Diameter of the said Orb, contains the Suns Diameter 220. times very near. And because the Spheres are to one another, as the Cubes of their Diameters, let us make the Cube of 220. which is 10648000. and we shall have the grand Orb, an hundred and six millions, four hundred and eighty thousand times bigger than the Sun, to which grand Orb, a star of the fixth magnitude, ought to be equal, according to the assertion of this Authour.

SAGR. The errour then of these men, consisteth in being extreamly mistaken, in taking the apparent Diameter of the fixed Stars.

A common errour of all the Astronomers, touching the magnitude of the stars.

SALV. This is one, but not the onely errour of them; and indeed, I do very much admire how so many *Astronomers*, and those very famous, as are *Alfagranus*, *Albategnus*, *Tebizius*, and much more modernly the *Tycho's* and *Clavius's*, and in summ, all the predecessors of our *Academian*, should have been so grosly mistaken, in determining the magnitudes of all the Stars, as well fixed as moveable, the two Luminaries excepted out of that number; and that they have not taken any heed to the adventitious irradiations that deceitfully represent them an hundred and more times bigger, than when they are beheld, without those capilli-

tious

ous rayes, nor can this their inadvertency be excuſed, in regard that it was in their power to have beheld them at their pleaſure without thoſe treſſes, which is done, by looking upon them at their firſt appearance in the evening, or their laſt occultation in the comming on of day; and if none of the reſt, yet *Venus*, which oft times is ſeen at noon day, ſo ſmall, that one muſt ſharpen the ſight in diſcerning it; and again, in the following night, ſeemeth a great flake of light, might advertiſe them of their fallacy; for I will not believe that they thought the true *Diſcus* to be that which is ſeen in the obſcureſt darkneſſes, and not that which is diſcerned in the luminous *Medium*: for our lights, which ſeen by night afar off appear great, and neer at hand ſhew their true luſtre to be terminate and ſmall, might have eaſily have made them cautious; nay, if I may freely ſpeak my thoughts, I abſolutely believe that none of them, no not *Tycho* himſelf, ſo accurate in handling Aſtronomical Inſtruments, and that ſo great and accurate, without ſparing very great coſt in their conſtruction, did ever go about to take and meaſure the apparent diameter of any Star, the Sun and Moon excepted; but I think, that arbitrarily, and as we ſay, with the eye, ſome one of the more antient of them pronounced the thing to be ſo and ſo, and that all that followed him afterwards, without more ado, kept cloſe to what the firſt had ſaid; for if any one of them had applied himſelf to have made ſome new proof of the ſame, he would doubtleſſe have diſcovered the fraud.

Venus *renders the errour of Aſtronomers in determining the magnitudes of ſtars inexcuſable.*

SAGR. But if they wanted the Teleſcope, and you have already ſaid, that our *Friend* with that ſame Inſtrument came to the knowledge of the truth, they ought to be excuſed, and not accuſed of ignorance.

SALV. This would hold good, if without the Teleſcope the buſineſſe could not be effected. Its true, that this Inſtrument by ſhewing the *Diſcus* of the Star naked, and magnified an hundred or a thouſand times, rendereth the operation much more eaſie, but the ſame thing may be done, although not altogether ſo exactly, without the Inſtrument, and I have many times done the ſame, and my method therein was this. I have cauſed a rope to be hanged towards ſome Star, and I have made uſe of the Conſtellation, called the *Harp*, which riſeth between the North and * North-eaſt, and then by going towards, and from the ſaid rope, interpoſed between me and the Star, I have found the place from whence the thickneſſe of the rope hath juſt hid the Star from me: this done, I have taken the diſtance from the eye to the rope, which was one of the ſides including the angle that was compoſed in the eye, and * which inſiſteth upon the thickneſſe of the rope, and which is like, yea the ſame with the angle

A way to meaſure the apparent diameter of a ſtar.

* Rendred in Latine *Corum*, that is to ſay, North-weſt.

* *i.e.* Is ſubtended by.

angle in the Starry Sphere, that inſiſteth upon the diameter of the Star, and by the proportion of the ropes thickneſſe to the diſtance from the eye to the rope, by the table of Arches and Chords, I have immediately found the quantity of the angle; uſing all the while the wonted caution that is obſerved in taking angles ſo acute, not to forme the concourſe of the viſive rayes in the centre of the eye, where they are onely refracted, but beyond the eye, where really the pupils greatneſſe maketh them to concur.

SAGR. I apprehend this your cautelous procedure, albeit I have a kind of hæſitancy touching the ſame, but that which moſt puzzleth me is, that in this operation, if it be made in the dark of night, methinks that you meaſure the diameter of the irradiated *Diſcus*, and not the true and naked face of the Star.

SALV. Not ſo, Sir, for the rope in covering the naked body of the Star, taketh away the rayes, which belong not to it, but to our eye, of which it is deprived ſo ſoon as the true *Diſcus* thereof is hid; and in making the obſervation, you ſhall ſee, how unexpectedly a little cord will cover that reaſonable big body of light, which ſeemed impoſſible to be hid, unleſſe it were with a much broader Screene: to meaſure, in the next place, and exactly to find out, how many of thoſe thickneſſes of the rope interpoſe in the diſtance between the ſaid rope and the eye, I take not onely one diameter of the rope, but laying many pieces of the ſame together upon a Table, ſo that they touch, I take with a pair of Compaſſes the whole ſpace occupied by fifteen, or twenty of them, and with that meaſure I commenſurate the diſtance before with another ſmaller cord taken from the rope to the concourſe of the viſive rayes. And with this ſufficiently-exact operation I finde the apparent diameter of a fixed Star of the firſt magnitude, commonly eſteemed to be 2 *min. pri.* and alſo 3 *min. prim.* by *Tycho* in his *Aſtronomical Letters*, *cap.* 167. to be no more than 5 *ſeconds*, which is one of the 24. or 36. parts of what they have held it: ſee now upon what groſſe errours their Doctrines are founded.

The diameter of a fixed ſtar of the firſt magnitude not more than five ſec. min.

SAGR. I ſee and comprehend this very well, but before we paſſe any further, I would propound the doubt that ariſeth in me in the finding the concourſe [or interſection] of the viſual rayes beyond the eye, when obſervation is made of objects comprehended between very acute angles; and my ſcruple proceeds from thinking, that the ſaid concourſe may be ſometimes more remote, and ſometimes leſſe; and this not ſo much, by meanes of the greater or leſſer magnitude of the object that is beheld, as becauſe that in obſerving objects of the ſame bigneſſe, it ſeems to me that the concourſe of the rayes, for certain other reſpects

ſpects ought to be made more and leſſe remote from the eye.

SALV. I ſee already, whither the apprehenſion of *Sagredus*, a moſt diligent obſerver of Natures ſecrets, tendeth; and I would lay any wager, that amongſt the thouſands that have obſerved Cats to contract and inlarge the pupils of their eyes very much, there are not two, nor haply one that hath obſerved the like effect to be wrought by the pupils of men in ſeeing, whilſt the *medium* is much or little illumin'd, and that in the open light the circlet of the pupil diminiſheth conſiderably: ſo that in looking upon the face or *Diſcus* of the Sun, it is reduced to a ſmallneſſe leſſer than a grain of * *Panick*, and in beholding objects that do not ſhine, and are in a leſſe luminous *medium*, it is inlarged to the bigneſſe of a * Lintel or more; and in ſumme this expanſion and contraction differeth in more than decuple proportion: From whence it is manifeſt, that when the pupil is much dilated, it is neceſſary that the angle of the rayes concourſe be more remote from the eye; which happeneth in beholding objects little luminated. This is a Doctrine which *Sagredus* hath, juſt now, given me the hint of, whereby, if we were to make a very exact obſervation, and of great conſequence, we are advertized to make the obſervation of that concourſe in the act of the ſame, or juſt ſuch another operation; but in this our caſe, wherein we are to ſhew the errour of *Aſtronomers*, this accurateneſſe is not neceſſary: for though we ſhould, in favour of the contrary party, ſuppoſe the ſaid concourſe to be made upon the pupil it ſelf, it would import little, their miſtake being ſo great. I am not certain, *Sagredus*, that this would have been your objection.

The circle of the pupil of the eye enlargeth and contracteth.

+ *Panicum*, a ſmall grain like to Mill, I take it to the ſame with that called Bird Seed.

SAGR. It is the very ſame, and I am glad that it was not altogether without reaſon, as your concurrence in the ſame aſſureth me; but yet upon this occaſion I would willingly hear what way may be taken to finde out the diſtance of the concourſe of the viſual rayes.

SALV. The method is very eaſie, and this it is, I take two long * labels of paper, one black, and the other white, and make the black half as broad as the white; then I ſtick up the white againſt a wall, and far from that I place the other upon a ſtick, or other ſupport, at a diſtance of fifteen or twenty yards, and receding from this, ſecond another ſuch a ſpace in the ſame right line, it is very manifeſt, that at the ſaid diſtance the right lines will concur, that departing from the termes of the breadth of the white piece, ſhall paſſe cloſe by the edges of the other label placed in the mid-way; whence it followeth, that in caſe the eye were placed in the point of the ſaid concourſe or interſection, the black ſlip of paper in the midſt would preciſely hide the op-

* Striſce.

How to find the diſtance of the rays concourſe from the pupil.

poſite blank, if the ſight were made in one onely point; but if we ſhould find, that the edges of the white cartel appear diſcovered, it ſhall be a neceſſary argument that the viſual rayes do not iſſue from one ſole point. And to make the white label to be hid by the black, it will be requiſite to draw neerer with the eye: Therefore, having approached ſo neer, that the intermediate label covereth the other, and noted how much the required approximation was, the quantity of that approach ſhall be the certain meaſure, how much the true concourſe of the viſive rayes, is remote from the eye in the ſaid operation, and we ſhall moreover have the diameter of the pupil, or of that circlet from whence the viſive rayes proceed: for it ſhall be to the breadth of the black paper, as is the diſtance from the concourſe of the lines, that are produced by the edges of the papers to the place where the eye ſtandeth, when it firſt ſeeth the remote paper to be hid by the intermediate one, as that diſtance is, I ſay, to the diſtance that is between thoſe two papers. And therefore when we would, with exactneſſe, meaſure the apparent diameter of a Star, having made the obſervation in manner, as aforeſaid, it would be neceſſary to compare the diameter of the rope to the diameter of the pupil; and having found *v.g.* the diameter of the rope to be quadruple to that of the pupil, and the diſtance of the eye from the rope to be, for example, thirty yards, we would ſay, that the true concourſe of the lines produced from the ends or extremities of the diameter of the ſtar, by the extremities of the diameter of the rope, doth fall out to be fourty yards remote from the ſaid rope, for ſo we ſhall have obſerved, as we ought, the proportion between the diſtance of the rope from the concourſe of the ſaid lines, and the diſtance from the ſaid concourſe to the place of the eye, which ought to be the ſame that is between the diameter of the rope, and diameter of the pupil.

SAGR. I have perfectly underſtood the whole buſineſſe, and therefore let us hear what *Simplicius* hath to alledge in defence of the *Anti-Copernicans*.

SIMP. Albeit that grand and altogether incredible inconvenience inſiſted upon by theſe adverſaries of *Copernicus* be much moderated and abated by the diſcourſe of *Salviatus*, yet do I not think it weakened ſo, as that it hath not ſtrength enough left to foil this ſame opinion. For, if I have rightly apprehended the chief and ultimate concluſion, in caſe, the ſtars of the ſixth magnitude were ſuppoſed to be as big as the Sun, (which yet I can hardly think) yet it would ſtill be true, that the grand Orb [or Ecliptick] would occaſion a mutation and variation in the ſtarry Sphere, like to that which the ſemidiameter of the Earth produceth in the Sun, which yet is obſervable; ſo that neither that, no

nor

nor a leſſe mutation being diſcerned in the fixed Stars, methinks that by this means the annual motion of the Earth is deſtroyed and overthrown.

SALV. You might very well ſo conclude, *Simplicius*, if we had nothing elſe to ſay in behalf of *Copernicus*: but we have many things to alledge that yet have not been mentioned; and as to that your reply, nothing hindereth, but that we may ſuppoſe the diſtance of the fixed Stars to be yet much greater than that which hath been allowed them, and you your ſelf, and whoever elſe will not derogate from the propoſitions admitted by *Ptolomy*'s ſectators, muſt needs grant it as a thing moſt requiſite to ſuppoſe the Starry Sphere to be very much bigger yet than that which even now we ſaid that it ought to be eſteemed. For all Aſtronomers agreeing in this, that the cauſe of the greater tardity of the Revolutions of the Planets is, the majority of their Spheres, and that therefore *Saturn* is more ſlow than *Jupiter*, and *Jupiter* than the Sun, for that the firſt is to deſcribe a greater circle than the ſecond, and that than this later; &c. conſidering that *Saturn* v.g. the altitude of whole Orb is nine times higher than that of the Sun, and that for that cauſe the time of one Revolution of *Saturn*, is thirty times longer than that of a converſion of the Sun, in regard that according to the Doctrine of *Ptolomy*, one converſion of the ſtarry Sphere is finiſhed in 36000. years, whereas that of *Saturn* is conſummate in thirty, and that of the Sun in one, arguing with a like proportion, and ſaying, if the Orb of *Saturn*, by reaſon it is nine times bigger than that of the Sun, revolves in a time thirty times longer, by converſion, how great ought that Orb to be, which revolves 36000. times more ſlowly? it ſhall be found that the diſtance of the ſtarry Sphere ought to be 10800 ſemidiameters of the grand Orb, which ſhould be full five times bigger than that, which even now we computed it to be, in caſe that a fixed Star of the ſixth magnitude were equal to the Sun: Now ſee how much leſſer yet, upon this account, the variation occaſioned in the ſaid Stars, by the annual motion of the Earth, ought to appear. And if at the ſame rate we would argue the diſtance of the ſtarry Sphere from *Jupiter*, and from *Mars*, that would give it us to be 15000. and this 27000 ſemidiameters of the grand Orb, to wit, the firſt ſeven, and the ſecond twelve times bigger than what the magnitude of the fixed Star, ſuppoſed equal to the Sun, did make it.

All Aſtronomers agree that the greater magnitudes of the Orbes is the cauſe of the tardity of the converſions.

By another ſuppoſition taken from Aſtronomers, the diſtance of the fixed Stars is calculated to be 10800 *ſemidiameters of the grand Orb.*

By the proportion of Jupiter *and of* Mars, *the ſtarry Sphere is found to be yet more remote.*

SIMP. Methinks that to this might be anſwered, that the motion of the ſtarry Sphere hath, ſince *Ptolomy*, been obſerved not to be ſo ſlow as he accounted it; yea, if I miſtake not, I have heard that *Copernicus* himſelf made the Obſervation.

SALV. You ſay very well; but you alledge nothing in that which may favour the cauſe of the *Ptolomæans* in the leaſt, who did never yet reject the motion of 36000. years in the ſtarry Sphere, for that the ſaid tardity would make it too vaſt and immenſe. For if that the ſaid immenſity was not to be ſuppoſed in Nature, they ought before now to to have denied a converſion ſo ſlow as that it could not with good proportion adapt it ſelf, ſave onely to a Sphere of monſtrous magnitude.

SAGR. Pray you, *Salviatus*, let us loſe no more time in proceeding, by the way of theſe proportions with people that are apt to admit things moſt diſ-proportionate, ſo that its impoſſible to win any thing upon them this way: and what more diſproportionate proportion can be imagined than that which theſe men ſwallow down, and admit, in that writing, that there cannot be a more convenient way to diſpoſe the Cœleſtial Spheres, in order, than to regulate them by the differences of the times of their periods, placing from one degree to another the more ſlow above the more ſwift, when they have conſtituted the Starry Sphere higher than the reſt, as being the ſloweſt, they frame another higher ſtill than that, and conſequently greater, and make it revolve in twenty four hours, whilſt the next below, it moves not round under 36000. years?

SALV. I could wiſh, *Simplicius*, that ſuſpending for a time the affection that you bear to the followers of your opinion, you would ſincerely tell me, whether you think that they do in their minds comprehend that magnitude, which they reject afterwards as uncapable for its immenſity to be aſcribed to the Univerſe. For I, as to my own part, think that they do not; But believe, that like as in the apprehenſion of numbers, when once a man begins to paſſe thoſe millions of millions, the imagination is confounded, and can no longer form a conceipt of the ſame, ſo it happens alſo in comprehending immenſe magnitudes and diſtances; ſo that there intervenes to the comprehenſion an effect like to that which befalleth the ſenſe; For whileſt that in a ſerene night I look towards the Stars, I judge, according to ſenſe, that their diſtance is but a few miles, and that the fixed Stars are not a jot more remote than *Jupiter* or *Saturn*, nay than the Moon. But without more ado, conſider the controverſies that have paſt between the Aſtronomers and Peripatetick Philoſophers, upon occaſion of the new Stars of *Caſſiopeia* and of *Sagittary*, the Aſtronomers placing them amongſt the fixed Stars, and the Philoſophers believing them to be below the Moon. So unable is our ſenſe to diſtinguiſh great diſtances from the greateſt, though theſe be in reality many thouſand times greater than thoſe. In a word, I ask of thee, O fooliſh man! Doth thy imagination comprehend that

Immenſe magnitudes and numbers are incomprehenſible by our underſtanding.

that vaſt magnitude of the Univerſe, which thou afterwards judgeſt to be too immenſe? If thou comprehendeſt it; wilt thou hold that thy apprehenſion extendeth it ſelf farther than the Divine Power? wilt thou ſay, that thou canſt imagine greater things than thoſe which God can bring to paſſe? But if thou apprehendeſt it not, why wilt thou paſſe thy verdict upon things beyond thy comprehenſion?

SIMP. All this is very well, nor can it be denied, but that Heaven may in greatneſſe ſurpaſſe our imagination, as alſo that God might have created it thouſands of times vaſter than now it is; but we ought not to grant any thing to have been made in vain, and to be idle in the Univerſe. Now, in that we ſee this admirable order of the Planets, diſpoſed about the Earth in diſtances proportionate for producing their effects for our advantage, to what purpoſe is it to interpoſe afterwards between the ſublime Orb of *Saturn* and the ſtarry Sphere, a vaſt vacancy, without any ſtar that is ſuperfluous, and to no purpoſe? To what end? For whoſe profit and advantage?

SALV. Methinks we arrogate too much to our ſelves, *Simplicius*, whilſt we will have it, that the onely care of us, is the adæquate work, and bound, beyond which the Divine Wiſdome and Power doth, or diſpoſeth of nothing. But I will not conſent, that we ſhould ſo much ſhorten its hand, but deſire that we may content our ſelves with an aſſurance that God and Nature are ſo imployed in the governing of humane affairs, that they could not more apply themſelves thereto, although they had no other care than onely that of mankind; and this, I think, I am able to make out by a moſt pertinent and moſt noble example, taken from the operation of the Suns light, which whileſt it attracteth theſe vapours, or ſcorcheth that plant, it attracteth, it ſcorcheth them, as if it had no more to do; yea, in ripening that bunch of grapes, nay that one ſingle grape, it doth apply it ſelf ſo, that it could not be more intenſe, if the ſum of all its buſineſs had been the only maturation of that grape. Now if this grape receiveth all that it is poſſible for it to receive from the Sun, not ſuffering the leaſt injury by the Suns production of a thouſand other effects at the ſame time; it would be either envy or folly to blame that grape, if it ſhould think or wiſh that the Sun would onely appropriate its rayes to its advantage. I am confident that nothing is omitted by the Divine Providence, of what concernes the government of humane affairs; but that there may not be other things in the Univerſe, that depend upon the ſame infinite Wiſdome, I cannot, of my ſelf, by what my reaſon holds forth to me, bring my ſelf to believe. However, if it were not ſo, yet ſhould I not forbear to believe the reaſons laid before me by ſome

God & Nature do imploy themſelves in caring for men, as if they minded nothing elſe.

An example of Gods care of mankind taken from the Sun.

ſome more ſublime intelligence. In the mean time, if one ſhould tell me, that an immenſe ſpace interpoſed between the Orbs of the Planets and the Starry Sphere, deprived of ſtars and idle, would be vain and uſeleſſe, as likewiſe that ſo great an immenſity for receipt of the fixed ſtars, as exceeds our utmoſt comprehenſion would be ſuperfluous, I would reply, that it is raſhneſſe to go about to make our ſhallow reaſon judg of the Works of God, and to call vain and ſuperfluous, whatſoever thing in the Univerſe is not ſubſervient to us.

It is great raſhneſſe to cenſure that to be ſuperfluous in the Univerſe, which we do not perceive to be made for us.

SAGR. Say rather, and I believe you would ſay better, that we know not what is ſubſervient to us; and I hold it one of the greateſt vanities, yea follies, that can be in the World, to ſay, becauſe I know not of what uſe *Jupiter* or *Saturn* are to me, that therefore theſe Planets are ſuperfluous, yea more, that there are no ſuch things *in rerum natura*; when as, oh fooliſh man! I know not ſo much as to what purpoſe the arteries, the griſtles, the ſpleen, the gall do ſerve; nay I ſhould not know that I have a gall, ſpleen, or kidneys, if in many defected Corps, they were not ſhewn unto me; and then onely ſhall I be able to know what the ſpleen worketh in me, when it comes to be taken from me. To be able to know what this or that Cœleſtial body worketh in me (ſeeing you will have it that all their influences direct themſelves to us) it would be requiſite to remove that body for ſome time; and then whatſoever effect I ſhould find wanting in me, I would ſay that it depended on that ſtar. Moreover, who will preſume to ſay that the ſpace which they call too vaſt and uſeleſſe between *Saturn* and the fixed ſtars, is void of other mundane bodies? Muſt it be ſo, becauſe we do not ſee them? Then the four Medicean Planets, and the companions of *Saturn* came firſt into Heaven, when we began to ſee them, and not before? And by this rule the innumerable other fixed ſtars had no exiſtence before that men did look on them? and the cloudy conſtellations called *Nebuloſæ* were at firſt only white flakes, but afterwards with the Teleſcope we made them to become conſtellations of many lucid and bright ſtars. Oh preſumptious, rather oh raſh ignorance of man!

By depriving Heaven of ſome ſtar, one might come to know what influence it hath upon us.

Many things may be in Heaven, that are inviſible to us

SALV. It's to no purpoſe *Sagredus*, to ſally out any more into theſe unprofitable exaggerations: Let us purſue our intended deſigne of examining the validity of the reaſons alledged on either ſide, without determining any thing, remitting the judgment thereof when we have done, to ſuch as are more knowing. Returning therefore to our natural and humane diſquiſitions, I ſay, that great, little, immenſe, ſmall, *&c.* are not abſolute, but relative terms, ſo that the ſelf ſame thing compared with divers others, may one while be called immenſe, and another while

Great, ſmall, immenſe, &c. are relative terms.

while imperceptible, not to say small. This being so, I demand in relation to what the Starry Sphere of *Copernicus* may be called over vast. In my judgment it cannot be compared, or said to be such, unless it be in relation to some other thing of the same kind; now let us take the very least of the same kind, which shall be the Lunar Orb; and if the Starry Orb may be so censured to be too big in respect to that of the Moon, every other magnitude that with like or greater proportion exceedeth another of the same kind, ought to be adjudged too vast, and for the same reason to be denied that they are to be found in the World; and thus an Elephant, and a Whale, shall without more ado be condemned for *Chymæra's*, and Poetical fictions, because that the one as being too vast in relation to an Ant, which is a Terrestrial animal, and the other in respect to the *Gudgeon, which is a Fish, and are certainly seen to be *in rerum natura*, would be too immeasurable; for without all dispute, the Elephant and Whale exceed the Ant and Gudgeon in a much greater proportion than the Starry Sphere doth that of the Moon, although we should fancy the said Sphere to be as big as the *Copernican* Systeme maketh it. Moreover, how hugely big is the Sphere of *Jupiter*, or that of *Saturn*, designed for a receptacle but for one single star; and that very small in comparison of one of the fixed? Certainly if we should assign to every one of the fixed stars for its receptacle so great a part of the Worlds space, it would be necessary to make the Orb wherein such innumerable multitudes of them reside, very many thousands of times bigger than that which serveth the purpose of *Copernicus*. Besides, do not you call a fixed star very small, I mean even one of the most apparent, and not one of those which shun our sight; and do we not call them so in respect of the vast space circumfused? Now if the whole Starry Sphere were one entire lucid body; who is there, that doth not know that in an infinite space there might be assigned a distance so great, as that the said lucid Sphere might from thence shew as little, yea less than a fixed star, now appeareth beheld from the Earth? From thence therefore we should *then* judg that self same thing to be little, which *now* from hence we esteem to be immeasurably great.

Vanity of those mens discourse who judg the starry sphere too vast in the Copernican *Hypothesis.*

**Spilloncola*, which is here put for the least of Fishes.

The space assigned to a fixed star, is much lesse than that of a Planet.

A star is called in respect of the space that environs it.

The whole starry sphere beheld from a great distance might appear as small as one single star.

SAGR. Great in my judgment, is the folly of those who would have had God to have made the World more proportinal to the narrow capacities of their reason, than to his immense, rather infinite power.

SIMP. All this that you say is very true; but that upon which the adversary makes a scruple, is, to grant that a fixed star should be not onely equal to, but so much bigger than the Sun; when as they both are particular bodies situate within the Starry

Starry Orb: "And indeed in my opinion this Authour very "pertinently queſtioneth and asketh: To what end, and "for whoſe ſake are ſuch huge machines made? Were they "produced for the Earth, for an inconſiderable point? And "why ſo remote? To the end they might ſeem ſo very ſmall, "and might have no influence at all upon the Earth? To "what purpoſe is ſuch a needleſſe monſtrous *immenſity be- "tween them and *Saturn*? All thoſe aſſertions fall to the "ground that are not upheld by probable reaſons.

Inſtances of the Authour of the Concluſions by way of interrogation.

* Or Gulph.

SALV. I conceive by the queſtions which this perſon asketh, that one may collect, that in caſe the Heavens, the Stars, and the quantity of their diſtances and magnitudes which he hath hitherto held, be let alone, (although he never certainly fancied to himſelf any conceivable magnitude thereof) he perfectly diſcerns and comprehends the benefits that flow from thence to the Earth, which is no longer an inconſiderable thing; nor are they any longer ſo remote as to appear ſo very ſmall, but big enough to be able to operate on the Earth; and that the diſtance between them and *Saturn* is very well proportioned, and that he, for all theſe things, hath very probable reaſons; of which I would gladly have heard ſome one: but being that in theſe few words he confounds and contradicts himſelf, it maketh me think that he is very poor and ill furniſhed with thoſe probable reaſons, and that thoſe which he calls reaſons, are rather fallacies, or dreams of an over-weening fancy. For I ask of him, whether theſe Celeſtial bodies truly operate on the Earth, and whether for the working of thoſe effects they were produced of ſuch and ſuch magnitudes, and diſpoſed at ſuch and ſuch diſtances, or elſe whether they have nothing at all to do with Terrene mattets. If they have nothing to do with the Earth; it is a great folly for us that are Earth-born, to offer to make our ſelves arbitrators of their magnitudes, and regulators of their local diſpoſitions, ſeeing that we are altogether ignorant of their whole buſineſſe and concerns; but if he ſhall ſay that they do operate, and that they are directed to this end, he doth affirm the ſame thing which a little before he denied, and praiſeth that which even now he condemned, in that he ſaid, that the Celeſtial bodies ſituate ſo far remote as that they appear very ſmall, cannot have any influence at all upon the Earth. But, good Sir, in the Starry Sphere pre-eſtabliſhed at its preſent diſtance, and which you did acknowledg to be in your judgment, well proportioned to have an influence upon theſe Terrene bodies, many ſtars appear very ſmall, and an hundred times as many more are wholly inviſible unto us (which is an appearing yet leſſe than very ſmall) therefore it is neceſſary that (contradicting your ſelf) you do now

Anſwers to the interrogatories of the ſaid Authour.

The Authour of the Concluſions confound and contradicts himſelfin his interrogations.

Interogatories put to the Authour of the Concluſions, by which the weakneſſe of his is made appear.

now deny their operation upon the the Earth; or elſe that (ſtill contradicting your ſelf) you grant that their appearing very ſmall doth not in the leaſt leſſen their influence; or elſe that (and this ſhall be a more ſincere and modeſt conceſſion) you acknowledg and freely confeſſe, that our paſſing judgment upon their magnitudes and diſtances is a vanity, not to ſay preſumption or raſhneſſe.

SIMP. Truth is, I my ſelf did alſo, in reading this paſſage perceive the manifeſt contradiction, in ſaying, that the Stars (if one may ſo ſpeak) of *Copernicus* appearing ſo very ſmall, could not operate on the Earth, and not perceiving that he had granted an influence upon the Earth to thoſe of *Ptolomy*, and his ſectators, which appear not only very ſmall, but are, for the moſt part, very invitible.

SALV. But I proceed to another conſideration: What is the reaſon, doth he ſay, why the ſtars appear ſo little? Is it haply, becauſe they ſeem ſo to us? Doth not he know, that this commeth from the Inſtrument that we imploy in beholding them, to wit, from our eye? And that this is true, by changing Inſtrument, we ſhall ſee them bigger and bigger, as much as we will. And who knows but that to the Earth, which beholdeth them without eyes, they may not ſhew very great, and ſuch as in reality they are? But it's time that, omitting theſe trifles, we come to things of more moment; and therefore I having already demonſtrated theſe two things: Firſt, how far off the Firmament ought to be placed to make, that the grand Orb cauſeth no greater difference than that which the Terreſtrial Orb occaſioneth in the remoteneſſe of the Sun; And next, how likewiſe to make that a ſtar of the Firmament appear to us of the ſame bigneſſe, as now we ſee it, it is not neceſſary to ſuppoſe it bigger than the Sun; I would know whether *Tycho*, or any of his adherents hath ever attempted to find out, by any means, whether any appearance be to be diſcovered in the ſtarry Sphere, upon which one may the more reſolutely deny or admit the annual motion of the Earth.

That remote objects appeare ſo ſmall, is the defect of the eye, as is demonſtrated.

SAGR. I would anſwer for them, that there is not, no nor is there any need there ſhould; ſeeing that it is *Copernicus* himſelf that ſaith, that no ſuch diverſity is there: and they, arguing *ad hominem*, admit him the ſame; and upon this aſſumption they demonſtrate the improbability that followeth thereupon, namely, that it would be neceſſary to make the Sphere ſo immenſe, that a fixed ſtar, to appear unto us as great as it now ſeems, ought of neceſſity to be of ſo immenſe a magnitude, as that it would exceed the bigneſſe of the whole grand Orb, a thing, which notwithſtanding, as they ſay, is altogether incredible.

Tycho nor his followers ever attempted to ſee whether there are any appearances in the Firmament for or againſt the annual motion.

SALV. I am of the ſame judgment, and verily believe that they argue *contra hominem*, ſtudying more to defend another man, than deſiring to come to the knowledge of the truth. And I do not only believe, that none of them ever applied themſelves to make any ſuch obſervation, but I am alſo uncertain, whether any of them do know what alteration the Earths annual motion ought to produce in the fixed ſtars, in caſe the ſtarry Sphere were not ſo far diſtant, as that in them the ſaid diverſity, by reaſon of its minuity diſ-appeareth; for their ſurceaſing that inquiſition, and referring themſelves to the meer aſſertion of *Copernicus*, may very well ſerve to convict a man, but not to acquit him of the fact: For its poſſible that ſuch a diverſity may be, and yet not have been ſought for; or that either by reaſon of its minuity, or for want of exact Inſtruments it was not diſcovered by *Copernicus*; for though it were ſo, this would not be the firſt thing, that he either for want of Inſtruments, or for ſome other defect hath not known; and yet he proceeding upon other ſolid and rational conjectures, affirmeth that, which the things by him not diſcovered do ſeem to contradict: for, as hath been ſaid already, without the Teleſcope, neither could *Mars* be diſcerned to increaſe 60. times; nor *Venus* 40. more in that than in this poſition; yea, their differences appear much leſſe than really they are: and yet nevertheleſſe it is certainly diſcovered at length, that thoſe mutations are the ſame, to an hair that the *Copernican* Syſteme required. Now it would be very well, if with the greateſt accurateneſſe poſſible one ſhould enquire whether ſuch a mutation as ought to be diſcoverable in the fixed ſtars, ſuppoſing the annual motion of the Earth, would be obſerved really and in effect, a thing which I verily believe hath never as yet been done by any; done, ſaid I? no, nor haply (as I ſaid before) by *many* well underſtood how it ought to be done. Nor ſpeak I this at randome, for I have heretofore ſeen a certain Manuſcript of one of theſe *Anti-Copernicans*, which ſaid, that there would neceſſarily follow, in caſe that opinion were true, a continual riſing and falling of the Pole from ſix moneths to ſix moneths, according as the Earth in ſuch a time, by ſuch a ſpace as is the diameter of the grand Orb, retireth one while towards the North, and another while towards the South; and yet it ſeemed to him reaſonable, yea neceſſary, that we, following the Earth, when we were towards the North ſhould have the Pole more elevated than when we are towards the South. In this very error did one fall that was otherwiſe a very skilful Mathematician, & a follower of *Copernic.* as *Tycho* relateth in his **Progymnaſma.pag.*684. which ſaid, that he had obſerved the Polar altitude to vary, and to differ in Summer from what it is in Winter: and becauſe *Tycho* denieth the merit of

Aſtronomers, perhaps, have not known what appearances ought to follow upon the annual motion of the Earth.

Copernicus *underſtood not ſome things for want of Inſtruments.*

Tycho *and others argue againſt the annual motion, from the invariable elevation of the Pole.*

* Chriſtophorus Rothmannus.

of the cauſe, but findeth no fault with the method of it; that is, denieth that there is any mutation to be ſeen in the altitude of the Pole, but doth not blame the inquiſition, for not being adapted to the finding of what is ſought, he thereby ſheweth, that he alſo eſteemed the Polar altitude varied, or not varied every ſix moneths, to be a good teſtimony to diſprove or inferre the annual motion of the Earth.

SIMP. In truth, *Salviatus*, my opinion alſo tells me, that the ſame muſt neceſſarily enſue: for I do not think that you will deny me, but that if we walk only 60. miles towards the North, the Pole will riſe unto us a degree higher, and that if we move 60. miles farther Northwards, the Pole will be elevated to us a degree more; &c. Now if the approaching or receding 60. miles onely, make ſo notable a change in the Polar altitudes, what alteration would follow, if the Earth and we with it, ſhould be tranſported, I will not ſay 60. miles, but 60. thouſand miles that way.

SALV. It would follow (if it ſhould proceed in the ſame proportion) that the Pole ſhall be elevated a thouſand degrees. See, *Simplicius*, what a long rooted opinion can do. Yea, by reaſon you have fixed it in your mind for ſo many years, that it is Heaven, that revolveth in twenty four hours, and not the Earth, and that conſequently the Poles of that Revolution are in Heaven, and not in the Terreſtrial Globe, cannot now, in an hours time ſhake off this habituated conceipt, and take up the contrary, fancying to your ſelf, that the Earth is that which moveth, only for ſo long time as may ſuffice to conceive of what would follow, thereupon ſhould that lye be a truth. If the Earth *Simplicius*, be that which moveth in its ſelf in twenty four hours, in it are the Poles, in it is the Axis, in it is the Equinoctial, that is, the grand Circle, deſcribed by the point, equidiſtant from the Poles, in it are the infinite Parallels bigger and leſſer deſcribed by the points of the ſuperficies more and leſſe diſtant from the Poles, in it are all theſe things; and not in the ſtarry Sphere; which, as being immoveable, wants them all, and can only by the imagination be conceived to be therein, prolonging the Axis of the Earth ſo far, till that determining, it ſhall mark out two points placed right over our Poles, and the plane of the Equinoctial being extended, it ſhall deſcribe in Heaven a circle like it ſelf. Now if the true Axis, the true Poles, the true Equinoctial, do not change in the Earth ſo long as you continue in the ſame place of the Earth, and though the Earth be tranſported, as you do pleaſe, yet you ſhall not change your habitude either to the Poles, or to the circles, or to any other Earthly thing; and this becauſe, that that tranſpoſition being common to you and to all Terreſtrial

Motion where it is common, is as if it never were.

things; and that motion where it is common, is as if it never were; and as you change not habitude to the Terreſtrial Poles (habitude I ſay, whether that they riſe, or deſcend) ſo neither ſhall you change poſition to the Poles imagined in Heaven; alwayes provided that by Celeſtial Poles we underſtand (as hath been already defined) thoſe two points that come to be marked out by the prolongation of the Terreſtrial Axis unto that length. Tis true thoſe points in Heaven do change, when the Earths tranſportment is made after ſuch a manner, that its Axis cometh to paſſe by other and other points of the immoveable Celeſtial Sphere, but our habitude thereunto changeth not, ſo as that the ſecond ſhould be more elevated to us than the firſt. If any one will have one of the points of the Firmament, which do anſwer to the Poles of the Earth to aſcend, and the other to deſcend, he muſt walk along the Earth towards the one, receding from the other; for the tranſportment of the Earth, and with it us our ſelves, (as I told you before) operates nothing at all.

An example fitted to prove that the altitude of the Pole ought not to vary by means of the Earths annual motion.

SAGR. Permit me, I beſeech you *Salviatus*, to make this a little more clear by an example, which although groſſe, is accommodated to this purpoſe. Suppoſe your ſelf, *Simplicius*, to be aboard a Ship, and that ſtanding in the Poope, or Hin-deck; you have directed a Quadrant, or ſome other Aſtronomical Inſtrument, towards the top of the Top-gallant-Maſt, as if you would take its height, which ſuppoſe it were *v. gr.* 40. degrees, there is no doubt, but that if you walk along the * Hatches towards the Maſt 25. or 30. paces; and then again direct the ſaid Inſtrument to the ſame Top-Gallant-Top. You ſhall find its elevation to be greater, and to be encreaſed *v. gr.* 10. degrees; but if inſtead of walking thoſe 25. or 30. paces towards the Maſt, you ſtand ſtill at the Sterne, and make the whole Ship to move thitherwards, do you believe that by reaſon of the 25. or 30. paces that it had paſt, the elevation of the Top-Gallant-Top would ſhew 10. degrees encreaſed?

* *Corſia*, the bank or bench on which ſlaves ſit in a Gally.

SIMP. I believe and know that it would not gain an hairs breadth in the paſſing of 30. paces, nor of a thouſand, no nor of an hundred thouſand miles; but yet I believe withal that looking through the ſights at the Top and Top-Gallant, if I ſhould find a fixed Star that was in the ſame elevation, I believe I ſay, that, holding ſtill the Quadrant, after I had ſailed towards the ſtar 60. miles, the eye would meet with the top of the ſaid Maſt, as before, but not with the ſtar, which would be elevated to me one degree.

SAGR. Then you do not think that the ſight would fall upon that point of the Starry Sphere, that anſwereth to the direction of the Top-Gallant Top?

SIMP.

SIMP. No: For the point would be changed, and would be beneath the ſtar firſt obſerved.

SAGR. You are in the right. Now like as that which in this example anſwereth to the elevation of the Top-Gallant-Top, is not the ſtar, but the point of the Firmament that lyeth in a right line with the eye, and the ſaid top of the Maſt, ſo in the caſe exemplified, that which in the Firmament anſwers to the Pole of the Earth, is not a ſtar, or other fixed thing in the Firmament; but is that point in which the Axis of the Earth continued ſtreight out, till it cometh thither doth determine, which point is not fixed, but obeyeth the mutations that the Pole of the Earth doth make. And therefore *Tycho*, or who ever elſe that did alledg this objection, ought to have ſaid that upon that ſame motion of the Earth, were it true, one might obſerve ſome difference in the elevation and depreſſion (not of the Pole, but) of ſome fixed ſtar toward that part which anſwereth to our Pole.

Upon the annual motion of the Earth, alteration may enſue in ſome fixed ſtar, not in the Pole.

SIMP. I already very well underſtand the miſtake by them committed; but yet therefore (which to me ſeems very great) of the argument brought on the contrary is not leſſened, ſuppoſing relation to be had to the variation of the ſtars, and not of the Pole; for if the moving of the Ship but 60. miles, make a fixed ſtar riſe to me one degree, ſhall I not find alike, yea and very much greater mutation, if the Ship ſhould ſail towards the ſaid ſtar for ſo much ſpace as is the Diameter of the Grand Orb, which you affirm to be double the diſtance that is between the Earth and Sun?

SAGR. Herein *Simplicius*, there is another fallacy, which, truth is, you underſtand, but do not upon the ſudden think of the ſame, but I will try to bring it to your remembrance: Tell me therefore; if when after you have directed the Quadrant to a fixed ſtar, and found *v. g.* its elevation to be 40. degrees, you ſhould without ſtirring from the place, incline the ſide of the Quadrant, ſo as that the ſtar might remain elevated above that direction, would you thereupon ſay that the ſtar had acquired greater elevation?

The equivoke of thoſe who believe that in the annual motion great mutations are to be made about the elevation of a fixed ſtar, is confuted.

SIMP. Certainly no: For the mutation was made in the Inſtrument and not in the Obſerver, that did change place, moving towards the ſame.

SAGR. But if you ſail or walk along the ſurface of the Terreſtrial Globe, will you ſay that there is no alteration made in the ſaid Quadrant, but that the ſame elevation is ſtill retained in reſpect of the Heavens, ſo long as you your ſelf do not incline it, but let it ſtand at its firſt conſtitution?

SIMP. Give me leave to think of it. I would ſay without more ado, that it would not retain the ſame, in regard the progreſſe

greſſe I make is not *in plano*, but about the circumference of the Terreſtrial Globe, which at every ſtep changeth inclination in reſpect to Heaven, and conſequently maketh the ſame change in the Inſtrument which is erected upon the ſame.

SAGR. You ſay very well: And you know withal, that by how much the bigger that circle ſhall be upon which you move, ſo many more miles you are to walk, to make the ſaid ſtar to riſe that ſame degree higher; and that finally if the motion towards the ſtar ſhould be in a right line, you ought to move yet farther, than if it were about the circumference of never ſo great a circle?

The right line, and circumference of an infinite circle, are the ſame thing.

SALV. True: For in ſhort the circumference of an infinite circle, and a right line are the ſame thing.

SAGR. But this I do not underſtand, nor as I believe, doth *Simplicius* apprehend the ſame; and it muſt needs be concealed from us under ſome miſtery, for we know that *Salviatus* never ſpeaks at random, nor propoſeth any Paradox, which doth not break forth into ſome conceit, not trivial in the leaſt. Therefore in due time and place I will put you in mind to demonſtrate this, that the right line is the ſame with the circumference of an infinite circle, but at preſent I am unwilling that we ſhould interrupt the diſcourſe in hand. Returning then to the caſe, I propoſe to the conſideration of *Simplicius*, how the acceſſion and receſſion that the Earth makes from the ſaid fixed ſtar which is neer the Pole can be made as it were by a right line, for ſuch is the Diameter of the Grand Orb, ſo that the attempting to regulate the elevation and depreſſion of the Polar ſtar by the motion along the ſaid Diameter, as if it were by the motion about the little circle of the Earth, is a great argument of but little judgment.

SIMP. But we continue ſtill unſatisfied, in regard that the ſaid ſmall mutation that ſhould be therein, would not be diſcerned; and if this be *null*, then muſt the annual motion about the Grand Orb aſcribed to the Earth, be *null* alſo.

SAGR. Here now I give *Salviatus* leave to go on, who as I believe will not overpaſſe the elevation and depreſſion of the Polar ſtar or any other of thoſe that are fixed as *null*, although not diſcovered by any one, and affirmed by *Copernicus* himſelf to be, I will not ſay *null*, but unobſervable by reaſon of its minuity.

Enquiry is made what mutations, & in what ſtars, are to be diſcovered, by means of the annual motion of the Earth.

SALV. I have already ſaid above, that I do not think that any one did ever ſet himſelf to obſerve, whether in different times of the year there is any mutation to be ſeen in the fixed ſtars, that may have a dependance on the annual motion of the Earth, and added withal, that I doubted leaſt haply ſome might never have under-

underſtood what thoſe mutations are, and amongſt what ſtars they ſhould be diſcerned; therefore it would be neceſſary that we in the next place narrowly examine this particular. My having onely found written in general terms that the annual motion of the Earth about the Grand Orb, ought not to be admitted, becauſe it is not probable but that by means of the ſame there would be diſcoverd ſome apparent mutation in the fixed ſtars, and not hearing ſay what thoſe apparent mutations ought to be in particular, and in what ſtars, maketh me very reaſonably to infer that they who rely upon that general poſition, have not underſtood, no nor poſſibly endeavoured to underſtand; how the buſineſſe of theſe mutations goeth, nor what things thoſe are which they ſay ought to be ſeen. And to this judgment I am the rather induced, knowing that the annual motion aſcribed by *Copernicus* to the Earth, if it ſhould appear ſenſible in the Starry Sphere, is not to make apparent mutations equal in reſpect to all the ſtars, but thoſe appearances ought to be made in ſome greater, in others leſſer, and in others yet leſſer; and laſtly, in others abſolutely nothing at all, by reaſon of the vaſt magnitude that the circle of this annual motion is ſuppoſed to be of. As for the mutations that ſhould b ſeen, they are of two kinds, one is the ſaid ſtars changing apparent magnitude, and the other their variation of altitudes in the Meridian. Upon which neceſſarily followeth the mutation of riſings and ſettings, and of their diſtances from the Zenith, *&c.*

Aſtronomers having omitted to inſtance what alterations thoſe are that may be derived from the annual motion of the Earth, do thereby teſtifie that they never rightly underſtood the ſame.

The mutations of the fixed ſtars ought to be in ſome greater, in others leſſer, and in others nothing at all.

SAGR. Methinks I ſee preparing for me ſuch a skean of theſe revolutions, that I wiſh it may never be my task to diſ-intangle them, for to confeſſe my infirmity to *Salviatus*; I have ſometimes thought thereon, but could never find the * Lay-band of it, and I ſpeak not ſo much of this which pertains to the fixed ſtars, as of another more terrible labour which you bring to my remembrance by maintaining theſe Meridian Altitudes; Ortive Latitudes and diſtances from the Vertex, *&c.* And that which puzzleth my brains, ariſeth from what I am now about to tell you; *Copernicus* ſuppoſeth the Starry-Sphere immoveable, and the Sun in the centre thereof immoveable alſo. Therefore every mutation which ſeemeth unto us to be made in the Sun or in the fixed ſtars; muſt of neceſſity befall the Earth and be ours. But the Sun riſeth and declineth in our Meridian by a very great arch of almoſt 47. degrees, and by arches yet greater and greater, varieth its Ortive and Occidual Latitudes in the oblique Horizons. Now how can the Earth ever incline and elevate ſo notably to the Sun, and nothing at all to the fixed ſtars; or ſo little, that it is not to be perceived? This is that knot which could never get thorow my * Loom-Combe; and if you ſhall untie

* *Bandola* that end of a skeen wherewith houſe-wives faſten their hankes of yarn, thread or ſilk.

The grand difficulty in Copernicus *his Doctrine, is that which concerns the* Phænomena *of the Sun and fixed ſtars.*

* *Pettine*, it is the ſtay in a Weavers Loom, that permitteth no knot or ſnarle to paſſe it, called by them the Combe of the Loom.

untie it, I ſhall hold you for more than an *Alexander*.

SALV. Theſe are ſcruples worthy of the ingenuity of *Sagredus*, and this doubt is ſo intricate, that even *Copernicus* himſelf almoſt deſpaired of being able to explain the ſame, ſo as to render it intelligible, which we ſee as well by his own confeſſion of its obſcurity, as alſo by his, at two ſeveral times, taking two different wayes to make it out. And, I ingenuouſly confeſſe that I underſtood not his explanation, till ſuch time as another method more plain and manifeſt, had rendred it intelligible; and yet neither was that done without a long and laborious application of my thoughts to the ſame.

Ariſtotles argument againſt the Ancients, who held that the Earth was a Planet.

SIMP. *Ariſtotle* ſaw the ſame ſcruple, and makes uſe thereof to oppoſe certain of the Ancients, who held that the Earth was a Planet; againſt whom he argueth, that if it were ſo, it would follow that it alſo, as the reſt of the Planets, ſhould have a plurality of motions, from whence would follow theſe variations in the riſings and ſettings of the fixed ſtars, and likewiſe in the Meridian Altitudes. And in regard that he propoundeth the difficulty, and doth not anſwer it, it muſt needs be, if not impoſſible, at leaſt very difficult to be reſolved.

SALV. The ſtreſſe and ſtrength of the knot rendereth the ſolution thereof more commendable and admirable; but I do not promiſe you the ſame at this time, and pray you to diſpenſe with me therein till too morrow, and for the preſent we will go conſidering and explaining thoſe mutations and differences that by means of the annual motion ought to be diſcerned in the fixed ſtars; like as even now we ſaid, for the explication whereof certain preparatory points offer themſelves, which may facilitate the anſwer to the grand objection. Now reaſſuming the two motions aſcribed to the Earth (two I ſay, for the third is no motion, as in its place I will declare) that is the annual and diurnal, the firſt is to be underſtood to be made by the centre of the Earth in or about the circumference of the grand Orb, that is of a very great circle deſcribed in the plain of the fixed and immutable Ecliptick; the other, namely the diurnal, is made by the Globe of the Earth in it ſelf about its own centre, and own Axis, not erect, but inclined to the Plane of the Ecliptick, with the inclination of 23. degrees and an half, or thereabouts, the which inclination is maintained all the year about, and that which ought eſpecially to be obſerved, is alwayes ſituate towards the ſame point of Heaven: in ſo much that the Axis of the diurnal motion doth alwayes remain parallel to it ſelf; ſo that if we imagine that ſame Axis to be continued out until it reach the fixed ſtars, whilſt the centre of the Earth is encircling the whole Ecliptick in a year, the ſaid Axis deſcribeth the ſuperficies

The annual motion made by the centre of the Earth under the Ecliptick, and the diurnal motion made by the Earth about its own centre.

The axis of the Earth continueth alwayes parallel to it ſelf, and deſcribeth a Cylindraical ſuperficies, inclining to the grand Orb.

ficies of an oblique Cylinder, which hath for one of its baſes the ſaid annual circle, and for the other a like circle imaginarily deſcribed by its extremity, or, (if you will) Pole, amongſt the fixed ſtars. And this ſame cylinder is oblique to the Plane of the Ecliptick, according to the inclination of the Axis that deſcribeth it, which we have ſaid to be 23 degrees and an half, the which continuing perpetually the ſame (ſave onely, that in many thouſands of years it maketh ſome very ſmall mutation, which nothing importeth in our preſent buſineſſe) cauſeth that the Terreſtrial Globe doth never more incline or elevate, but ſtill conſerveth the ſame ſtate without mutation. From whence enſueth, that as to what pertaineth to the mutations to be obſerved in the fixed ſtars dependant on the ſole annual motion, the ſame ſhall happen to any point whatſoever of the Earths ſurface, as befalleth unto the centre of the Earth it ſelf; and therefore in the preſent explanations we will make uſe of the centre, as if it were any whatſoever point of the ſuperficies. And for a more facile underſtanding of the whole, let us deſign the ſame in lineal figures: And firſt of all let us deſcribe in the Plane of the Ecliptick the circle A N B O [*in Fig. 7.*] and let us underſtand the points A and B, to be the extreams towards the North and South; that is, the beginning of [*or entrance into*] *Cancer* or *Capricorn*, and let us prolong the Diameter A B, indeterminately by D and C towards the Starry Sphere. I ſay now in the firſt place, that none of the fixed ſtars placed in the Ecliptick, ſhall ever vary elevation, by reaſon of any whatſoever mutation made by the Earth along the ſaid Plane of the Ecliptick, but ſhall alwayes appear in the ſame ſuperficies, although the Earth ſhall approach and recede as great a ſpace as is that of the diameter of the Grand Orb, as may plainly be ſeen in the ſaid figure. For whether the Earth be in the point A or in B, the ſtar C alwayes appeareth in the ſame line A B C; although the diſtance B C, be leſſe than A C, by the whole diameter A B. The moſt therefore that can be diſcovered in the ſtar C, and in any other placed in the Ecliptick, is the augmented or diminiſhed apparent magnitude, by reaſon of the approximation or receſſion of the Earth.

The Orb of the Earth never inclineth, but is immutably the ſame.

The fixed ſtars placed in the Ecliptick never elevate nor deſcend, on account of the annual motion, but yet approach and recede.

SAGR. Stay a while I pray you, for I meet with a certain ſcruple, which much troubleth me, and it is this; That the ſtar C may be ſeen by the ſame line A B C, as wel when the Earth is in A, as when it is in B, I underſtand very well, as alſo furthermore I apprehend that the ſame would happen in all the points of the line A B, ſo long as the Earth ſhould paſſe from A to B by the ſaid line; but it paſſing thither, as is to be ſuppoſed, by the arch A N B, it is manifeſt that when it ſhall be in the

Objections againſt the Earths annual motion taken from the fixed ſtars placed in the Ecliptick.

point N, and in any other except thoſe two A and B, the ſaid ſtar ſhall no longer be obſerved in the line A B; but in others. So that, if the appearing under ſeveral lines ought to cauſe apparent mutations, ſome difference muſt needs appear in this caſe. Nay more, I will ſpeak it with that Philoſophical freedom, which ought to be allowed amongſt Philoſophick friends, methinks that you, contradicting your ſelf, deny that now, which but even now to our admiration, you proved to be really true, and conſiderable; I mean that which happeneth in the Planets, and particularly in the three ſuperiour ones, that being conſtantly in the Ecliptick, or very near unto it, do not onely ſhew themſelves one while near unto us, and another while remote, but ſo deformed in their regular motions, that they ſeem ſometimes immoveable, and ſometimes many degrees retrograde; and all upon no other occaſion than the annual motion of the Earth.

SALV. Though by a thouſand accidents I have been heretofore aſſured of the wittineſſe of *Sagredus*, yet I had a deſire by this one experiment more to aſcertain me of what I may expect from his ingenuity, and all this for my own intereſt, for in caſe my Propoſitions ſtand but proof againſt the hammer and furnace of his judgment, I ſhall be confident that they will abide the * teſt of all Touch-ſtones. I ſay therefore that I had purpoſely diſſembled this objection, but yet not with any intent to deceive you, and to put any falſhood upon you, as it might have happened if the objection by me diſguiſed, and by you over-look't, had been the ſame in effect as it ſeemed to be in appearance, that is, really valid and concluſive; but it is not ſo; nay I rather ſuſpect that to try me, you make as if you did not ſee its nullity. But I will herein be too hard for you, and force from your tongue, that which you would ſo artificially conceal; and therefore tell me, what that thing ſhould be, whereby you come to know the ſtation and retrogradation of the Planets, which is derived from the annual motion, and which is ſo great, that at leaſt ſome foot-ſteps of ſuch an effect ought to appear in the ſtars of the Ecliptick?

* Or will prove of good alloy.

SAGR. This demand of yours containeth two queſtions, to which it is neceſſary that I make reply; the firſt relates to the imputation which you lay upon me of a Diſſembler; the other concerneth that which may appear in the ſtars, *&c.* As to the firſt, I will ſay with your permiſſion, that it is not true, that I have diſſembled my knowing the nullity of that objection; and to aſſure you of the ſame, I now tell you that I very well underſtand the nullity thereof.

SALV. But yet I do not underſtand how it can be, that you ſpake

ſpake not friendly, when you ſaid you did not know that ſame fallacy which you now confeſſe that you know very well.

SAGR. The very confeſſion of knowing it may aſſure you that I did not diſſemble, when I ſaid that I did not underſtand it; for if I had had a mind, and would diſſemble, who could hinder me from continuing in the ſame ſimulation, and denying ſtill that I underſtand the fallacy? I ſay therefore that I underſtood not the ſame, at that time, but that I do now at this preſent apprehend it, for that you have prompted my intellect, firſt by telling me reſolutely that it is *null*, and then by beginning to queſtion me ſo at large what thing that might be, whereby I might come to know the ſtation and retrogradation of the Planets; and becauſe this is known by comparing them with the fixed ſtars, in relation to which, they are ſeen to vary their motions, one while towards the Weſt, and another towards the Eaſt, and ſometimes to abide immoveable; and becauſe there is not any thing above the Starry Sphere, immenſely more remote from us, and viſible unto us, wherewith we may compare our fixed ſtars; therefore we cannot diſcover in the fixed ſtars any foot-ſteps of what appeareth to us in the Planets. This I believe is the ſubſtance of that which you would force from me.

The ſtation, direction and retrogradation of the Planets is known, in relation to the fixed ſtars.

SALV. It is ſo, with the addition moreover of your admirable ingenuity; and if with half a word I did open your eyes, you by the like have remembred me that it is not altogether impoſſible, but that ſometime or other ſomething obſervable may be found amongſt the fixed ſtars, by which it may be gathered wherein the annual converſion reſides, ſo as that they alſo no leſſe than the Planets and Sun it ſelf, may appear in judgment to bear witneſſe of that motion, in favour of the Earth; for I do not think that the ſtas are ſpread in a ſpherical ſuperficies equally remote from a common centre, but hold, that their diſtances from us are ſo various, that ſome of them may be twice and thrice as remote as others; ſo that if with the Teleſcope one ſhould obſerve a very ſmall ſtar neer to one of the bigger, and which therefore was very exceeding high, it might happen, that ſome ſenſible mutation might fall out between them, correſpondent to that of the ſuperiour Planets. And ſo much ſhall ſerve to have ſpoken at this time touching the ſtars placed in the Ecliptick. Let us now come to the fixed ſtars, placed out of the Ecliptick, and let us ſuppoſe a great circle erect upon [*i. e. at right angles to*] the Plane of the *ſame; and let it, for example, be a circle that in the Starry Sphere anſwers to the Solſtitial Colure, and let us mark it C E H [*in Fig.* 8.] which ſhall happen to be withal a Meridian, and in it we will take a ſtar without the Ecliptick, which let be E. Now this ſtar will indeed vary its elevati-

An Indice in the fixed ſtars like to that which is ſeen in the Planets, is an argument of the Earths annual motion.

The fixed ſtars without the Ecliptick elevate and deſcend more or leſſe, according to their diſtance from the ſaid Ecliptick.

**i. e.* of the Ecliptick.

on upon the Earths motion; for from the Earth in A it ſhall be ſeen according to the ray A E, with the elevation of the angle E A C; but from the Earth placed in B, it ſhall be ſeen according to the ray B E, with the elevation of the angle E B C, bigger than the other E A C, that being extern, and this intern and oppoſite in the triangle E A B, the diſtance therefore of the ſtar E from the Ecliptick, ſhall appear changed; and likewiſe its altitude in the Meridian ſhall become greater in the poſition B, than in the place A, according as the angle E B C exceeds the angle E A C, which exceſſe is the quantity of the angle A E B: For in the triangle E A B, the ſide A B being continued to C, the exteriour angle E B C (as being equal to the two interiour and oppoſite E and A) exceedeth the ſaid angle A, by the quantity of the angle *E*. And if we ſhould take another ſtar in the ſame Meridian, more remote from the Ecliptick, as for inſtance the ſtar H, the diverſity in it ſhall be greater by being obſerved from the two ſtations A and B, according as the angle A H B is greater than the other *E*; which angle ſhall encreaſe continually according as the obſerved ſtar ſhall be farther and farther from the Ecliptick, till that at laſt the greateſt mutation will appear in that ſtar that ſhould be placed in the very Pole of the Ecliptick. As for a full underſtanding thereof we thus demonſtrate. Suppoſe the diameter of the Grand Orb to be A B, whoſe centre [*in the ſame Figure*] is G, and let it be ſuppoſed to be continued out as far as the Starry Sphere in the points D and C, and from the centre G let there be erected the Axis of the Ecliptick G F, prolonged till it arrive at the ſaid Sphere, in which a Meridian D F C is ſuppoſed to be deſcribed, that ſhall be perpendicular to the Plane of the Ecliptick; and in the arch F C any points H and *E*, are imagined to be taken, as places of fixed ſtars: Let the lines F A, F B, A H, H G, H B, A *E*, G *E*, B *E*, be conjoyned. And let the angle of difference, or, if you will, the Parallax of the ſtar placed in the Pole F, be A F B, and let that of the ſtar placed in H, be the angle A H *B*, and let that of the ſtar in *E*, be the angle A *E* B. I ſay, that the angle of difference of the Polar ſtar F, is the greateſt, and that of the reſt, thoſe that are nearer to the greateſt are bigger than the more remote; that is to ſay, that the angle F is bigger than the angle H, and this bigger than the angle *E*. Now about the triangle F A B, let us ſuppoſe a circle to be deſcribed. And becauſe the angle F is acute, (by reaſon that its baſe A B is leſſe than the diameter D C, of the ſemicircle D F C) it ſhall be placed in the greater portion of the circumſcribed circle cut by the baſe A B. And becauſe the ſaid A B is divided in the midſt, and at right angles by E G, the centre of the circumſcribed

bed circle ſhall be in the line F G, which let be the point I; and becauſe that of ſuch lines as are drawn from the point G, which is not the centre, unto the circumference of the circumſcribed circle, the biggeſt is that which paſſeth by the centre, G F ſhall be bigger than any other that is drawn from the point G, to the circumference of the ſaid circle; and therefore that circumference will cut the line G H (which is equal to the line G F) and cutting G H, it will alſo cut A H. Let it cut it in L, and conjoyn the line L B. Theſe two angles, therefore, A F B and A L B ſhall be equal, as being in the ſame portion of the circle circumſcribed. But A L B external, is bigger than the internal H; therefore the angle F is bigger than the angle H. And by the ſame method we might demonſtrate the angle H to be bigger than the angle E, becauſe that of the circle deſcribed about the triangle A H B, the centre is in the perpendicular G F, to which the line G H is nearer than the line G E, and therefore the circumference of it cutteth G E, and alſo A E, whereupon the propoſition is manifeſt. We will conclude from hence, that the difference of appearance, (which with the proper term of art, we might call the Parallax of the fixed ſtars) is greater, or leſſe, according as the Stars obſerved are more or leſſe adjacent to the Pole of the Ecliptick, ſo that, in concluſion of thoſe Stars that are in the Ecliptick it ſelf, the ſaid diverſity is reduced to nothing. In the next place, as to the Earths acceſſion by that motion to, or receſſion from the Stars, it appeareth to, and recedeth from thoſe that are in the Ecliptick, the quantity of the whole diameter of the grand Orb; as we did ſee even now, but that acceſſion or receſſion to, or from the ſtars about the Pole of the Ecliptick, is almoſt nothing; and in going to and from others, this difference groweth greater, according as they are neerer to the Ecliptick. We may, in the third place, know, that the ſaid difference of Aſpect groweth greater or leſſer, according as the Star obſerved ſhall be neerer to us, or farther from us. For if we draw another Meridian, leſſe diſtant from the Earth; as for example, this D F I [*in Fig.* 7.] a Star placed in F, and ſeen by the ſame ray A F E, the Earth being in A, would, in caſe it ſhould be obſerved from the Earth in B, appear according to the ray B F, and would make the angle of difference, namely, B F A, bigger than the former A E B, being the exteriour angle of the triangle B F E.

The Earth approacheth or recedeth from the fixed ſtars of the Ecliptick, the quantity of the Diameter of the Grand Orb.

The ſtars nearer to us make greater differences than the more remote.

SAGR. With great delight, and alſo benefit have I heard your diſcourſe; and that I may be certain, whether I have rightly underſtood the ſame, I ſhall give you the ſumme of the Concluſions in a few words. As I take it, you have explained to us the different appearances, that by means of the Earths annual motion,

The Epilogue of the Phænomena *of the fixed ſtars cauſed by the annual motion of the Earth.*

tion, may be by us obſerved in the fixed ſtars to be of two kinds: The one is, that of their apparent magnitudes varied, according as we, tranſported by the Earth, approach or recede from the ſame: The other (which likewiſe dependeth on the ſame acceſſion and receſſion) their appearing unto us in the ſame Meridian, one while more elevated, and another while leſſe. Moreover, you tell us (and I underſtand it very well) that the one and other of theſe mutations are not made alike in all the ſtars, but in ſome greater, and in others leſſer, and in others not at all. The acceſſion and receſſion whereby the ſame ſtar ought to appear, one while bigger, and another while leſſer, is inſenſible, and almoſt nothing in the ſtars neer unto the pole of the Ecliptick, but is greateſt in the ſtars placed in the Ecliptick it ſelf, and indifferent in the intermediate: the contrary happens in the other difference, that is, the elevation or depreſſion of the ſtars placed in the Ecliptick is nothing at all, greateſt in thoſe neereſt to the Pole of the ſaid Ecliptick, and indifferent in the intermediate. Beſides, both theſe differences are more ſenſible in the Stars neereſt to us, in the more remote leſſe ſenſible, and in thoſe that are very far diſtant wholly diſappear. This is, as to what concerns my ſelf; it remaineth now, as I conceive, that ſomething be ſaid for the ſatisfaction of *Simplicius*, who, as I believe, will not eaſily be made to over-paſſe thoſe differences, as inſenſible that are derived from a motion of the Earth ſo vaſt, and from a mutation that tranſports the Earth into places twice as far diſtant from us as the Sun.

SIMP. Truth is, to ſpeak freely, I am very loth to confeſſe, that the diſtance of the fixed Stars ought to be ſuch, that in them the fore-mentioned differences ſhould be wholly imperceptible.

SALV. Do not throw your ſelf into abſolute deſpair, *Simplicius*, for there may perhaps yet ſome qualification be found for your difficulties. And firſt, that the apparent magnitude of the ſtars is not ſeen to make any ſenſible alteration, ought not to be judged by you a thing improbable, in regard you ſee the gueſſes of men in this particular to be ſo groſſely erroneous, eſpecially in looking upon ſplendid objects; and you your ſelf beholding *v. g.* a lighted Torch at the diſtance of 200 paces, if it approach nearer to you 3. or 4. yards, do you think that it will ſhew any whit encreaſed in magnitude? I for my part ſhould not perceive it certainly, although it ſhould approach 20. or 30. yards nearer; nay it hath ſometimes happened that in ſeeing ſuch a light at that diſtance I know not how to reſolve whether it came towards me, or retreated from me, when as it did in reality approach nearer to me. But what need I ſpeak of this? If the ſelf ſame acceſſion and receſſion (I ſpeak of a diſtance twice

In objects far remote, and luminous, a ſmall approach or receſſion is imperceptible.

twice as great as that from the Sun to us) in the ſtar of *Saturn* is almoſt totally imperceptible, and in *Jupiter* not very obſervable, what ſhall we think of the fixed ſtars, which I believe you will not ſcruple to place twice as far off as *Saturn*? In *Mars*, which for that it is nearer to us ——

SIMP. Pray Sir, put your ſelf to no farther trouble in this particular, for I already conceive that what hath been ſpoken touching the unaltered apparent magnitude of the fixed ſtars may very well come to paſſe, but what ſhall we ſay of the other difficulty that proceeds from not perceiving any variation in the mutation of aſpect?

SALV. We will ſay that which peradventure may ſatisfie you alſo in this particular. And to make ſhort, would you not be ſatisfied if there ſhould be diſcovered in the ſtars face mutations that you think ought to be diſcovered, in caſe the annual motion belonged to the Earth?

SIMP. I ſhould ſo doubtleſſe, as to what concerns this particular.

If in the fixed ſtars one ſhould diſcover any annual mutation, the motion of the Earth would be undeniable.

SALV. I could wiſh you would ſay that in caſe ſuch a difference were diſcovered, nothing more would remain behind, that might render the mobility of the Earth queſtionable. But although yet that ſhould not ſenſibly appear, yet is not its mobility removed, nor its immobility neceſſarily proved, it being poſſible, (as *Copernicus* affirmeth) that the immenſe diſtance of the Starry Sphere rendereth ſuch very ſmall *Phænomena* unobſervable; the which as already hath been ſaid, may poſſibly not have been hitherto ſo much as ſought for, or if ſought for, yet not ſought for in ſuch a way as they ought, to wit, with that exactneſſe which to ſo minute a punctuality would be neceſſary; which exactneſſe is very difficult to obtain, as well by reaſon of the deficiency of Aſtronomical Inſtruments, ſubject to many alterations, as alſo through the fault of thoſe that manage them with leſs diligence then is requiſite. A neceſſary argument how little credit is to be given to thoſe obſervations may be deduced from the differences which we find amongſt Aſtronomers in aſſigning the places, I will not ſay, of the new Stars or Comets, but of the fixed ſtars themſelves, even to the altitudes of the very Poles, in which, moſt an end, they are found to differ from one another many minutes. And to ſpeak the truth, who can in a Quadrant, or Sextant, that at moſt ſhall have its ſide * 3. or 4. yards long, aſcertain himſelf in the incidence of the perpendicular, or in the direction of the ſights, not to erre two or three minutes, which in its circumference ſhall not amount to the breadth of a grain of *Mylet*? Beſides that, it is almoſt impoſſible, that the Inſtrument ſhould be made, and kept with abſolute exactneſſe. *Ptolomey* ſheweth

It is proved what ſmall credit is to be given to Aſtronomical Inſtruments in minute obſervations.

* Braccia Italian.

* Or Mill.

Ptolomy *did not trust to an Instrument made by* Archimedes.

sheweth his distrust of a Spherical Instrument composed by *Archimedes* himself to take the Suns ingression into the Æquinoctial.

Instruments of Tycho *made with great expence.*

SIMP. But if the Instruments be so suspitious, and the observations so dubious, how can we ever come to any certainty of things, or free our selves from mistakes? I have heard strange things of the Instruments of *Tycho* made with extraordinary cost, and of his singular diligence in observations.

What Instruments are apt for most exact observation.

SALV. All this I grant you; but neither one nor other of these is sufficient to ascertain us in a business of this importance. I desire that we may make use of Instruments greater by far, and by far certainer than those of *Tycho*, made with a very small charge; the sides of which are of 4. 6. 20. 30. and 50. miles, so as that a degree is a mile broad, a minute prim. 50 *yards, a second but little lesse than a yard, and in short we may without a farthing expence procure them of what bignesse we please. I being in a Countrey Seat of mine near to *Florence*, did plainly observe the Suns arrival at, and departure from the Summer Solstice, whilst one Evening at the time of its going down it appeared upon the top of a Rock on the Mountains of *Pietrapana*, about 60. miles from thence, leaving discovered of it a small streak or filament towards the North, whose breadth was not the hundredth part of its Diameter; and the following Evening at the like setting, it shew'd such another part of it, but notably more small, a necessary argument, that it had begun to recede from the Tropick; and the regression of the Sun from the first to the second observation, doth not import doubtlesse a second minute in the East. The observation made afterwards with an exquisite Telescope, and that multiplyeth the *Discus* of the Sun more than a thousand times, would prove easie, and withall delightful. Now with such an Instrument as this, I would have observations to be made in the fixed stars, making use of some of those wherein the mutation ought to appear more conspicuous, such as are (as hath already been declared) the more remote from the Ecliptick; amongst which the Harp a very great star, and near to the Pole of the Ecliptick, would be very proper in Countries far North, proceeding according to the manner that I shall shew by and by, but in the use of another star; and I have already fancied to my self a place very well adapted for such an observation. The place is an open Plane, upon which towards the North there riseth a very eminent Mountain, in the apex or top whereof is built a little Chappel, situate East and West, so as that the ridg of its Roof may intersect at right angles, the meridian of some building standing in the Plane. I will place a beam parallel to the said ridg, or top of the Roof,

* Italian braces.

An exquisite observation of the approach and departure of the Sun from the Summer Solstice.

A place accommodated for the observation of the fixed stars, as to what concers the annual motion of the Earth.

and

and distant from it a yard or thereabouts. This being placed, I will seek in the Plain the place from whence one of the stars of *Charls's* Waine, in passing by the Meridian, cometh to hide it self behind the beam so placed, or in case the beam should not be so big as to hide the star, I will finde a station where one may see the said beam to cut the said star into two equal parts; an effect that with an *exquisite Telescope may be perfectly discerned. And if in the place where the said accident is discovered, there were some building, it will be the more commodious; but if not, I will cause a Pole to be stuck very fast in the ground, with some standing mark to direct where to place the eye anew, when ever I have a mind to repeat the observation. The first of which observations I will make about the Summer Solstice, to continue afterwards from Moneth to Moneth, or when I shall so please, to the other Solstice; with which observation one may discover the elevation and depression of the star, though it be very small. And if in that operation it shall happen, that any mutation shall discover it self, what and how great benefit will it bring to Astronomy? Seeing that thereby, besides our being assured of the annual motion, we may come to know the grandure and distance of the same star.

SAGR. I very well comprehend your whole proceedings; and the operation seems to me so easie, and so commodious for the purpose, that it may very rationally be thought, that either *Copernicus* himself, or some other Astronomer had made trial of it.

SALV. But I judg the quite contrary, for it is not probable, that if any one had experimented it, he would not have mentioned the event, whether it fell out in favour of this, or that opinion; besides that, no man that I can find, either for this, or any other end, did ever go about to make such an Observation; which also without an exact Telescope could but badly be effected.

SIMP. I am fully satisfied with what you say. But seeing that it is a great while to night, if you desire that I shall passe the same quietly, let it not be a trouble to you to explain unto us those Problems, the declaration whereof you did even now request might be deferred until to morrow. Be pleased to grant us your promised indulgence, and, laying aside all other discourses, proceed to shew us, that the motions which *Copernicus* assigns to the Earth being taken for granted, and supposing the Sun and fixed stars immoveable, there may follow the same accidents touching the elevations and depressions of the Sun, touching the mutations of the Seasons, and the inequality of dayes and nights, *&c.* in the self same manner, just as they are with

facility apprehended in the *Ptolomaick* Syſteme.

SALV. I neither ought, nor can deny any thing that *Sagredus* ſhall requeſt: And the delay by me deſired was to no other end, ſave only that I might have time once again to methodize thoſe prefatory points, in my fancy, that ſerve for a large and plain declaration of the manner how the forenamed accidents follow, as well in the *Copernican* poſition, as in the *Ptolomaick*: nay, with much greater facility and ſimplicity in that than in this. Whence one may manifeſtly conceive that Hypotheſis to be as eaſie to be effected by nature, as difficult to be apprehended by the underſtanding: yet nevertheleſſe, I hope by making uſe of another kind of explanation, than that uſed by *Copernicus*, to render likewiſe the apprehending of it ſomewhat leſſe obſcure. Which that I may do, I will propoſe certain ſuppoſitions of themſelves known and manifeſt, and they ſhall be theſe that follow.

The Copernican Syſteme difficult to be underſtood, but eaſie to be effected.

Neceſſary propoſitions for the better conceiving of the conſequences of the Earths motion.

Firſt, I ſuppoſe that the Earth is a ſpherical body, turning round upon its own Axis and Poles, and that each point aſſigned in its ſuperficies, deſcribeth the circumference of a circle, greater or leſſer, according as the point aſſigned ſhall be neerer or farther from the Poles: And that of theſe circles the greateſt is that which is deſcribed by a point equidiſtant from the ſaid Poles; and all theſe circles are parallel to each other; and *Parallels* we will call them.

Secondly, The Earth being of a Spherical Figure, and of an opacous ſubſtance, it is continually illuminated by the Sun, according to the half of its ſurface, the other half remaining obſcure, and the boundary that diſtinguiſheth the illuminated part from the dark being a grand circle, we will call that circle the *terminator of the light*.

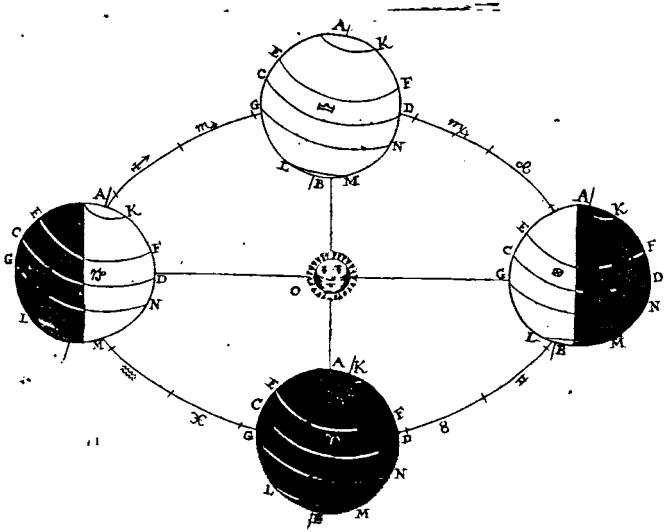
Thirdly, If the Circle that is terminator of the light ſhould paſſe by the Poles of the Earth, it would cut (being a grand and principal circle) all the parallels into equal parts; but not paſſing by the Poles, it would cut them all in parts unequal, except only the circle in the middle, which, as being a grand circle will be cut into equal parts.

Fourthly, The Earth turning round upon its own Poles, the quantities of dayes and nights are termined by the arches of the Parallels, interſected by the circle, that is, the terminator of the light, and the arch that is ſcituate in the illuminated Hemiſphere preſcribeth the length of the day, and the remainer is the quantity of the night.

A plain Scheme repreſenting the Copernican Hypotheſis, and its conſequences.

Theſe things being preſuppoſed, for the more clear underſtanding of that which remaines to be ſaid, we will lay it down in a Figure. And firſt, we will draw the circumference of a circle, that ſhall repreſent unto us that of the grand Orb deſcribed

bed in the plain of the Ecliptick, and this we will divide into four equal parts with the two diameters *Capricorn Cancer*, and *Libra Aries*, which, at the same time, shall represent unto us the four Cardinal points, that is, the two Solstices, and the two Equinoctials; and in the centre of that circle we will place the Sun O, fixed and immoveable.



Let us next draw about the four points, Capricorn, Cancer, Libra and Aries, as centres, four equal circles, which represent unto us the Earth placed in them at four several times of the year. The which, with its centre, in the space of a year, passeth through the whole circumference, Capricorn, Aries, Cancer, Libra, moving from East to West, that is, according to the order of the Signes. It is already manifest, that whilst the Earth is in Capricorn, the Sun will appear in Cancer, and the Earth moving along the arch Capricorn Aries, the Sun will seem to move along the arch Cancer Libra, and in short, will run thorow the Zodiack according to the order of the Signes, in the space of a year; and by this first assumption, without all question, full satisfaction is given for the Suns apparent annual motion under the Ecliptick. Now, coming to the other, that is, the diurnal motion of the Earth in it self, it is necessary to establish its Poles and its Axis, the which must be understood not to be erect perpendicularly upon the plain of the Ecliptick, that is, not to be parallel to the Axis of the grand Orb, but declining from a right angle 23 degrees and an half, or thereabouts, with its North Pole towards

The Suns annual motion, how it comes to passe, according to Copernicus.

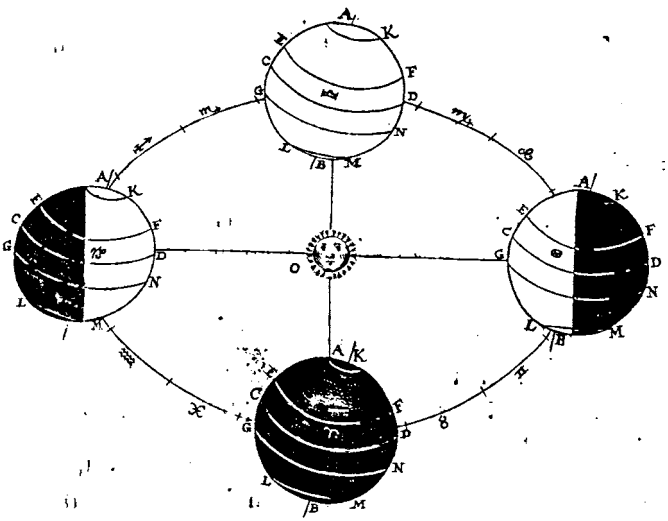
the Axis of the grand Orb, the Earths centre being in the Solſtitial point of Capricorn. Suppoſing therefore the Terreſtrial Globe to have its centre in the point Capricorn, we will deſcribe its Poles and Axis A B, inclined upon the diameter Capricorn Cancer 23 degrees and an half; ſo that the angle A Capricorn Cancer cometh to be the complement of a Quadrant or Radius, that is, 66 degrees and an half; and this inclination muſt be underſtood to be immutable, and we will ſuppoſe the ſuperiour Pole A to be Boreal, or North, and the other Auſtral, or South. Now imagining the Earth to revolve in it ſelf about the Axis A B in twenty four hours, from Weſt to Eaſt, there ſhall by all the points aſſigned in its ſuperficies, be circles deſcribed parallel to each other. We will draw, in this firſt poſition of the Earth, the greateſt C D, and thoſe two diſtant from it *gr.* 23. and an half, E F above, and G M beneath, and the other two extream ones I K and L M remote; by thoſe intervals from the Poles A and B; and as we have marked theſe five, ſo we may imagine innumerable others, parallel to theſe, deſcribed by the innumerable points of the Terreſtrial ſurface. Next let us ſuppoſe the Earth, with the annual motion of its centre, to transferre it ſelf into the other places already marked; but to paſſe thither in ſuch a manner, that its own Axis A B ſhall not only not change inclination upon the plain of the Ecliptick, but ſhall alſo never vary direction; ſo that alwayes keeping parallel to it ſelf, it may continually tend towards the ſame part of the Univerſe, or, if you will, of the Firmament, whereas, if we do but ſuppoſe it prolonged, it will, with its extream termes, deſigne a Circle parallel and equal to the grand Orb, Libra Capricorn Aries Cancer, as the ſuperiour baſe of a Cylinder deſcribed by it ſelf in the annual motion above the inferiour baſe, Libra Capricorn Aries Cancer. And therefore this immutability of inclination continuing, we will deſign theſe other three figures about the centres Aries, Cancer, and Libra, alike in every thing to that firſt deſcribed about the centre Capricorn. Now we will conſider the firſt figure of the Earth, in which, in regard the Axis A B is declined from perpendicularity upon the diameter Capricorn Cancer 23 degrees and an half towards the Sun O, and the arch A I being alſo 23 degrees and an half, the illumination of the Sun will illuſtrate the Hemiſphere of the Terreſtrial Globe expoſed towards the Sun (of which, in this place, half is to be ſeen) divided from the obſcure part by the Terminator of the light I M, by which the parallel C D, as being a grand circle, ſhall come to be divided into equal parts, but all the reſt into parts unequal; being that the terminator of the light I M paſſeth not by their Poles A, B, and the parallel I K, together with all the reſt deſcribed

described within the same, and neerer to the pole A, shall wholly be included in the illuminated part; as on the contrary, the opposite ones towards the Pole B, contained within the parallel L M, shall remain in the dark. Moreover, the arch A I being equal to the arch F D, and the arch A F, common to them both, the two arches I K F and A F D shall be equal, and each a quadrant or 90 degrees. And because the whole arch I F M is a semicircle, the arch F M shall be a quadrant, and equal to the other F K I; and therefore the Sun O shall be in this state of the Earth vertical to one that stands in the point F. But by the revolution diurnal about the standing Axis A B, all the points of the parallel E F passe by the same point F: and therefore in that same day the Sun, at noon, shall be vertical to all the inhabitants of the Parallel EF, and will seem to them to describe in its apparent motion the circle which we call the Tropick of Cancer. But to the inhabitants of all the Parallels that are above the parallel E F, towards the North pole A, the Sun declineth from their *Vertex* or Zenith towards the South; and on the contrary, to all the inhabitants of the Parallels that are beneath E F, towards the Equinoctial C D, and the South Pole B, the Meridian Sun is elevated beyond their *Vertex* towards the North Pole A. Next, it is visible that of all the Parallels, only the greatest C D is cut in equal parts by the Terminator of the light I M. But the rest, that are beneath and above the said grand circle, are all intersected in parts unequal: and of the superiour ones, the semidiurnal arches, namely those of the part of the Terrestrial surface, illustrated by the Sun, are bigger than the seminocturnal ones that remain in the dark: and the contrary befalls in the remainder, that are under the great one C D, towards the pole B, of which the semidiurnal arches are lesser than the seminocturnal, It is likewise apparently manifest, that the differences of the said arches go augmenting, according as the Parallels are neerer to the Poles, till such time as the parallel I K comes to be wholly in the part illuminated, and the inhabitants thereof have a day of twenty four hours long, without any night; and on the contrary, the Parallel L M, remaining all in obscurity, hath a night of twenty four hours, without any day. Come we next to the third Figure of the Earth, placed with its centre in the point Cancer, where the Sun seemeth to be in the first point of Capricorn. We have already seen very manifestly, that by reason the Axis A B doth not change inclination, but continueth parallel to it self, the aspect and situation of the Earth is the same to an hair with that in the first Figure; save onely that that Hemisphere which in the first was illuminated by the Sun, in this remaineth obtenebrated, and that cometh to be luminous, which in the

the firſt was tenebrous: whereupon that which happened before concerning the differences of dayes and nights, touching the dayes being greater or leſſer than the nights, now falls out quite contrary. And firſt, we ſee, that whereas in the firſt Figure the circle I K was wholly in the light, it is now wholly in the dark; and the oppoſite arch L M is now wholly in the light, which was before wholly in the dark. Of the parallels between the grand circle C D, and the Pole A, the ſemidiurnal arches are now leſſer than the ſeminocturnal, which before were the contrary. Of the others likewiſe towards the Pole B, the ſemidiurnal arches are now bigger than the ſeminocturnal, the contrary to what happened in the other poſition of the Earth. We now ſee the Sun made vertical to the inhabitants of the Tropick G N, and to be depreſſed towards the South, with thoſe of the Parallel E F, by all the arch E C G, that is, 47 degrees; and in ſumme, to have paſſed from one to the other Tropick, traverſing the Equinoctial, elevating and declining in the Meridians the ſaid ſpace of 47 degrees. And all this mutation is derived not from the inclination or elevation of the Earth, but on the contrary, from its not inclining or elevating at all; and in a word, by continuing always in the ſame poſition, in reſpect of the Univerſe, onely with turning about the Sun ſituate in the midſt of the ſaid plane, in which it moveth it ſelf about circularly with its annual motion. And here is to be noted an admirable accident, which is, that like as the Axis of the Earth conſerving the ſame direction towards the Univerſe, or we may ſay, towards the higheſt Sphere of the fixed ſtars, cauſeth the Sun to appear to elevate and incline ſo great a ſpace, namely, for 47 degrees, and the fixed Stars to incline or elevate nothing at all; ſo, on the contrary, if the ſame Axis of the Earth ſhould maintain it ſelf continually in the ſame inclination towards the Sun, or, if you will, towards the Axis of the Zodiack, no mutation would appear to be made in the Sun about its elevating or declining, whereupon the inhabitants of one and the ſame place would alwayes have one and the ſame difference of dayes and nights, and one and the ſame conſtitution of Seaſons, that is, ſome alwayes Winter, others alwayes Summer, others Spring, &c. but, on the contrary, the alterations in the fixed Stars would appear very great, as touching their elevation, and inclination to us, which would amount to the ſame 47 degrees. For the underſtanding of which let us return to conſider the poſition of the Earth, in its firſt Figure, where we ſee the Axis A B, with the ſuperiour Pole A, to incline towards the Sun; but in its third Figure, the ſame Axis having kept the ſame direction towards the higheſt Sphere, by keeping parallel to it ſelf, inclines no longer towards the Sun with its ſuperiour Pole A, but on

An admirable accident depending on the not inclining of the Earths axis

on the contrary reclines from its former poſition *gr.* 47. and inclineth towards the oppoſite part, ſo that to reſtore the ſame inclination of the ſaid Pole A towards the Sun, it would be requiſite by turning round the Terreſtrial Globe, according to the circumference A C B D, to tranſport it towards E thoſe ſame *gr.* 47. and for ſo many degrees, any whatſoever fixed ſtar obſerved in the Meridian, would appear to be elevated, or inclined. Let us come now to the explanation of that which remains, and let us conſider the Earth placed in the fourth Figure, that is, with its centre in the firſt point of Libra; upon which the Sun will appear in the beginning of Aries. And becauſe the Axis of



the Earth, which in the firſt Figure is ſuppoſed to be inclined upon the diameter Capricorn Cancer, and therefore to be in that ſame plane, which cutting the plane of the grand Orb, according to the line Capricorn Cancer, was erected perpendicularly upon the ſame, tranſpoſed into the fourth Figure, and maintained, as hath alwayes been ſaid, parallel to it ſelf, it ſhall come to be in a plane in like manner erected to the ſuperficies of the Grand Orbe, and parallel to the plane, which at right angles cuts the ſame ſuperficies, according to the diameter Capricorn Cancer. And therefore the line which goeth from the centre of the Sunne to the centre of the Earth, that is, O Libra, ſhall be perpendicular to the Axis B A: but the ſame line which goeth from the centre of the Sunne to the centre of the Earth, is alſo alwayes perpendicular to the

circle

circle that is the Terminator of the light; therefore this ſame circle ſhall paſſe by the Poles A B in the fourth figure, and in its plain the Axis A B ſhall fall, but the greateſt circle paſſing by the Poles of the Parallels, divideth them all in equal parts; therefore the arches I K, E F, C D, G N, L M, ſhall be all ſemicircles, and the illumin'd Hemiſphere ſhall be this which looketh towards us, and the Sun, and the Terminator of the light ſhall be one and the ſame circle A C B D, and the Earth being in this place ſhall make it Equinoctial to all its Inhabitants. And the ſame happeneth in the ſecond figure, where the Earth having its illuminated Hemiſphere towards the Sun, ſheweth us the other that is obſcure, with its nocturnal arches, which in like manner are all ſemicircles, and conſequently, here alſo it maketh the Equinoctial. And laſtly in regard that the line produced from the centre of the Sun to the centre of the Earth, is perpendicular to the Axis A B, to which the greateſt circle of the parallels C D, is likewiſe erect, the ſaid line Q *Libra* ſhall paſſe of neceſſity by the ſame Plain of the parallel C D, cutting its circumference in the midſt of the diurnal arch C D; and therefore the Snn ſhall be vertical to any one that ſhall ſtand where that interſection is made; but all the Inhabitants of that Parallel ſhall paſſe the ſame, as being carried about by the Earths diurnal converſion; therefore all theſ upon that day ſhall have the Meridian Sun in their vertex. And the Sun at the ſame time to all the Inhabitants of the Earth ſhall ſeem to deſcribe the Grand Parallel called the Equinoctial. Furthermore, foraſmuch as the Earth being in both the Solſtitial points of the Polar circles I K and L M, the one is wholly in the light, and the other wholly in the dark; but when the Earth is in the Equinoctial points, the halves of thoſe ſame polar circles are in the light, the remainder of them being in the dark; it ſhould not be hard to underſtand, how that the Earth *v. gr.* from *Cancer* (where the paralſel I K is wholly in the dark) to *Leo*, one part of the parallel towards the point I, beginneth to enter into the light, and that the Terminator of the light I M beginneth to retreat towards the Pole A B, interſecting the circle A G B D no longer in I M, but in two other points falling between the terms I A and M B, of the arches I A and M B; whereupon the Inhabitants of the circle begin to enjoy the light, and the other Inhabitants of the circle L M to partake of night. And thus you ſee that by two ſimple motions made in times proportionate to their bigneſſes, and not contrary to one another, but performed, as all others that belong to moveable mundane bodies, from Weſt to Eaſt aſſigned to the Terreſtrial Globe, adequate reaſons are rendred of all thoſe *Phænomena* or appearances, for the accommodating of which

which to the ſtability of the Earth it is neceſſary (forſaking that Symetry which is obſerved to be between the velocities and magnitudes of moveables) to aſcribe to a Sphere, vaſt above all others, an unconceiveable celerity, whilſt the other leſſer Spheres move extream ſlowly; and which is more, to make that motion contrary to all their motions; and, yet again to adde to the improbability, to make that ſuperiour Sphere forcibly to tranſport all the inferiour ones along with it contrary to their proper inclination. And here I refer it to your judgment to determine which of the two is the moſt probable.

SAGR. To me, as far as concerneth ſenſe, there appeareth no ſmall difference betwixt the ſimplicity and facility of operating effects by the means aſſigned in this new conſtitution, and the multiplicity, confuſion, and difficulty, that is found in the ancient and commonly received Hypotheſis. For if the Univerſe were diſpoſed according to this multiplicity, it would be neceſſary to renounce many Maximes in Philoſophy commonly received by Philoſophers, as for inſtance, That Nature doth not multiply things without neceſſity; and, That She makes uſe of the moſt facile and ſimple means in producing her effects; and, That She doth nothing in vain, and the like. I do confeſſe that I never heard any thing more admirable than this, nor can I believe that Humane Underſtanding ever penetrated a more ſublime ſpeculation. I know not what *Simplicius* may think of it.

Axiomes commonly admitted by all Philoſophers.

SIMP. Theſe (if I may ſpeak my judgment freely) do ſeem to me ſome of thoſe Geometrical ſubtilties which *Ariſtotle* finds fault with in *Plato*, when he accuſeth him that by his too much ſtudying of Geometry he forſook ſolid Philoſophy; and I have known and heard very great *Peripatetick* Philoſophers to diſſwade their Scholars from the Study of the Mathematicks, as thoſe that render the wit cavilous, and unable to philoſophate well; an Inſtitute diametrically contrary to that of *Plato*, who admitted uone to Philoſophy, unleſſe he was firſt well entered in Geometry.

Ariſtotle *taxeth* Plato *for being too ſtudious of Geometry.*

SALV. I commend the policy of theſe your *Peripateticks*, in dehorting their Diſciples from the Study of Geometry, for that there is no art more commodious for detecting their fallacies; but ſee how they differ from the Mathematical Philoſophers, who much more willingly converſe with thoſe that are well verſt in the commune Peripatetick Philoſophy, than with thoſe that are deſtitute of that knowledg, who for want thereof cannot diſtinguiſh between doctrine and doctrine. But paſſing by this, tell me I beſeech you, what are thoſe extravagancies and thoſe too affected ſubtilties that make you think this *Copernican* Syſteme the leſſe plauſible?

Peripatetick *Philoſophers condemn the Study of Geometry, and why.*

SIMP. To tell you true, I do not very well know; perhaps, becauſe I have not ſo much as learnt the reaſons that are by *Ptolomy* produced, of thoſe effects, I mean of thoſe ſtations, retrogradations, acceſſions, receſſions of the Planets; lengthenings and ſhortnings of dayes, changes of ſeaſons, &c. But omitting the conſequences that depend on the firſt ſuppoſitions, I find in the ſuppoſitions themſelves no ſmall difficulties; which ſuppoſitions, if once they be overthrown, they draw along with them the ruine of the whole fabrick. Now foraſmuch as becauſe the whole module of *Copernicus* ſeemeth in my opinion to be built upon infirm foundations, in that it relyeth upon the mobility of the earth, if this ſhould happen to be diſproved, there would be no need of farther diſpute. And to diſprove this, the Axiom of *Ariſtotle* is in my judgement moſt ſufficient, That of one ſimple body, one ſole ſimple motion can be natural: but here in this caſe, to the Earth, a ſimple body, there are aſſigned 3. if not 4. motions, and all very different from each other. For beſides the right motion, as a grave body towards its centre, which cannot be denied it, there is aſſigned to it a circular motion in a great circle about the Sun in a year, and a vertiginous converſion about its own centre in twenty four hours. And that in the next place which is more exorbitant, & which happly for that reaſon you paſs over in ſilence, there is aſcribed to it another revolution about its own centre, contrary to the former of twenty four hours, and which finiſheth its period in a year. In this my underſtanding apprehendeth a very great contradiction.

Four ſeveral motions aſſigned to the Earth.

SALV. As to the motion of deſcent, it hath already been concluded not to belong to the Terreſtrial Globe which did never move with any ſuch motion, nor never ſhall do; but is (if there be ſuch a thing) that propenſion of its parts to reunite themſelves to their whole. As, in the next place, to the Annual motion, and the Diurnal, theſe being both made towards one way, are very compatible, in the ſame manner juſt as if we ſhould let a Ball trundle downwards upon a declining ſuperficies, it would in its deſcent along the ſame ſpontaneouſly revolve in it ſelf. As to the third motion aſſigned it by *Copernicus*, namely about it ſelf in a year, onely to keep its Axis inclined and directed towards the ſame part of the Firmament, I will tell you a thing worthy of great conſideration: namely *ut tantum abeſt* (although it be made contrary to the other annual) it is ſo far from having any repugnance or difficulty in it, that naturally and without any moving cauſe, it agreeth to any whatſoever ſuſpended and libra-ted body, which if it ſhall be carried round in the circumference of a circle, immediate of it ſelf, it acquireth a converſion about its own centre, contrary to that which carrieth it about, and of ſuch

The motion of deſcent belongs not to the terreſtrial Globe, but to its parts.

The annual and diurnal motion are compatible in the Earth.

Every penſil and librated body carryed round in the circumference of a circle, acquireth of it ſelf a motion in it ſelf contrary to that.

ſuch velocity, that they both finiſh one revolution in the ſame time preciſely. You may ſee this admirable, and to our purpoſe accommodate experience, if putting in a Baſon of water a Ball that will ſwim; and holding the Baſon in your hand, you turn round upon your toe, for you ſhall immediatly ſee the Ball begin to revolve in it ſelf with a motion, contrary to that of the Baſon, and it ſhall finiſh its revolution, when that of the Baſon it ſhall finiſh. Now what other is the Earth than a penſil Globe librated in tenuous and yielding aire, which being carried about in a year along the circumference of a great circle, muſt needs acquire, without any other mover, a revolution about its own centre, annual, and yet contrary to the other motion in like manner annual? You ſhall ſee this effect I ſay, but if afterwards you more narrowly conſider it, you ſhall find this to be no real thing, but a meer appearance; and that which you think to be a revolution in it ſelf, you will find to be a not moving at all; but a continuing altogether immoveable in reſpect of all that which without you, and without the veſſel is immoveable: for if in that Ball you ſhall make ſome mark, and conſider to what part of the Room where you are, or of the Field, or of Heaven it is ſituate, you ſhall ſee that mark in yours, and the veſſels revolution to look alwayes towards that ſame part; but comparing it to the veſſel and to your ſelf that are moveable, it will appear to go altering its direction, and with a motion contrary to yours, and that of the veſſel, to go ſeeking all the points of its circumgyration; ſo that with more reaſon you and the baſon may be ſaid to turn round the immoveable Ball, than that it moveth round in the baſon. In the ſame manner the Earth ſuſpended and librated in the circumference of the Grand Orbe, and ſcituate in ſuch ſort that one of its notes, as for example, its North Pole, looketh towards ſuch a Star or other part of the Firmament, it always keepeth directed towards the ſame; although carried round by the annual motion about the circumference of the ſaid Grand Orbe. This alone is ſufficient to make the Wonder ceaſe, and to remove all difficulties. But what will *Simplicius* ſay; if to this non-indigence of the co-operating cauſe we ſhould adde an admirable intrinſick vertue of the Terreſtrial Globe, of looking with its determinate parts towards determinate parts of the Firmament, I ſpeak of the Magnetick vertue conſtantly participated by any whatſoever piece of Loade-ſtone. And if every minute particle of that Stone have in it ſuch a vertue, who will queſtion but that the ſame more powerfully reſides in this whole Terreſtrial Globe, abounding in that Magnetick matter, and which happily it ſelf, as to its internal and primary ſubſtance, is nothing elſe but a huge maſſe of Loade-ſtone.

An Experiment which ſenſibly ſhews that two contrary motions may naturally agree in the ſame moveable.

The third motion aſcribed to the Earth is rather a reſting immoveable.

An admirable intern vertue of the terreſtrial Globe of alwayes beholding the ſame part of Heaven.

The terreſtrial Globe made of Loade-ſtone.

SIMP. Then you are one of thoſe it ſeems that hold the Magnetick Phyloſophy *William* * *Gilbert*.

* An eminent Doctor of Phyſick, our Countreyman, born at *Colcheſter*, and famous for this his learned Treatiſe, publiſhed about 60 years ſince at *London*, *The Magnetick Philoſophy of* William Gilbert.

SALV. I am for certain, and think that all thoſe that have ſeriouſly read his Book, and tried his experiments, will bear me company therein; nor ſhould I deſpair, that what hath befallen me in this caſe, might poſſibly happen to you alſo, if ſo be a curioſity like to mine, and a notice that infinite things in Nature are ſtill conceal'd from the wits of mankind, by delivering you from being captivated by this or that particular writer in natural things, ſhould but ſlacken the reines of your Reaſon, and mollifie the contumacy and tenaceouſneſſe of your ſenſe; ſo as that they would not refuſe to hearken ſometimes to novelties never before ſpoken of. But (permit me to uſe this phraſe) the puſillanimity of vulgar Wits is come to that paſſe, that not only like blind men, they make a gift, nay tribute of their own aſſent to whatſoever they find written by thoſe Authours, which in the infancy of their Studies were laid before them, as authentick by their Tutors, but refuſe to hear (not to ſay examine) any new Propoſition or Probleme, although it not only never hath been confuted, but not ſo much as examined or conſidered by their Authours. Amongſt which, one is this, of inveſtigating what is the true, proper, primary, interne, and general matter and ſubſtance of this our Terreſtrial Globe; For although it never came into the mind either of *Ariſtotle*, or of any one elſe, before *William Gilbert* to think that it might be a Magnet, ſo far are *Ariſtotle* and the reſt from confuting this opinion, yet nevertheleſſe I have met with many, that at the very firſt mention of it, as a Horſe at his own ſhadow, have ſtart back, and refuſed to diſcourſe thereof, and cenſured the conceipt for a vain *Chymæra*, yea, for a ſolemn madneſſe: and its poſſible the Book of *Gilbert* had never come to my hands, if a Peripatetick Philoſopher, of great fame, as I believe, to free his Library from its contagion, had not given it me.

The Puſillanimity of Popular Wits.

SIMP. I, who ingenuouſly confeſſe my ſelf to be one of thoſe vulgar Wits, and never till within theſe few dayes that I have been admitted to a ſhare in your conferences, could I pretend to have in the leaſt withdrawn from thoſe trite and popular paths, yet, for all that, I think I have advantaged my ſelf ſo much, as that I could without much trouble or difficulty, maſter the roughneſſes of theſe novel and fantaſtical opinions.

SALV. If that which *Gilbert* writeth be true, then is it no opinion, but the ſubject of Science; nor is it new, but as antient as the Earth it ſelf; nor can it (being true) be rugged or difficult, but plain and eaſie; and when you pleaſe I ſhall make you feel the ſame in your hand, for that you of your ſelf fancy it to

SIMP. be

be a Ghoſt, and ſtand in fear of that which hath nothing in it of dreadfull, like as a little child doth fear the Hobgoblin, without knowing any more of it, ſave the name; as that which beſides the name is nothing.

SIMP. I ſhould be glad to be informed, and reclaimed from an errour.

SALV. Anſwer me then to the queſtions that I ſhall ask you. And firſt of all, Tell me whether you believe, that this our Globe, which we inhabit and call Earth, conſiſteth of one ſole and ſimple matter, or elſe that it is an aggregate of matters different from each other.

SIMP. I ſee it to be compoſed of ſubſtances and bodies very different; and firſt, for the greateſt parts of the compoſition, I ſee the Water and the Earth, which extreamly differ from one another.

The Terreſtrial Globe *compoſed of ſundry matters.*

SALV. Let us, for this once, lay aſide the Seas and other Waters, and let us conſider the ſolid parts, and tell me, if you think them one and the ſame thing, or elſe different.

SIMP. As to appearance, I ſee that they are different things, there being very great heaps of unfruitful ſands, and others of fruitful ſoiles; There are infinite ſharp and ſteril mountains, full of hard ſtones and quarries of ſeveral kinds, as Porphyre, Alablaſter, Jaſper, and a thouſand other kinds of Marbles: There are vaſt Minerals of ſo many kinds of metals; and in a word, ſuch varieties of matters, that a whole day would not ſuffice only to enumerate them.

SALV. Now of all theſe different matters, do you think, that in the compoſition of this grand maſſe, there do concur portions, or elſe that amongſt them all there is one part that far exceeds the reſt, and is as it were the matter and ſubſtance of the immenſe lump?

SIMP. I believe that the Stones, Marbles, Metals, Gems, and the ſo many other ſeveral matters are as it were Jewels, and exteriour and ſuperficial Ornaments of the primary Globe, which in groſſe, as I believe, doth without compare exceed all theſe things put together.

SALV. And this principal and vaſt maſſe, of which thoſe things above named are as it were excreſſences and ornaments, of what matter do you think that it is compoſed?

SIMP. I think that it is the ſimple, or leſſe impure element of Earth.

SALV. But what do you underſtand by Earth? Is it haply that which is diſperſed all over the fields, which is broke up with Mattocks and Ploughs, wherein we ſowe corne, and plant fruits, and in which great boſcages grow up, without the help of culture

ture, and which is, in a word, the habitation of all animals, and the womb of all vegetables?

SIMP. Tis this that I would affirm to be the ſubſtance of this our Globe.

SALV. But in this you do, in my judgment, affirm that which is not right: for this Earth which is broke up, is ſowed, and is fertile, is but one part, and that very ſmall of the ſurface of the Globe, which doth not go very deep, yea, its depth is very ſmall, in compariſon of the diſtance to the centre: and experience ſheweth us, that one ſhall not dig very low, but one ſhall finde matters very different from this exteriour ſcurf, more ſolid, and not good for the production of vegetables. Beſides the interne parts, as being compreſſed by very huge weights that lie upon them, are, in all probability, ſlived, and made as hard as any hard rock. One may adde to this, that fecundity would be in vain conferred upon thoſe matters which never were deſigned to bear fruit, but to reſt eternally buried in the profound and dark abyſſes of the Earth.

SIMP. But who ſhall aſſure us, that the parts more inward and near to the centre are unfruitful? They alſo may, perhaps, have their productions of things unknown to us?

SALV. You may aſwell be aſſured thereof, as any man elſe, as being very capable to comprehend, that if the integral bodies of the Univerſe be produced onely for the benefit of Mankind, this above all the reſt ought to be deſtin'd to the ſole conveniences of us its inhabitants. But what benefit can we draw from matters ſo hid and remote from us, as that we ſhall never be able to make uſe of them? Therefore the interne ſubſtance of this our Globe cannot be a matter frangible, diſſipable, and noncoherent, like this ſuperficial part which we call * EARTH: but it muſt, of neceſſity, be a moſt denſe and ſolid body, and in a word, a moſt hard ſtone. And, if it ought to be ſo, what reaſon is there that ſhould make you more ſcrupulous to believe that it is a Loadſtone than a Porphiry, a Jaſper, or other hard Marble? Happily if *Gilbert* had written, that this Globe is all compounded within of * *Pietra Serena*, or of *Chalcedon*, the paradox would have ſeemed to you leſſe exorbitant?

The interne parts of the terreſtrial Globe muſt of neceſſity be ſolid.

* Or MOULD.

* Of which with the Latin tranſlatour, I muſt once more profeſſe my ſelf ignorant.

SIMP. That the parts of this Globe more intern are more compreſſed, and ſo more ſlived together and ſolid, and more and more ſo, according as they lie lower, I do grant, and ſo likewiſe doth *Ariſtotle*, but that they degenerate and become other than Earth, of the ſame ſort with this of the ſuperficial parts, I ſee nothing that obliegeth me to believe.

SALV. I undertook not this diſcourſe with an intent to prove demonſtratively that the primary and real ſubſtance of this our Globe

Globe is Load-ſtone; but onely to ſhew that no reaſon could be given why one ſhould be more unwilling to grant that it is of Load-ſtone, than of ſome other matter. And if you will but ſeriouſly conſider, you ſhall find that it is not improbable, that one ſole, pure, and arbitrary name, hath moved men to think that it conſiſts of Earth; and that is their having made uſe commonly from the beginning of this word Earth, as well to ſignifie that matter which is plowed and ſowed, as to name this our Globe. The denomination of which if it had been taken from ſtone, as that it might as well have been taken from that as from the Earth; the ſaying that its primary ſubſtance was ſtone, would doubtleſſe have found no ſcruple or oppoſition in any man. And is ſo much the more probable, in that I verily believe, that if one could but pare off the ſcurf of this great Globe, taking away but one full thouſand or two thouſand yards; and afterwards ſeperate the Stones from the Earth, the accumulation of the ſtones would be very much biger than that of the fertile Mould. But as for the reaſons which concludently prove *de facto*, that is our Globe is a Magnet, I have mentioned none of them, nor is this a time to alledg them, and the rather, for that to your benefit you may read them in *Gilbert*; onely to encourage you to the peruſal of them, I will ſet before you, in a ſimilitude of my own, the method that he obſerved in his Philoſophy. I know you underſtand very well how much the knowledg of the accidents is ſubſervient to the inveſtigation of the ſubſtance and eſſence of things; therefore I deſire that you would take pains to informe your ſelf well of many accidents and properties that are found in the Magnet, and in no other ſtone, or body; as for inſtance of attracting Iron, of conferring upon it by its ſole preſence the ſame virtue, of communicating likewiſe to it the property of looking towards the Poles, as it alſo doth it ſelf; and moreover endeavour to know by trial, that it containeth in it a virtue of conferring upon the magnetick needle not onely the direction under a Meridian towards the Poles, with an Horizontal motion, (a property a long time ago known) but a new found accident, of declining (being ballanced under the Meridian before marked upon a little ſpherical Magnet) of declining I ſay to determinate marks more or leſſe, according as that needle is held nearer or farther from the Pole, till that upon the Pole it ſelf it erecteth perpendicularly, whereas in the middle parts it is parallel to the Axis. Furthermore procure a proof to be made, whether the virtue of attracting Iron, reſiding much more vigorouſly about the Poles, than about the middle parts, this force be not notably more vigorous in one Pole than in the other, and that in all pieces of Magnet; the ſtronger

Our Globe would have been called ſtone, in ſtead of Earth, if that name had been given it in the beginning.

The method of Gilbert *in his Philoſophy.*

Many properties in the Magnet.

ſtronger of which Poles is that which looketh towards the South. Obſerve, in the next place, that in a little Magnet this South and more vigorous Pole, becometh weaker, when ever it is to take up an iron in preſence of the North Pole of another much bigger Magnet: and not to make any tedious diſcourſe of it, aſſertain your ſelf, by experience, of theſe and many other properties deſcribed by *Gilbert*, which are all ſo peculiar to the Magnet, as that none of them agree with any other matter. Tell me now, *Simplicius*, if there were laid before you a thouſand pieces of ſeveral matters, but all covered and concealed in a cloth, under which it is hid, and you were required, without uncovering them, to make a gueſſe, by external ſignes, at the matter of each of them, and that in making trial, you ſhould hit upon one that ſhould openly ſhew it ſelf to have all the properties by you already acknowledged to reſide onely in the Magnet, and in no other matter, what judgment would you make of the eſſence of ſuch a body? Would you ſay, that it might be a piece of Ebony, or Alablaſter, or Tin.

An Argument proving the terreſtrial Globe to be a Magnet.

SIMP. I would ſay, without the leaſt hæſitation, that it was a piece of Load-ſtone.

SALV. If it be ſo, ſay reſolutely, that under this cover and ſcurf of Earth, ſtones, metals, water, &c. there is hid a great Magnet, foraſmuch as about the ſame there may be ſeen by any one that will heedfully obſerve the ſame, all thoſe very accidents that agree with a true and viſible Globe of Magnet; but if no more were to be ſeen than that of the Declinatory Needle, which being carried about the Earth, more and more inclineth, as it approacheth to the North Pole, and declineth leſſe towards the Equinoctial, under which it finally is brought to an *Æquilibrium*, it might ſerve to perſwade even the moſt ſcrupulous judgment. I forbear to mention that other admirable effect, which is ſenſibly obſerved in every piece of Magnet, of which, to us inhabitants of the Northern Hemiſphere, the Meridional Pole of the ſaid Magnet is more vigorous than the other; and the difference is found greater, by how much one recedeth from the Equinoctial; and under the Equinoctial both the parts are of equal ſtrength, but notably weaker. But, in the Meridional Regions, far diſtant from the Equinoctial, it changeth nature, and that part which to us was more weak, acquireth more ſtrength than the other: and all this I confer with that which we ſee to be done by a ſmall piece of Magnet, in the preſence of a great one, the vertue of which ſuperating the leſſer, maketh it to become obedient to it, and according as it is held, either on this or on that ſide the Equinoctial of the great one, maketh the ſelf ſame mutations, which I have ſaid are made by every Magnet, carried on this

ſide, or that ſide of the Equinoctiall of the Earth.

SAGR. I was perſwaded, at the very firſt reading of the Book of *Gilbertus*; and having met with a moſt excellent piece of Magnet, I, for a long time, made many Obſervations, and all worthy of extream wonder; but above all, that ſeemeth to me very ſtupendious of increaſing the faculty of taking up Iron ſo much by arming it, like as the ſaid Authour teacheth; and with arming that piece of mine, I multiplied its force in octuple proportion; and whereas unarmed it ſcarce took up nine ounces of Iron, it being armed did take up above ſix pounds: And, it may be, you have ſeen this Loadſtone in the Gallery of your *Moſt Serene Grand Duke* (to whom I preſented it) upholding two little Anchors of Iron.

[*The Magnet armed takes up much more Iron, than when unarmed.*

+ Or Cloſet of rarities.

SALV. I ſaw it many times, and with great admiration; till that a little piece of the like ſtone gave me greater cauſe of wonder, that is in the keeping of our Academick, which being no more than of ſix ounces weight, and ſuſtaining, when unarmed, hardly two ounces, doth, when armed, take up 160. ounces, ſo as that it is of 80. times more force armed than unarmed, and takes up a weight 26. times greater than its own; a much greater wonder than *Gilbert* could ever meet with, who writeth, that he could never get any Loadſtone that could reach to take up four times its own weight.

SAGR. In my opinion, this Stone offers to the wit of man a large Field to Phyloſophate in; and I have many times thought with my ſelf, how it can be that it conferreth on that Iron, which armeth it, a ſtrength ſo ſuperiour to its own; and finally, I finde nothing that giveth me ſatisfaction herein; nor do I find any thing extraordinary in that which *Gilbert* writes about this particular; I know not whether the ſame may have befallen you.

SALV. I extreamly praiſe, admire, and envy this Authour, for that a conceit ſo ſtupendious ſhould come into his minde, touching a thing handled by infinite ſublime wits, and hit upon by none of them: I think him moreover worthy of extraordinary applauſe for the many new and true Obſervations that he made, to the diſgrace of ſo many fabulous Authours, that write not only what they do not know, but what ever they hear ſpoken by the fooliſh vulgar, never ſeeking to aſſure themſelves of the ſame by experience, perhaps, becauſe they are unwilling to diminiſh the bulk of their Books. That which I could have deſired in *Gilbert*, is, that he had been a little greater Mathematician, and particularly well grounded in *Geometry*, the practice whereof would have rendered him leſs reſolute in accepting thoſe reaſons for true Demonſtrations, which he produceth for true

cauſes of the true concluſions obſerved by himſelf. Which reaſons (freely ſpeaking) do not knit and bind ſo faſt, as thoſe undoubtedly ought to do, in that of natural, neceſſary, and laſting concluſions may be alledged. And I doubt not, but that in proceſſe of time this new Science will be perfected with new obſervations, and, which is more, with true and neceſſary Demonſtrations. Nor ought the glory of the firſt Inventor to be thereby diminiſhed, nor do I leſſe eſteem, but rather more admire, the Inventor of the Harp (although it may be ſuppoſed that the Inſtrument at firſt was but rudely framed, and more rudely fingered) than an hundred other Artiſts, that in the inſuing Ages reduced that profeſſion to great perfection. And methinks, that Antiquity had very good reaſon to enumerate the firſt Inventors of the Noble Arts amongſt the Gods; ſeeing that the common wits have ſo little curioſity, and are ſo little regardful of rare and elegant things, that though they ſee and hear them exercitated by the exquiſite profeſſors of them, yet are they not thereby perſwaded to a deſire of learning them. Now judge, whether Capacities of this kind would ever have attempted to have found out the making of the Harp, or the invention of Muſick, upon the hint of the whiſtling noiſe of the dry ſinews of a Tortois, or from the ſtriking of four Hammers. The application to great inventions moved by ſmall hints, and the thinking that under a primary and childiſh appearance admirable Arts may lie hid, is not the part of a trivial, but of a ſuper-humane ſpirit. Now anſwering to your demands, I ſay, that I alſo have long thought upon what might poſſibly be the cauſe of this ſo tenacious and potent union, that we ſee to be made between the one Iron that armeth the Magnet, and the other that conjoyns it ſelf unto it. And firſt, we are certain, that the vertue and ſtrength of the ſtone doth not augment by being armed, for it neither attracts at greater diſtance, nor doth it hold an Iron the faſter, if between it, and the arming or cap, a very fine paper, or a leaf of beaten gold, be interpoſed; nay, with that interpoſition, the naked ſtone takes up more Iron than the armed. There is therefore no alteration in the vertue, and yet there is an innovation in the effect. And becauſe its neceſſary, that a new effect have a new cauſe, if it be inquired what novelty is introduced in the act of taking up with the cap or arming, there is no mutation to be diſcovered, but in the different contact; for whereas before Iron toucht Loadſtone, now Iron toucheth Iron. Therefore it is neceſſary to conclude, that the diverſity of contacts is the cauſe of the diverſity of effects. And for the difference of contacts it cannot, as I ſee, be derived from any thing elſe, ſave from that the ſubſtance of the Iron is of parts more ſubtil, more pure, and more compact-

The firſt obſervers and inventers of things ought to be admired.

The true cauſe of the multiplication of vertue in the Magnet, by means of the arming.

Of a new effect its neceſſary that the cauſe be likewiſe new.

It is proved, that Iron conſiſts of parts more ſubtil, pure, and compact than the magnet.

ed

ed than thoſe of the Magnet, which are more groſſe, impure, and rare. From whence it followeth, that the ſuperficies of two Irons that are to touch, by being exquiſitely plained, filed, and burniſhed, do ſo exactly conjoyn, that all the infinite points of the one meet with the infinite points of the other; ſo that the filaments, if I may ſo ſay, that collegate the two Irons, are many more than thoſe that collegate the Magnet to the Iron, by reaſon that the ſubſtance of the Magnet is more porous, and leſſe compact, which maketh that all the points and filaments of the Loadſtone do not cloſe with that which it unites unto. In the next place, that the ſubſtance of Iron (eſpecially the well refined, as namely, the pureſt ſteel) is of parts much more denſe, ſubtil, and pure than the matter of the Loadſtone, is ſeen, in that one may bring its edge to an extraordinary ſharpneſſe, ſuch as is that of the Raſor, which can never be in any great meaſure effected in a piece of Magnet. Then, as for the impurity of the Magnet, and its being mixed with other qualities of ſtone, it is firſt ſenſibly diſcovered by the colour of ſome little ſpors, for the moſt part white; and next by preſenting a needle to it, hanging in a thread, which upon thoſe ſtonyneſſes cannot find repoſe, but being attracted by the parts circumfuſed, ſeemeth to fly from * *thoſe*, and to leap upon the Magnet contiguous to *them*: and as ſome of thoſe Heterogeneal parts are for their magnitude very viſible, ſo we may believe, that there are others, in great abundance, which, for their ſmallneſſe, are imperceptible, that are diſſeminated throughout the whole maſſe. That which I ſay, (namely, that the multitude of contacts that are made between Iron and Iron, is the cauſe of the ſo ſolid conjunction) is confirmed by an experiment, which is this, that if we preſent the ſharpned point of a needle to the cap of a Magnet, it will ſtick no faſter to it, than to the ſame ſtone unarmed: which can proceed from no other cauſe, than from the equality of the contacts that are both of one ſole point. But what then? Let a * Needle be taken and placed upon a Magnet, ſo that one of its extremities hang ſomewhat over, and to that preſent a Nail; to which the Needle will inſtantly cleave, inſomuch that withdrawing the Nail, the Needle will ſtand in ſuſpenſe, and with its two ends touching the Magnet and the Iron; and withdrawing the Nail yet a little further, the Needle will forſake the Magnet; provided that the eye of the Needle be towards the Nail, and the point towards the Magnet; but if the eye be towards the Loadſtone, in withdrawing the Nail the Needle will cleave to the Magnet; and this, in my judgment, for no other reaſon, ſave onely that the Needle, by reaſon it is bigger towards the eye, toucheth in much more points than its ſharp point doth.

A ſenſible proof of the impurity of the Magnet.

* The Author hereby meaneth that the ſtone doth not all conſiſt of magnetick matter, but that the whiter ſpecks being weak, thoſe other parts of the Loadſtone of a more dark & conſtant colour, contain all that vertue wherewith bodies are attracted.

* A common ſewing needle.

SAGR. Your whole diſcourſe hath been in my judgment very concluding, and this experiment of the Needle hath made me think it little inferiour to a Mathematical Demonſtration; and I ingenuouſly confeſſe, that in all the Magnetick Philoſophy, I never heard or read any thing, that with ſuch ſtrong reaſons gave account of its ſo many admirable accidents, of which, if the cauſes were with the ſame perſpicuity laid open, I know not what ſweeter food our Intellects could deſire.

SALV. In ſeeking the reaſons of concluſions unknown unto us, it is requiſite to have the good fortune to direct the diſcourſe from the very beginning towards the way of truth; in which if any one walk, it will eaſily happen, that one ſhall meet with ſeveral other Propoſitions known to be true, either by diſputes or experiments, from the certainty of which the truth of ours acquireth ſtrength and evidence; as it did in every reſpect happen to me in the preſent Probleme, for being deſirous to aſſure my ſelf, by ſome other accident, whether the reaſon of the Propoſition, by me found, were true; namely, whether the ſubſtance of the Magnet were really much leſſe continuate than that of Iron or of Steel, I made the Artiſts that work in the Gallery of my Lord the Grand Duke, to ſmooth one ſide of that piece of Magnet, which formerly was yours, and then to poliſh and burniſh it; upon which to my ſatisfaction I found what I deſired. For I diſcovered many ſpecks of colour different from the reſt, but as ſplendid and bright, as any of the harder ſort of ſtones; the reſt of the Magnet was polite, but to the tact onely, not being in the leaſt ſplendid; but rather as if it were ſmeered over with ſoot; and this was the ſubſtance of the Load-ſtone, and the ſhining part was the fragments of other ſtones intermixt therewith, as was ſenſibly made known by preſenting the face thereof to filings of Iron, the which in great number leapt to the Load-ſtone, but not ſo much as one grain did ſtick to the ſaid ſpots, which were many, ſome as big as the fourth part of the nail of a mans finger, others ſomewhat leſſer, the leaſt of all very many, and thoſe that were ſcarce viſible almoſt innumerable. So that I did aſſure my ſelf, that my conjecture was true, when I firſt thought that the ſubſtance of the Magnet was not cloſe and compact, but porous, or to ſay better, ſpongy; but with this difference, that whereas the ſponge in its cavities and little cels conteineth Air or Water, the Magnet hath its pores full of hard and heavy ſtone, as appears by the exquiſite luſtre which thoſe ſpecks receive. Whereupon, as I have ſaid from the beginning, applying the ſurface of the Iron to the ſuperficies of the Magnet the minute particles of the Iron, though perhaps more continuate than theſe of any other body (as its

ſhining

ſhining more than any other matter doth ſhew) do not all, nay but very few of them incounter pure Magnet; and the contacts being few, the union is but weak. But becauſe the cap of the Load-ſtone, beſides the contact of a great part of its ſuperficies, inveſts its ſelf alſo with the virtue of the parts adjoyning, although they touch not; that ſide of it being exactly ſmoothed to which the other face, in like manner well poliſht of the Iron to be attracted, is applyed, the contract is made by innumerable minute particles, if not haply by the infinite points of both the ſuperficies, whereupon the union becometh very ſtrong. This obſervation of ſmoothing the ſurfaces of the Irons that are to touch, came not into the thoughts of *Gilbert*, for he makes the Irons convex, ſo that their contact is very ſmall; and thereupon it cometh to paſſe that the tenacity, wherewith thoſe Irons conjoyn, is much leſſer.

SAGR. I am, as I told you before, little leſſe ſatisfied with this reaſon, that if it were a pure Geometrical Demonſtration; and becauſe we ſpeak of a Phyſical Problem, I believe that alſo *Simplicius* will find himſelf ſatisfied as far as natural ſcience admits, in which he knows that Geometrical evidence is not to be required.

SIMP. I think indeed, that *Salviatus* with a fine circumlocution hath ſo manifeſtly diſplayed the cauſe of this effect, that any indifferent wit, though not verſt in the Sciences, may apprehend the ſame; but we, confining our ſelves to the terms of Art, reduce the cauſe of theſe and other the like natural effects to *Sympathy*, which is a certain agreemet and mutual appetite which ariſeth between things that are ſemblable to one another in qualities; as likewiſe on the contrary that hatred & enmity for which other things ſhun & abhor one another we call *Antipathy*.

Sympathy and Antipathy, terms uſed by Philoſophers to give a reaſon eaſily of many natural effects.

SAGR. And thus with theſe two words men come to render reaſons of a great number of accidents and effects which we ſee not without admiration to be produced in nature. But this kind of philoſophating ſeems to me to have great ſympathy with a certain way of Painting that a Friend of mine uſed, who writ upon the *Tele* or Canvaſſe in chalk, here I will have the Fountain with *Diana* and her Nimphs, there certain Hariers, in this corner I will have a Huntſman with the Head of a Stag, the reſt ſhall be Lanes, Woods, and Hills; and left the remainder for the Painter to ſet forth with Colours; and thus he perſwaded himſelf that he had painted the Story of *Acteon*, when as he had contributed thereto nothing of his own more than the names. But whether are we wandred with ſo long a digreſſion, contrary to our former reſolutions? I have almoſt forgot what the point was that we were upon when we fell into this magnetick diſcourſe?

A pleaſant example declaring the invalidity of ſome Phyloſophical Argumentations.

courſe: and yet I had ſomething in my mind that I intended to have ſpoken upon that ſubject.

SALV. We were about to demonſtrate that third motion aſcribed by *Copernicus* to the Earth to be no motion but a quieſcence and maintaining of it ſelf immutably directed with its determinate parts towards the ſame & determinate parts of the Univerſe, that is a perpetual conſervation of the Axis of its diurnal revolution parallel to it ſelf, and looking towards ſuch and ſuch fixed ſtars; which moſt conſtant poſition we ſaid did naturally agree with every librated body ſuſpended in a fluid and yielding *medium*, which although carried about, yet did it not change direction in reſpect of things external, but onely ſeemed to revolve in its ſelf, in reſpect of that which carryed it round, and to the veſſel in which it was tranſported. And then we added to this ſimple and natural accident the magnetick virtue, whereby the ſelf Terreſtrial Globe might ſo much the more conſtantly keep it immutable, ——

SAGR. Now I remember the whole buſineſſe; and that which then came into my minde, & which I would have intimated, was a certain conſideration touching the ſcruple and objection of *Simplicius*, which he propounded againſt the mobility of the Earth, taken from the multiplicity of motions, impoſſible to be aſſigned to a ſimple body, of which but one ſole and ſimple motion, according to the doctrine of *Ariſtotle*, can be natural; and that which I would have propoſed to conſideration, was the Magnet, to which we manifeſtly ſee three motions naturally to agree: one towards the centre of the Earth, as a *Grave*; the ſecond is the circular Horizontal Motion, whereby it reſtores and conſerves its Axis towards determinate parts of the Univerſe; and the third is this, newly diſcovered by *Gilbert*, of inclining its Axis, being in the plane of a Meridian towards the ſurface of the Earth, and this more and leſſe, according as it ſhall be diſtant from the Equinoctial, under which it is parallel to the Axis of the Earth. Beſides theſe three, it is not perhaps improbable, but that it may have a fourth, of revolving upon its own Axis, in caſe it were librated and ſuſpended in the air or other fluid and yielding *Medium*, ſo that all external and accidental impediments were removed, and this opinion *Gilbert* himſelf ſeemeth alſo to applaud. So that, *Simplicius*, you ſee how tottering the Axiome of *Ariſtotle* is.

The ſeveral natural motions of the Magnet.

SIMP. This doth uot only not make againſt the Maxime, but not ſo much as look towards it: for that he ſpeaketh of a ſimple body, and of that which may naturally conſiſt therewith; but you propoſe that which befalleth a mixt body; nor do you tell us of any thing that is new to the doctrine of *Ariſtotle*, for that he

he likewiſe granteth to mixt bodies compound motions by——

SAGR. Stay a little, *Simplicius*, & anſwer me to the queſtions I ſhall ask you. You ſay that the Load-ſtone is no ſimple body, now I deſire you to tell me what thoſe ſimple bodies are, that mingle in compoſing the Load-ſtone.

Ariſtole grants a compound motion to mixt bodies.

SIMP. I know not how to tell you th'ingredients nor ſimples preciſely, but it ſufficeth that they are things elementary.

SALV. So much ſufficeth me alſo. And of theſe ſimple elementary bodies, what are the natural motions?

SIMP. They are the two right and ſimple motions, *ſurſum*, and *deorſum*.

SAGR. Tell me in the next place? Do you believe that the motion, that ſhall remain natural to that ſame mixed body, ſhould be one that may reſult from the compoſition of the two ſimple natural motions of the ſimple bodies compounding, or that it may be a motion impoſſible to be compoſed of them.

The motion of mixt bodies ought to be ſuch as may reſult from the compoſition of the motions of the ſimple bodies compounding.

SIMP. I believe that it ſhall move with the motion reſulting from the compoſition of the motions of the ſimple bodies compounding, and that with a motion impoſſible to be compoſed of theſe, it is impoſſible that it ſhould move.

With two right motions one cannot compoſe circular motions.

SAGR. But, *Simplicius*, with two right and ſimple motions, you ſhall never be able to compoſe a circular motion, ſuch as are the two, or three circular motions that the magnet hath: you ſee then into what abſurdities evil-grounded Principles, or, to ſay better, the ill-inferred conſequences of good Principles carry a man; for you are now forced to ſay, that the Magnet is a mixture compounded of ſubſtances elementary and cœleſtial, if you will maintain that the ſtraight motion is a peculiar to the Elements, and the circular to the cœleſtial bodies. Therefore if you will more ſafely argue, you muſt ſay, that of the integral bodies of the Univerſe, thoſe that are by nature moveable, do all move circularly, and that therefore the Magnet, as a part of the true primary, and integral ſubſtance of our Globe, pertaketh of the ſame qualities with it. And take notice of this your fallacy, in calling the Magnet a mixt body, and the Terreſtrial Globe a ſimple body, which is ſenſibly perceived to be a thouſand times more compound: for, beſides that it containeth an hundred an hundred matters, exceeding different from one another, it containeth great abundance of this which you call mixt, I mean of the Load-ſtone. This ſeems to me juſt as if one ſhould call bread a mixt body, and * *Pannada* a ſimple body, in which there is put no ſmall quantity of bread, beſides many other things edible. This ſeemeth to me a very admirable thing, amongſt others

Philoſophers are forced to confeſſe that the Magnet is compounded of cœleſtial ſubſtances, and of elementary.

The errour of thoſe who call the Magnet a mixt body, and the terreſtrial Globe a ſimple body.

* Ogliopotrida *a Spaniſh diſh of many ingredients boild together.*

of

The Diſcourſes of Peripateticks, full of errours and contradictions.

of the Peripateticks, who grant (not can it be denied) that our Terreſtrial Globe is, *de facto*, a compound of infinite different matters; and grant farther that of compound bodies the motion ought to be compound: now the motions that admit of compoſition are the right and circular; For the two right motions, as being contrary, are incompatible together; they affirm, that the pure Element of Earth is no where to be found; they confeſſe, that it never hath been moved with a local motion; and yet they will introduce in Nature that body which is not to be found, and make it move with that motion which it never exerciſed, nor never ſhall do, and to that body which hath, and ever had a being, they deny that motion, which before they granted, ought naturally to agree therewith.

SALV. I beſeech you, *Sagredus*, let us not weary our ſelves any more about theſe particulars, and the rather, becauſe you know that our purpoſe was not to determine reſolutely, or to accept for true, this or that opinion, but only to propoſe for our divertiſement ſuch reaſons, and anſwers as may be alledged on the one ſide, or on the other; and *Simplicius* maketh this anſwer, in defence of his Peripateticks, therefore let us leave the judgment in ſuſpenſe, and remit the determination into the hands of ſuch as are more known than we. And becauſe I think that we have, with ſufficient prolixity, in theſe three dayes, diſcourſed upon the Syſteme of the Univerſe, it will now be ſeaſonable that we proceed to the grand accident, from whence our Diſputations took beginning, I mean, of the ebbing and flowing of the Sea, the cauſe whereof may, in all probability, be referred to the motion of the Earth. But that, if you ſo pleaſe, we will reſerve till to morrow. In the mean time, that I may not forget it, I will ſpeak to one particular, to which I could have wiſhed, that *Gilbert* had not lent an ear; I mean that of admitting, that in caſe a little Sphere of Loadſtone might be exactly librated, it would revolve in it ſelf; becauſe there is no reaſon why it ſhould do ſo; For if the whole Terreſtrial Globe hath a natural faculty of revolving about its own centre in twenty four hours, and that all its parts ought to have the ſame, I mean, that faculty of turning round together with their *whole*, about its centre in twenty four hours; they already have the ſame in effect, whilſt that, being upon the Earth, they turn round along with it: And the aſſigning them a revolution about their particular centres, would be to aſcribe unto them a ſecond motion much different from the firſt: for ſo they would have two, namely, the revolving in twenty four hours about the centre of their *whole*; and the turning about their own: now this ſecond is arbitrary, nor is there any rea-

An improbable effect admired by Gilbertus in the Loadſtone.

reaſon for the introducing of it: If by plucking away a piece of Loadſtone from the whole natural maſſe, it were deprived of the faculty of following it, as it did, whilſt it was united thereto, ſo that it is thereby deprived of the revolution about the univerſal centre of the Terreſtrial Globe, it might haply, with ſomewhat greater probability be thought by ſome, that the ſaid Magnet was to appropriate to it ſelf a new converſion about its particular centre; but if it do no leſſe, when ſeparated, than when conjoyned, continue always to purſue its firſt, eternal, and natural courſe, to what purpoſe ſhould we go about to obtrude upon it another new one?

SAGR. I underſtand you very well, and this puts me in mind of a Diſcourſe very like to this for the vanity of it, falling from certain Writers upon the Sphere, and I think, if I well remember, amongſt others from *Sacroboſco*, who, to ſhew how the Element of Water, doth, together with the Earth, make a compleat Spherical Figure, and ſo between them both compoſe this our Globe, writeth, that the ſeeing the ſmall * particles of water ſhape themſelves into rotundity, as in the drops, and in the dew daily apparent upon the leaves of ſeveral herbs, is a ſtrong argument; and becauſe, according to the trite Axiome, there is the ſame reaſon for the whole, as for the parts, the parts affecting that ſame figure, it is neceſſary that the ſame is proper to the whole Element: and truth is, methinks it is a great overſight that theſe men ſhould not perceive ſo apparent a vanity, and conſider that if their argument had run right, it would have followed, that not only the ſmall drops, but that any whatſoever greater quantity of water ſeparated from the whole Element, ſhould be reduced into a Globe: Which is not ſeen to happen; though indeed the Senſes may ſee, and the Underſtanding perceive that the Element of Water loving to form it ſelf into a Spherical Figure about the common centre of gravity, to which all grave bodies tend (that is, the centre of the Terreſtrial Globe) it therein is followed by all its parts, according to the Axiome; ſo that all the ſurfaces of Seas, Lakes, Pools, and in a word, of all the parts of Waters conteined in veſſels, diſtend themſelves into a Spherical Figure, but that Figure is an arch of that Sphere that hath for its centre the centre of the Terreſtrial Globe, and do not make particular Spheres of themſelves.

The vain argumentation of ſome to prove the Element of Water to be of a Spherical ſuperficies.

SALV. The errour indeed is childiſh; and if it had been onely the ſingle miſtake of *Sacroboſco*, I would eaſily have allowed him in it; but to pardon it alſo to his Commentators, and to other famous men, and even to *Ptolomy* him-

himſelfe; this I cannot do, without bluſhing for their reputation. But it is high time to take leave, it now being very late, and we being to meet again to morrow, at the uſual hour, to bring all the foregoing Diſcourſes to a final concluſion.

Fig: 1.

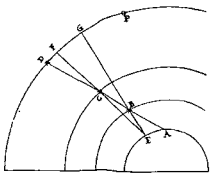


Fig: 2.

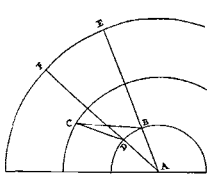


Fig: 4.

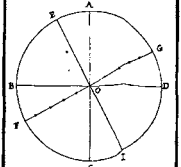
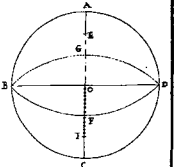


Fig: 5



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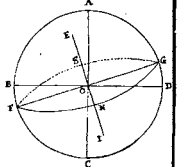


Fig: 3.

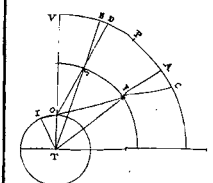


Fig: 7

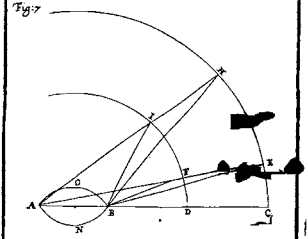
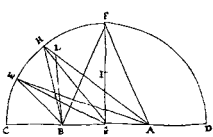


Fig 8.



Place this Plate

at the end of

the third

Dialogue

GALILÆUS Gailæus Lyncæus, HIS SYSTEME OF THE WORLD.

The Fourth Dialogue.

INTERLOCUTORS.

SALVIATUS, SAGREDUS, & SIMPLICIUS.

SAGR.

I know not whether your return to our accuſtomed conferences hath really been later than uſual, or whether the deſire of hearing the thoughts of *Salviatus*, touching a matter ſo curious, hath made me think it ſo: But I have tarried a long hour at this window, expecting every moment when the *Gondola* would appear that I ſent to fetch you.

SALV. I verily believe that your imagination more than our tarriance hath prolonged the time: and to make no longer demurre, it would be well, if without interpoſing more words, we came to the matter it ſelf; and did ſhew, that nature hath permitted (whether the buſineſs *in rei veritate* be ſo, or elſe to play

Nature in ſpare maketh the ebbing and flowing of the Sea, to approve the Earths mobility.

The tide, and mobility of the Earth mutually confirm each other

All terrene effects, indifferently confirm the motion or rest of the Earth, except the ebbing and flowing of the Sea.

and sport with our Fancies) hath, I say, hath permitted that the motions for every other respect, except to resolve the ebbing and flowing of the Sea, assigned long since to the earth, should be found now at last to answer exactly to the cause thereof; and, as it were, with mutual a emulation, the said ebbing and flowing to appear in confirmation of the Terrestrial motion: the *judices* whereof have hitherto been taken from the cœlestial Phænomena, in regard that of those things that happen on Earth, not any one was of force to prove one opinion more than another, as we already have at large proved, by shewing that all the terrene occurrences upon which the stability of the Earth and mobility of the Sun and Firmament is commonly inferred, are to seem to us performed in the same manner, though we supposed the mobility of the Earth, and the immobility of them. The Element of Water onely, as being most vast, and which is not annexed and concatenated to the Terrestrial Globe as all its other solid parts are; yea, rather which by reason of its fluidity, remaineth apart *sui juris*, and free, is to be ranked amongst those sublunary things, from which we may collect some hinte and intimation of what the Earth doth in relation to motion and rest. After I had many and many a time examined with my self the effects and accidents, partly seen and partly understood from others, thar are to be observed in the motions of waters: and moreover read and heard the great vanities produced by many, as the causes of those accidents, I have been induced upon no slight reasons to omit these two conclusions (having made withal the necessary presuppositions) that in case the terrestrial Globe be immoveable, the flux and reflux of the Sea cannot be natural; and that, in case those motions be conferred upon the said Globe, which have been long since assigned to it, it is necessary that the Sea be subject to ebbing and flowing, according to all that which we observe to happen in the same.

The first general conclusion of the impossibility of the ebbing and flowing the immobility of the terrestrial Globe being granted.

SAGR. The Proposition is very considerable, as well for it self, as for what followeth upon the same by way of consequence, so that I shall the more intensly hearken to the explanation and confirmation of it.

The knowledge of the effects contributes to the investigation of the causes.

SALV. Because in natural questions, of which number this which we have in hand is one, the knowledge of the effects is a means to guide us to the investigation and discovery of the causes, and without which we should walk in the dark, nay with more uncertainty, for that we know not whither we would go, whereas the blind, at least, know where they desire to arrive; therefore first of all it is necessary to know the effects whereof we enquire the causes: of which effects you, *Sagredus*, ought more abundantly and more certainly to be informed than I am,

as

as one, that beſides your being born, and having, for a long time, dwelt in *Venice*, where the Tides are very notable for their greatneſſe, have alſo ſailed into *Syria*, and, as an ingenuous and apprehenſive wit, muſt needs have made many Obſervations upon this ſubject: whereas I, that could onely for a time, and that very ſhort, obſerve what happened in theſe extream parts of the *Adriatick* Gulph, and in our Seas below about the *Tyrrhene* ſhores, muſt needs take many things upon the relation of others, who, for the moſt part, not very well agreeing, and conſequently being very uncertain, contribute more of confuſion than confirmation to our ſpeculations. Nevertheleſſe, from thoſe that we are ſure of, and which are the principal, I think I am able to attain to the true and primary cauſes; not that I pretend to be able to produce all the proper and adequate reaſons of thoſe effects that are new unto me, and which conſequently I could never have thought upon. And that which I have to ſay, I propoſe only, as a key that openeth the doore to a path never yet trodden by any, in certain hope, that ſome wits more ſpeculative than mine, will make a further progreſſe herin, and penetrate much farther than I ſhall have done in this my firſt Diſcovery: And although that in other Seas, remote from us, there may happen ſeveral accidents, which do not happen in our Mediterranean Sea, yet doth not this invalidate the reaſon and cauſe that I ſhall produce, if ſo be that it verifie and fully reſolve the accidents which evene in our Sea: for that in concluſion there can be but one true and primary cauſe of the effects that are of the ſame kind. I will relate unto you, therefore, the effects that I know to be true, and aſſigne the cauſes thereof that I think to be true, and you alſo, Gentlemen, ſhall produce ſuch others as are known to you, beſides mine, and then we will try whether the cauſe, by me alledged, may ſatisfie them alſo.

Three Periods of ebbings and flowings, diurnal, monethly, and annual.

I therefore affirm the periods that are obſerved in the fluxes and refluxes of the Sea-waters to be three: the firſt and principal is this great and moſt obvious one; namely, the diurnal, according to which the intervals of ſome hours with the waters flow and ebbe; and theſe intervals are, for the moſt part, in the Mediterrane from ſix hours to ſix hours, or thereabouts, that is, they for ſix hours flow, and for ſix hours ebbe. The ſecond period is monethly, and it ſeemes to take its origen from the motion of the Moon, not that it introduceth other motions, but only altereth the greatneſſe of thoſe before mentioned, with a notable difference, according as it ſhall wax or wane, or come to the Quadrature with the Sun. The third Period is annual, and is ſeen to depend on the Sunne, and onely altereth the diurnal motions,

motions, by making them different in the times of the Solſtices, as to greatneſſe, from what they are in the Equinoxes.

Varieties that happen in the diurnal period.

We will ſpeak (in the firſt place, of the diurnal motion, as being the principal, and upon which the Moon and Sun ſeem to exerciſe their power ſecondarily, in their monethly and annual alterations. Three differences are obſervable in theſe horary mutations; for in ſome places the waters riſe and fall, without making any progreſſive motion; in others, without riſing or falling they run one while towards the Eaſt, and recur another while towards the Weſt; and in others they vary the heights and courſe alſo, as happeneth here in *Venice*, where the Tides in coming in riſe, and in going out fall; and this they do in the extremities of the lengths of Gulphs that diſtend from Weſt to Eaſt, and terminate in open ſhores, up along which ſhores the Tide at time of flood hath room to extend it ſelf: but if the courſe of the Tide were intercepted by Cliffes and Banks of great height and ſteepneſſe, there it will flow and ebbe without any progreſſive motion. Again, it runs to and again, without changing height in the middle parts of the Mediterrane, as notably happeneth in the * *Faro de Meſſina*, between *Scylla* and *Carybdis*, where the Currents, by reaſon of the narrowneſſe of the Channel, are very ſwift; but in the more open Seas, and about the Iſles that ſtand farther into the Mediterranean Sea, as the *Baleares*, *Corſica*, *Sardignia*, * *Elba*, *Sicily* towards the *Affrican* Coaſts, *Malta*, * *Candia*, *&c.* the changes of watermark are very ſmall; but the currents indeed are very notable, and eſpecially when the Sea is pent between Iſlands, or between them and the Continent.

* A Strait, ſo called.

* Or Ilva.

* Or Creta.

Now theſe onely true and certain effects, were there no more to be obſerved, do, in my judgment, very probably perſwade any man, that will contain himſelf within the bounds of natural cauſes, to grant the mobility of the Earth: for to make the veſſel (as it may be called) of the Mediterrane ſtand ſtill, and to make the water contained therein to do, as it doth, exceeds my imagination, and perhaps every mans elſe, who will but pierce beyond the rinde in theſe kind of inquiries.

The cauſe of the ebbing and flowing alledged by a certain modern Philoſopher.

SIMP. Theſe accidents, *Salviatus*, begin not now, they are moſt ancient, and have been obſerved by very many, and ſeveral have attempted to aſſigne, ſome one, ſome another cauſe for the ſame: and there dwelleth not many miles from hence a famous Peripatetick, that alledgeth a cauſe for the ſame newly fiſhed out of a certain Text of *Ariſtotle*, not well underſtood by his Expoſitors, from which Text he collecteth, that the true cauſe of theſe motions doth only proceed from the different profundities of Seas: for that the waters of greateſt depth being greater in abun-

abundance, and therefore more grave, drive back the Waters of leſſe depth, which being afterwards raiſed, deſire to deſcend, and from this continual colluctation or conteſt proceeds the ebbing and flowing. Again thoſe that referre the ſame to the Moon are many, ſaying that ſhe hath particular Dominion over the Water; and at laſt a certain Prelate hath publiſhed a little Treatiſe, wherein he ſaith that the Moon wandering too and fro in the Heavens attracteth and draweth towards it a Maſſe of Water, which goeth continually following it, ſo that it is full Sea alwayes in that part which lyeth under the Moon; and becauſe that though ſhe be under the Horizon, yet nevertheleſſe the Tide returneth, he ſaith that no more can be ſaid for the ſalving of that particular, ſave onely, that the Moon doth not onely naturally retain this faculty in her ſelf; but in this caſe hath power to confer it upon that degree of the Zodiack that is oppoſite unto it. Others, as I believe you know, do ſay that the Moon is able with her temperate heat to rarefie the Water, which being rarefied, doth thereupon flow. Nor hath there been wanting ſome that ——

The cauſe of the ebbing and flowing aſcribed to the Moon by a certain Prelate.

Hieronymus Borrius and other Peripateticks refer it to the temperate heat of the Moon.

SAGR. I pray you *Simplicius* let us hear no more of them, for I do not think it is worth the while to waſt time in relating them, or to ſpend our breath in confuting them; and for your part, if you gave your aſſent to any of theſe or the like fooleries, you did a great injury to your judgment; which nevertheleſſe I acknowledg to be very piercing.

SALV. But I that am a little more flegmatick than you, *Sagredus*, will ſpend a few words in favour of *Simplicius*, if haply he thinks that any probability is to be found in thoſe things that he hath related. I ſay therefore: The Waters, *Simplicius*, that have their exteriour ſuperficies higher, repel thoſe that are inferiour to them, and lower; but ſo do not thoſe Waters that are of greateſt profundity; and the higher having once driven back the lower, they in a ſhort time grow quiet and * level. This your *Peripatetick* muſt needs be of an opinion, that all the Lakes in the World that are in a calme, and that all the Seas where the ebbing and flowing is inſenſible, are level in their bottoms; but I was ſo ſimple, that I perſwaded my ſelf that had we no other plummet to ſound with, the Iſles that advance ſo high above Water, had been a ſufficient evidence of the unevenneſſe of their bottomes. To that Prelate I could ſay that the Moon runneth every day along the whole Mediterrane, and yet its Waters do not riſe thereupon, ſave onely in the very extream bounds of it Eaſtward, and here to us at *Venice*. And for thoſe that make the Moons temperate heat able to make the Water ſwell, bid them put fire under a Kettle full of Water; and hold their

Anſwers to the vanities alledged as cauſes of the ebbing and flowing.

* Or rather ſmooth.

The Iſles are tokens of the unevenneſſe of the bottomes of Seas.

their right hand therein till that the Water by reaſon of the heat do riſe but one ſole inch, and then let them take it out, and write off the tumefaction of the Sea. Or at leaſt deſire them to ſhew you how the Moon doth to rarefie a certain part of the Waters, and not the remainder; as for inſtance, theſe here of *Venice*, and not thoſe of *Ancona*, *Naples*, *Genova*: the truth is Poetick Wits are of two kinds, ſome are ready and apt to invent Fables, and others diſpoſed and inclined to believe them.

Poetick wits of two kinds.

SIMP. I believe that no man believeth Fables, ſo long as he knows them to be ſo; and of the opinions concerning the cauſes of ebbing and flowing, which are many, becauſe I know that of one ſingle effect there is but one ſingle cauſe that is true and primary, I underſtand very well; and am certain that but one alone at the moſt can be true, and for all the reſt I am ſure that they are fabulous, and falſe; and its poſſible that the true one may not be among thoſe that have been hitherto produced; nay I verily believe that it is not; for it would be very ſtrange that the truth ſhould have ſo little light, as that it ſhould not be viſible amongſt the umbrages of ſo many falſhoods. But this I ſhall ſay with the liberty that is permitted amongſt us, that the introduction of the Earths motion, and the making it the cauſe of the ebbing and flowing of Tides, ſeemeth to me as yet a conjecture no leſſe fabulous than the reſt of thoſe that I have heard; and if there ſhould not be propoſed to me reaſons more conformable to natural matters, I would without any more ado proceed to believe this to be a ſupernatural effect, and therefore miraculous, and unſearchable to the underſtandings of men, as infinite others there are, that immediately depend on the Omnipotent hand of God.

Truth hath not ſo little light, as not to be diſcovered amidſt the umbrages of falſhoods.

SAGR. You argue very prudently, and according to the Doctrine of *Ariſtotle*, who you know in the beginning of his mechanical queſtions referreth thoſe things to a Miracle, the cauſes whereof are occult. But that the cauſe of the ebbing and flowing is one of thoſe that are not to be found out, I believe you have no greater proof than onely that you ſee, that amongſt all thoſe that have hitherto been produced for true cauſes thereof, there is not one wherewith, working by what artifice you will, we are able to repreſent ſuch an effect; in regard that neither with the light of the Moon nor of the Sun, nor with temperate heats, nor with different profundities, ſhall one ever artificially make the Water conteined in an immoveable Veſſel to run one way or another, and to ebbe and flow in one place, and not in another. But if without any other artifice, but with the onely moving of the Veſſel, I am able punctually to repreſent all thoſe mutations that are obſerved in the Sea Water, why will you refuſe this reaſon and run to a Miracle?

Ariſtotle holdeth thoſe effects to be miraculous, of which the cauſes are unknown.

SIMP.

SIMP. I will run to a Miracle ſtill, if you do not with ſome other natural cauſes, beſides that of the motion of the Veſſels of the Sea-water diſſwade me from it; for I know that thoſe Veſſels move not, in regard that all the entire Terreſtrial Globe is naturally immoveable.

SALV. But do not you think, that the Terreſtrial Globe might ſupernaturally, that is, by the abſolute power of God, be made moveable? SIMP. Who doubts it?

SALV. Then *Simplicius*, ſeeing that to make the flux and reflux of the Sea, it is neceſſary to introduce a Miracle, let us ſuppoſe the Earth to move miraculouſly, upon the motion of which the Sea moveth naturally: and this effect ſhall be alſo the more ſimple, and I may ſay natural, amongſt the miraculous operations, in that the making a Globe to move round, of which kind we ſee many others to move, is leſſe difficult than to make an immenſe maſſe of water go forwards and backwards, in one place more ſwiftly, and in another leſſe, and to riſe and fall in ſome places more; in ſome leſſe, and in ſome not at all: and to work all theſe different effects in one and the ſame Veſſel that containeth it: beſides, that theſe are ſeveral Miracles, and that is but one onely. And here it may be added, that the Miracle of making the water to move is accompanied with another, namely, the holding of the Earth ſtedfaſt againſt impetuoſities of the water, able to make it ſwage ſometimes one way, and ſometimes another, if it were not miraculouſly kept to rights.

SAGR. Good *Simplicius*, let us for the preſent ſuſpend our judgement about ſentencing the new opinion to be vain that *Salviatus* is about to explicate unto us, nor let us ſo haſtily flye out into paſſion like the ſcolding overgrown Haggs: and as for the Miracle, we may as well recurre to it when we have done hearing the Diſcourſes contained within the bounds of natural cauſes: though to ſpeak freely, all the Works of nature, or rather of God, are in my judgement miraculous.

SALV. And I am of the ſame opinion; nor doth my ſaying, that the motion of the Earth is the Natural cauſe of the ebbing and flowing, hinder, but that the ſaid motion of the Earth may be miraculous. Now reaſſuming our Argument, I apply, and once again affirm, that it hath been hitherto unknown how it might be that the Waters contained in our Mediterranean Straights ſhould make thoſe motions, as we ſee it doth, if ſo be the ſaid Straight, or containing Veſſel were immoveable. And that which makes the difficulty, and rendreth this matter inextricable, are the things which I am about to ſpeak of, and which are daily obſerved. Therefore lend me your attention.

We are here in *Venice*, where at this time the Waters are low,

It is proved impoſſible that there ſhould naturally be any ebbing and flowing, the Earth being immoveable.

the Sea calm, the Air tranquil; ſuppoſe it to be young flood, and that in the term of five or ſix hours the water do riſe ten * hand breadths and more; that riſe is not made by the firſt water, which was ſaid to be rarefied, but it is done by the acceſſion of new Water: Water of the ſame ſort with the former, of the ſame brackiſhneſs, of the ſame denſity, of the ſame weight: Ships, *Simplicius*, float therein as in the former, without drawing an hairs breadth more water; a Barrel of this ſecond doth not weigh one ſingle grain more or leſs than ſuch another quantity of the other, and retaineth the ſame coldneſs without the leaſt alteration: And it is, in a word, Water newly and viſibly entred by the Channels and Mouth of the * *Lio*. Conſider now, how and from whence it came thither. Are there happly hereabouts any Gulphs or Whirle pools in the bottom of the Sea, by which the Earth drinketh in and ſpueth out the Water, breathing as it were a great and monſtruous Whale? But if this be ſo, how comes it that the Water doth not flow in the ſpace of ſix hours in *Ancona*, in * *Raguſa*, in *Corfu*, where the Tide is very ſmall, and happly unobſervable? Who will invent a way to pour new Water into an immoveable Veſſel, and to make that it riſe onely in one determinate part of it, and in other places not? Will you ſay, that this new Water is borrowed from the Ocean, being brought in by the Straight of *Gibraltar*? This will not remove the doubt aforeſaid, but will beget a greater. And, firſt tell me what ought to be the current of that Water, that entering at the Straights mouth, is carried in ſix hours to the remoteſt Creeks of the Mediterrane, at a diſtance of two or three thouſand Miles, and that returneth the ſame ſpace again in a like time at its going back? What would Ships do that lye out at Sea? What would become of thoſe that ſhould be in the Straights-mouth in a continual precipice of a vaſt accumulation of Waters, that entering in at a Channel but eight Mile broad, is to give admittance to ſo much Water as in ſix hours over-floweth a tract of many hundred Miles broad, & thouſands in length? What Tygre, what Falcon runneth or flyeth with ſo much ſwiftneſs? With the ſwiftneſs, I ſay, of above 400 Miles an hour. The currents run (nor can it be denied) the long-wayes of the Gulph, but ſo ſlowly, as that a Boat with Oars will out-go them, though indeed not without defalking for their wanderings. Moreover, if this Water come in at the Straight, the other doubt yet remaineth, namely, how it cometh to flow here ſo high in a place ſo remote, without firſt riſing a like or greater height in the parts more adjacent? In a word, I cannot think that either obſtinacy, or ſharpneſs of wit can ever find an anſwer to theſe Objections, nor conſequently to maintain the ſtability of the Earth againſt them, keeping within the bounds of Nature. SAGR.

* Palms.

† *Lio* is a fair Port in the Venetian Gulph, lying N. E. from the City.

SAGR. I have all the while perfectly apprehended you in this; and I ſtand greedily attending to hear in what manner theſe wonders may occur without obſtruction from the motion already aſſigned to the Earth.

SALV. Theſe effects being to enſue in conſequence of the motions that naturally agree with the Earth, it is neceſſary that they not onely meet with no impediment or obſtacle, but that they do follow eaſily, & not onely that they follow with facility, but with neceſſity, ſo as that it is impoſſible that it ſhould ſucceed otherwiſe; for ſuch is the property & condition of things natural & true. Having therefore ſhewen the impoſſibility of rendring a reaſon of the motions diſcerned in the Waters, & at the ſame time to maintain the immobility of the veſſel that containeth them: we may proceed to enquire, whether the mobility of the Container may produce the required effect, in the manner that it is obſerved to evene.

True and natural effects follow without difficulty.

Two kinds of motions may be conferred upon a Veſſel, whereby the Water therein contained, may acquire a faculty of fluctuating in it, one while towards one ſide, and another while towards another; and there one while to ebbe, and another while to flow. The firſt is, when firſt one, and then another of thoſe ſides is declined, for then the Water running towards the inclining ſide, will alternately be higher and lower, ſometimes on one ſide, and ſometimes on another. But becauſe that this riſing and abating is no other than a receſſion and acceſſion to the centre of the Earth, ſuch a motion cannot be aſcribed to the concavities of the ſaid Earth, that are the Veſſels which contain the Waters; the parts of which Veſſel cannot by any whatſoever motion aſſigned to the Earth, be made to approach or recede from the centre of the ſame: The other ſort of motion is, when the Veſſel moveth (without inclining in the leaſt) with a progreſſive motion, not uniform, but that changeth velocity, by ſometimes accellerating, and other times retarding: from which diſparity it would follow, that the VVater contained in the Veſſel its true, but not fixed faſt to it, as its other ſolid parts, but by reaſon of its fluidity, as if it were ſeparated and at liberty; and not obliged to follow all the mutations of its Container; in the retardation of the Veſſel, it keeping part of the *impetus* before conceived, would run towards the the preceding part, whereupon it would of neceſſity come to riſe; and on the contrary, if new velocity ſhould be added to the Veſſel, with retaining parts of its tardity, ſtaying ſomewhat behind, before it could habituate it ſelf to the new *impetus*, it would hang back towards the following part, where it would come to riſe ſomething. The which effects we may plainly declare and make out to the Senſe by the example of one of thoſe ſame Barks yonder, which continually come from

Two ſorts of motions of the containing Veſſel, may make the contained water to riſe and fall.

The Cavities of the Earth cannot approach or go farther from the centre of the ſame.

The progreſſive and uneven motion may make the water contained in a Veſſel to run to and fro.

+ A Town lying S.E. of *Venice*

* *Lizza-Fuſina*, laden with freſh water, for the ſervice of the City. Let us therefore fancy one of thoſe Barks, to come from thence with moderate velocity along the Lake, carrying the water gently, of which it is full: and then either by running a ground, or by ſome other impediment that it ſhall meet with, let it be notably retarded. The water therein contained ſhall not, by that means, loſe, as the Bark doth, its pre-conceived *impetus*, but retaining the ſame, ſhall run forwards towards the prow, where it ſhall riſe notably, falling as much a ſtern. But if, on the contrary, the ſaid Bark, in the midſt of its ſmooth courſe, ſhall have a new velocity, with notable augmentation added to it, the water contained before it can habituate it ſelf thereto, continuing in its tardity, ſhall ſtay behinde, namely a ſtern, where of conſequence it ſhall mount, and abate for the ſame at the prow. This effect is undoubted and manifeſt, and may hourly be experimented; in which I deſire that for the preſent three particulars may be noted. The firſt is, that to make the water to riſe on one ſide of the veſſel, there is no need of new water, nor that it run thither, forſaking the other ſide. The ſecond is, that the water in the middle doth not riſe or fall notably, unleſſe the courſe of the Bark were not before that very ſwift, and the ſhock or other arreſt that held it exceeding ſtrong and ſudden, in which caſe its poſſible, that not only all the water might run forwards, but that the greater part thereof might iſſue forth of the Bark: and the ſame alſo would enſue, whilſt that being under ſail in a ſmooth courſe, a moſt violent *impetus* ſhould, upon an inſtant, overtake it: But when to its calme motion there is added a moderate retardation or incitation, the middle parts (as I ſaid) unobſervedly riſe and fall: and the other parts, according as they are neerer to the middle, riſe the leſſe; and the more remote, more. The third is, that whereas the parts about the midſt do make little alteration in riſing and falling, in reſpect of the waters of the ſides; on the contrary, they run forwards and backwards very much, in compariſon of the extreams. Now, my Maſters, that which the Bark doth, in reſpect of the water by it contained, and that which the water contained doth, in reſpect of the Bark its container, is the ſelf-ſame, to an hair, with that which the Mediterranean Veſſel doth, in reſpect of the waters in it contained, and that which the waters contained do, in reſpect of the Mediterranean Veſſel their container. It followeth now that we demonſtrate how, and in what manner it is true, that the Mediterrane, and all the other Straits; and in a word, all the parts of the Earth do all move, with a motion notably uneven, though no motion that is not regular and uniforme, is thereby aſſigned to all the ſaid Globe taken collectively.

The parts of the terreſtrial Globe accelerate and retard in their motion.

SIMP-

SIMP. This Propoſition, at firſt ſight to me, that am neither Geometrician nor Aſtronomer, hath the appearance of a very great Paradox; and if it ſhould be true, that the motion of the *whole*, being regular, that of the parts, which are all united to their *whole*, may be irregular, the Paradox will overthrow the Axiome that affirmeth, *Eandem eſſe rationem totius & partium.*

SALV. I will demonſtrate my Paradox, and leave it to your care, *Simplicius*, to defend the Axiome from it, or elſe to reconcile them; and my demonſtration ſhall be ſhort and familiar, depending on the things largely handled in our precedent conferences, without introducing the leaſt ſyllable, in favour of the flux and reflux.

Demonſtrations how the parts of the terreſtriall Globe accelerate and retard.

We have ſaid, that the motions aſſigned to the Terreſtrial Globe are two, the firſt Annual, made by its centre about the circumference of the Grand Orb, under the Ecliptick, according to the order of the Signes, that is, from Weſt to Eaſt; the other made by the ſaid Globe revolving about its own centre in twenty four hours; and this likewiſe from Weſt to Eaſt: though about an Axis ſomewhat inclined, and not equidiſtant from that of the Annual converſion. From the mixture of theſe two motions, each of it ſelf uniform, I ſay, that there doth reſult an uneven and deformed motion in the parts of the Earth. Which, that it may the more eaſily be underſtood, I will explain, by drawing a Scheme thereof. And firſt, about the centre A [*in Fig. 1. of this Dialogue*] I will deſcribe the circumference of the Grand Orb B C, in which any point being taken, as B, about it as a centre we will deſcribe this leſſer circle D E F G, repreſenting the Terreſtrial Globe; the which we will ſuppoſe to run thorow the whole circumference of the Grand Orb, with its centre B, from the Weſt towards the Eaſt, that is, from the part B towards C; and moreover we will ſuppoſe the Terreſtrial Globe to turn about its own centre B likewiſe from Weſt to Eaſt; that is, according to the ſucceſſion of the points D E F G, in the ſpace of twenty four hours. But here we ought carefully to note, that a circle turning round upon its own centre, each part of it muſt, at different times, move with contraty motions: the which is manifeſt, conſidering that whilſt the parts of the circumference about the point D move to the left hand, that is, towards E, the oppoſite parts that are about F, approach to the right hand, that is, towards G; ſo that when the parts D ſhall be in F, their motion ſhall be contrary to what it was before, when it was in D. Furthermore, the ſame time that the parts E deſcend, if I may ſo ſpeak, towards F, thoſe in G aſcend towards D. It being therefore preſuppoſed, that

The parts of a Circle regularly moved about its own centre move in divers times with contrary motions.

there

The mixture of the two motions annual and diurnal, cauſeth the inequality in the motion of the parts of the terreſtrial Globe.

there are ſuch contrarieties of motions in the parts of the Terreſtrial Surface, whilſt it turneth round upon its own centre, it is neceſſary, that in conjoyning this Diurnal Motion, with the other Annual, there do reſult an abſolute motion for the parts of the ſaid Terreſtrial Superficies, one while very accelerate, and another while as ſlow again. The which is manifeſt, conſidering firſt the parts about D, the abſolute motion of which ſhall be extream ſwift, as that which proceedeth from two motions made both one way, namely, towards the left hand; the firſt of which is part of the Annual Motion, common to all the parts of the Globe, the other is that of the ſaid point D., carried likewiſe to the left, by the Diurnal Revolution; ſo that, in this caſe, the Diurnal motion increaſeth and accelerateth the Annual. The contrary to which happeneth in the oppoſite part F, which, whilſt it is by the common annual motion carried, together with the whole Globe, towards the left, it happeneth to be carried by the Diurnal converſion alſo towards the right: ſo that the Diurnal motion by that means detracteth from the Annual, whereupon the abſolute motion, reſulting from the compoſition of both the other, is much retarded. Again, about the points E and G, the abſolute motion becometh in a manner equal to the ſimple Annual one, in regard that little or nothing increaſeth or diminiſheth it, as not tending either to the left hand, or to the right, but downwards and upwards. We will conclude therefore, that like as it is true, that the motion of the whole Globe, and of each of its parts, would be equal and uniforme, in caſe they did move with one ſingle motion, whether it were the meer Annual, or the ſingle Diurnal Revolution, ſo it is requiſite, that mixing thoſe two motions together, there do reſult thence for the parts of the ſaid Globe irregular motions, one while accelerated, and another while retarded, by means of the additions or ſubſtractions of the Diurnal converſion from the annual circulation. So that, if it be true (and moſt true it is, as experience proves) that the acceleration and retardation of the motion of the Veſſel, makes water contained therein to run to and again the long wayes of it, and to riſe and fall in its extreames, who will make ſcruple of granting, that the ſaid effect may, nay ought to ſucceed in the Sea-waters, contained within their Veſſels, ſubject to ſuch like alterations, and eſpecially in thoſe that diſtend themſelves long-wayes from Weſt to Eaſt, which is the courſe that the motion of thoſe ſame Veſſels ſteereth? Now this is the moſt potent and primary cauſe of the ebbing and flowing, without the which no ſuch effect would enſue. But becauſe the particular accidents are many and various, that in ſeveral places and times are obſerved, which muſt of neceſſity have dependance

The moſt potent and primary cauſe of the ebbing and flowing.

on

on other different concomitant cauſes, although they ought all to have connexion with the primary; therefore it is convenient that we propound and examine the ſeveral accidents that may be the cauſes of ſuch different effects.

Sundry accidents that happen in the ebbings & flowings

The firſt accident.

The firſt of which is, that when ever the water, by means of a notable retardation or acceleration of the motion of the Veſſel, its container, ſhall have acquired a cauſe of running towards this or that extream, and ſhall be raiſed in the one, and abated in the other, it ſhall not nevertheleſſe continue, for any time in that ſtate, when once the primary cauſe is ceaſed: but by vertue of its own gravity and natural inclination to level and grow, even it ſhall ſpeedily return backwards of its own accord, and, as being grave and fluid, ſhall not only move towards *Æquilibrium*; but being impelled by its own *impetus*, ſhall go beyond it, riſing in the part, where before it was loweſt; nor ſhall it ſtay here, but returning backwards anew, with more reiterated reciprocations of its undulations, it ſhall give us to know, that it will not from a velocity of motion, once conceived, reduce it ſelf, in an inſtant, to the privation thereof, and to the ſtate of reſt, but will ſucceſſively, by decreaſing a little and a little, reduce it ſelf unto the ſame, juſt in the ſame manner as we ſee a weight hanging at a cord, after it hath been once removed from its ſtate of reſt, that is, from its perpendicularity, of its own accord, to return thither and ſettle it ſelf, but not till ſuch time as it ſhall have often paſt to one ſide, and to the other, with its reciprocall vibrations.

The Water raiſed in one end of the Veſſel returneth of its ſelf to Æquilibrium.

In the ſhorter Veſſels the undulations of waters are more frequent.

The ſecond accident to be obſerved is, that the before-declared reciprocations of motion come to be made and repeated with greater or leſſer frequency, that is, under ſhorter or longer times, according to the different lengths of the Veſſels containing the waters; ſo that in the ſhorter ſpaces the reciprocations are more frequent, and in the longer more rare: juſt as in the former example of pendent bodies, the vibrations of thoſe that are hanged to longer cords are ſeen to be leſſe frequent, than thoſe of them that hang at ſhorter ſtrings.

The greater profundity maketh the undulations of waters more frequent.

And here, for a third obſervation, it is to be noted, that not onely the greater or leſſer length of the Veſſel is a cauſe that the water maketh its reciprocations under different times; but the greater or leſſer profundity worketh the ſame effect. And it happeneth, that of waters contained in receptacles of equall length, but of unequal depth, that which ſhall be the deepeſt, maketh its undulations under ſhorter times, and the reciprocations of the ſhallower waters are leſſe frequent.

Fourthly, there are two effects worthy to be noted, and diligently obſerved, which the water worketh in thoſe its vibrations;

Water riſeth & falleth in the extream parts of the Veſſel, and runneth to and fro in the midſt.

tions; the one is its riſing and falling alternately towards the one and other extremity; the other is its moving and running, to ſo ſpeak, Horizontally forwards and backwards. Which two different motions differently reſide in divers parts of the Water: for its extream parts are thoſe which moſt eminently riſe and fall; thoſe in the middle never abſolutely moving upwards and downwards; of the reſt ſucceſſively thoſe that are neereſt to the extreams riſe and fall proportionally more than the remote: but on the contrary, touching the other progreſſive motion forwards and backwards, the middle parts move notably, going and returning, and the waters that are in the extream parts gain no ground at all; ſave onely in caſe that in their riſing they overflow their banks, and break forth of their firſt channel and receptacle; but where there is the obſtacle of banks to keep them in, they onely riſe and fall; which yet hindereth not the waters in the middle from fluctuating to and again; which likewiſe the other parts do in proportion, undulating more or leſſe, according as they are neerer or more remote from the middle.

An accident of the Earths motions impoſſible to be reduced to practice by art.

The fifth particular accident ought the more attentively to be conſidered, in that it is impoſſible to repreſent the effect thereof by an experiment or example; and the accident is this. In the veſſels by us framed with art, and moved, as the abovenamed Bark, one while more, and another while leſſe ſwiftly, the acceleration and retardation is imparted in the ſame manner to all the veſſel, and to every part of it; ſo that whilſt *v. g.* the Bark forbeareth to move, the parts precedent retard no more than the ſubſequent, but all equally partake of the ſame retardment; and the ſelf-ſame holds true of the acceleration, namely, that conferring on the Bark a new cauſe of greater velocity, the Prow and Poop both accelerate in one and the ſame manner. But in huge great veſſels, ſuch as are the very long bottomes of Seas, albeit they alſo are no other than certain cavities made in the ſolidity of the Terreſtrial Globe, it alwayes admirably happeneth, that their extreams do not unitedly equall, and at the ſame moments of time increaſe and diminiſh their motion, but it happeneth that when one of its extreames hath, by vertue of the commixtion of the two Motions, Diurnal, and Annual, greatly retarded its velocity, the other extream is animated with an extream ſwift motion. Which for the better underſtanding of it we will explain, reaſſuming a Scheme like to the former; in which if we do but ſuppoſe a tract of Sea to be long, *v. g.* a fourth part, as is the arch B C [*in Fig.* 2.] becauſe the parts B are, as hath been already declared, very ſwift in motion, by reaſon of the union of the two motions diurnal and annual, towards one and the ſame way, but

but the part C at the ſame time is retarded in its motion, as being deprived of the progreſſion dependant on the diurnal motion: If we ſuppoſe, I ſay, a tract of Sea as long as the arch B C, we have already ſeen, that its extreams ſhall move in the ſame time with great inequality. And extreamly different would the velocities of a tract of Sea be that is in length a ſemicircle, and placed in the poſition B C D, in regard that the extream B would be in a moſt accelerate motion, and the other D, in a moſt ſlow one; and the intermediate parts towards C, would be in a moderate motion. And according as the ſaid tracts of Sea ſhall be ſhorter, they ſhall leſſe participate of this extravagant accident, of being in ſome hours of the day with their parts diverſly affected by velocity and tardity of motion. So that, if, as in the firſt caſe, we ſee by experience that the acceleration and retardation, though equally imparted to all the parts of the conteining Veſſel, is the cauſe that the water contained, fluctuates too and again, what may we think would happen in a Veſſel ſo admirably diſpoſed, that retardation and acceleration of motion is very unequally contributed to its parts? Certainly we muſt needs grant that greater and more wonderful cauſes of the commotions in the Water ought to be looked for. And though it may ſeem impoſſible to ſome, that in artificial Machines and Veſſels we ſhould be able to experiment the effects of ſuch an accident; yet nevertheleſſe it is not abſolutely impoſſible to be done; and I have by me the model of an Engine, in which the effect of theſe admirable commixtions of motions may be particularly obſerved. But as to what concerns our preſent purpoſe, that which you may have hitherto comprehended with your imagination may ſuffice.

SAGR. I for my own particular very well conceive that this admirable accident ought neceſſarily to evene in the Straights of Seas, and eſpecially in thoſe that diſtend themſelves for a great length from VVeſt to Eaſt; namely according to the courſe of the motions of the Terreſtrial Globe; and as it is in a certain manner unthought of, and without a preſident among the motions poſſible to be made by us, ſo it is not hard for me to believe, that effects may be derived from the ſame, which are not to be imitated by our artificial experiments.

SALV. Theſe things being declared, it is time that we proceed to examine the particular accidents, which, together with their diverſities, are obſerved by experience in the ebbing and flowing of the waters. And firſt we need not think it hard to gueſſe whence it happeneth, that in Lakes, Pooles, and alſo in the leſſer Seas there is no notable flux and reflux; the which hath two very ſolid reaſons. The one is, that by reaſon of the ſhortneſſe

Reaſons renewed of the particular accidents obſerved in the ebbings and flowings.

Second cauſes why in ſmall Seas and in Lakes there are no ebbings and flowings.

neſſe of the Veſſel, in its acquiring in ſeveral hours of the day ſeveral degrees of velocity, they are with very little difference acquired by all its parts; for as well the precedent as the ſubſequent, that is to ſay, both the Eaſtern and VVeſtern parts, do accelerate and retard almoſt in the ſame manner; and withal making that alteration by little and little, and not by giving the motion of the conteining Veſſel a ſudden check, and retardment, or a ſudden and great impulſe or acceleration; both it and all its parts, come to be gently and equally impreſſed with the ſame degrees of velocity; from which uniformity it followeth, that alſo the conteined water with but ſmall reſiſtance and oppoſition, receiveth the ſame impreſſions, and by conſequence doth give but very obſcure ſignes of its riſing or falling, or of its running towards one part or another. The which effect is likewiſe manifeſtly to be ſeen in the little artificial Veſſels, wherein the contained water doth receive the ſelf ſame impreſſions of velocity; when ever the acceleration and retardation is made by gentle and uniform proportion. But in the Straights and Bays that for a great length diſtend themſelves from Eaſt to Weſt, the acceleration and retardation is more notable and more uneven, for that one of its extreams ſhall be much retarded in motion, and the other ſhall at the ſame time move very ſwiftly: The reciprocal libration or levelling of the water proceeding from the *impetus* that it had conceived from the motion of its container. The which libration, as hath been noted, hath its undulations very frequent in ſmall Veſſels; from whence enſues, that though there do reſide in the Terreſtrial motions the cauſe of conferring on the waters a motion onely from twelve hours to twelve hours, for that the motion of the conteining Veſſels do extreamly accelerate and extreamly retard but once every day, and no more; yet nevertheleſſe this ſame ſecond cauſe depending on the gravity of the water which ſtriveth to reduce it ſelf to equilibration, and that according to the ſhortneſſe of the Veſſel hath its reciprocations of one, two, three, or more hours; this intermixing with the firſt, which alſo it ſelf in ſmall Veſſels is very little, it becommeth upon the whole altogether inſenſible. For the primary cauſe, which hath the periods of twelve hours, having not made an end of imprinting the precedent commotion, it is overtaken and oppoſed by the other ſecond, dependant on the waters own weight, which according to the brevity and profundity of the Veſſel, hath the time of its undulations of one, two, three, four, or more hours; and this contending with the other former one, diſturbeth and removeth it, not permitting it to come to the height, no nor to the half of its motion; and by this conteſtation the evidence of the ebbing and flow-

flowing is wholly annihilated, or at leaſt very much obſcured. I paſſe by the continual alteration of the air, which diſquieting the water, permits us not to come to a certainty, whether any, though but ſmall, encreaſe or abatement of half an inch, or leſſe, do reſide in the Straights, or receptacles of water not above a degree or two in length.

The reaſon given, why the ebbings and flowings, for the moſt part, are every ſix hours.

I come in the ſecond place to reſolve the queſtion, why, there not reſiding any vertue in the primary principle of commoving the waters, ſave onely every twelve hours, that is to ſay, once by the greateſt velocity, and once by the greateſt tardity of motion; the ebbings and flowings ſhould yet nevertheleſſe appear to be every ſix hours. To which is anſwered, that this determination cannot any wayes be taken from the primary cauſe onely; but there is a neceſſity of introducing the ſecondary cauſes, as namely the greater or leſſe length of the Veſſels, and the greater or leſſe depth of the waters in them conteined. Which cauſes although they have not any operation in the motions of the waters, thoſe operations belonging to the ſole primary cauſe, without which no ebbing or flowing would happen, yet nevertheleſſe they have a principal ſhare in determining the times or periods of the reciprocations, and herein their influence is ſo powerful, that the primary cauſe muſt of force give way unto them. The period of ſix hours therefore is no more proper or natural than thoſe of other intervals of times, though indeed its the moſt obſerved, as agreeing with our Mediterrane, which was the onely Sea that for many Ages was navigated: though neither is that period obſerved in all its parts; for that in ſome more anguſt places, ſuch as are the *Helleſpont*, and the *Ægean* Sea, the periods are much ſhorter, and alſo very divers amongſt themſelves; for which diverſities, and their cauſes incomprehenſible to *Ariſtotle*, ſome ſay, that after he had a long time obſerved it upon ſome cliffes of *Negropont*, being brought to deſperation, he threw himſelf into the adjoyning *Euripus*, and voluntarily drowned himſelf.

The cauſe why ſome Seas, though very long, ſuffer no ebbing and flowing.

In the third place we have the reaſon ready at hand, whence it commeth to paſſe, that ſome Seas, although very long, as is the Red Sea, are almoſt altogether exempt from Tides, which happeneth becauſe their length extendeth not from Eaſt to Weſt, but rather tranſverſly from the Southeaſt to the Northweſt; but the motions of the Earth going from Weſt to Eaſt; the impulſes of the water, by that means, alwayes happen to fall in the Meridians; and do not move from parallel to parallel; inſomuch that in the Seas that extend themſelves athwart towards the Poles, and that the contrary way are narrow; there is

no cauſe of ebbing and flowing, ſave onely by the participation of another Sea, wherewith it hath communication, that is ſubject to great commotions.

Ebbings and flowings why greateſt in the extremities of Gulphs, and leaſt in the middle parts.

In the fourth place we ſhall very eaſily find out the reaſon why the fluxes and refluxes are greateſt, as to the waters riſing and falling in the utmoſt extremities of Gulphs, and leaſt in the intermediate parts; as daily experience ſheweth here in *Venice*, lying in the farther end of the *Adriatick* Sea, where that difference commonly amounts to five or ſix feet; but in the places of the Mediterrane, far diſtant from the extreams, that mutation is very ſmall, as in the Iſles of *Corſica* and *Sardinnia*, and in the Strands of *Rome* and *Ligorne*, where it exceeds not half a foot; we ſhall underſtand alſo, why on the contrary, where the riſings and fallings are ſmall, the courſes and recourſes are great: I ſay it is an eaſie thing to underſtand the cauſes of theſe accidents, ſeeing that we meet with many manifeſt occurrences of the ſame nature in every kind of Veſſel by us artificially compoſed, in which the ſame effects are obſerved naturally to follow upon our moving it unevenly, that is, one while faſter, and another while ſlower.

Why in narrow places the courſe of the waters is more ſwift than in larger.

Moreover, conſidering in the fifth place, that the ſame quantity of Water being moved, though but gently, in a ſpatious Channel, comming afterwards to go through a narrow paſſage, will of neceſſity run, with great violence, we ſhall not finde it hard to comprehend the cauſe of the great Currents that are made in the narrow Channel that ſeparateth *Calabria* from *Sicilia*: for that all the Water that, by the ſpaciouſneſſe of the Iſle, and by the *Ionick* Gulph, happens to be pent in the Eaſtern part of the Sea, though it do in that, by reaſon of its largeneſs, gently deſcend towards the Weſt, yet nevertheleſſe, in that it is pent up in the *Boſphorus*, it floweth with great violence between *Scilla* and *Caribdis*, and maketh a great agitation. Like to which, and much greater, is ſaid to be betwixt *Africa* and the great Iſle of St. *Lorenzo*, where the Waters of the two vaſt Seas, *Indian* and *Ethiopick*, that lie round it, muſt needs be ſtraightned into alleſſe Channel between the ſaid Iſle and the *Ethiopian* Coaſt. And the Currents muſt needs be very great in the Straights of *Magellanes*, which joyne together the vaſt Oceans of *Ethiopia*, and *Del Zur*, called alſo the *Pacifick* Sea.

A diſcuſſion of ſome more abſtruſe accidents obſerved in the ebbing and flowing.

It follows now, in the ſixth place, that to render a reaſon of ſome more abſtruſe and incredible accidents, which are obſerved upon this occaſion, we make a conſiderable reflection upon the two principal cauſes of ebbings and flowings, afterwards compounding and mixing them together. The firſt and ſimpleſt of

of which is (as hath often been ſaid) the determinate acceleration and retardation of the parts of the Earth, from whence the Waters have a determinate period put to their decurſions towards the Eaſt, and return towards the Weſt, in the time of twenty four hours. The other is that which dependeth on the proper gravity of the Water, which being once commoved by the primary cauſe, ſeeketh, in the next place, to reduce it ſelf to *Æquilibrium*, with iterated reciprocations; which are not determined by one ſole and prefixed time; but have as many varieties of times as are the different lengths and profundities of the receptacles, and Straights of Seas; and by what dependeth on this ſecond principle, they would ebbe and flow, ſome in one hour, others in two, in four, in ſix, in eight, in ten, &c. Now if we begin to put together the firſt cauſe, which hath its ſet Period from twelve hours to twelve hours, with ſome one of the ſecondary, that hath its Period *verb. grat.* from five hours to five hours, it would come to paſſe, that at ſometimes the primary cauſe and ſecondary would accord to make impulſes both one and the ſame way; and in this concurrency, and (as one may call it) unanimous conſpiration the flowings ſhall be great. At other times it happening that the primary impulſe doth, in a certain manner, oppoſe that which the ſecondary Period would make, and in this conteſt one of the Principles being taken away, that which the other would give, will weaken the commotion of the Waters, and the Sea will return to a very tranquil State, and almoſt immoveable. And at other times, according as the two aforeſaid Principles ſhall neither altogether conteſt, nor altogether concur, there ſhall be other kinds of alterations made in the increaſe and diminution of the ebbing and flowing. It may likewiſe fall out that two Seas, conſiderably great and which communicate by ſome narrow Channel, may chance to have, by reaſon of the mixtion of the two Principles of motion, one cauſe to flow at the time that the other hath cauſe to move a contrary way; in which caſe in the Channel, whereby they diſimbogue themſelves into each other, there do extraordinary conturbations inſue, with oppoſite and vortick motions, and moſt dangerous boilings and breakings, as frequent relations and experiences do aſſure us. From ſuch like diſcordant motions, dependent not onely on the different poſitions and longitudes, but very much alſo upon the different profundities of the Seas, which have the ſaid intercourſe there do happen at ſometimes different commotions in the Waters, irregular, and that can be reduced to no rules of obſervation, the reaſons of which have much troubled, and alwayes do trouble Mariners, for that they meet with them without ſeeing either impulſe of winds, or

other

other eminent aereal alteration that might occaſion the ſame; of which diſturbance of the Air we ought to make great account in other accidents, and to take it for a third and accidental cauſe, able to alter very much the obſervation of the effects depending on the ſecondary and more eſſential cauſes. And it is not to be doubted, but that impetuous windes, continuing to blow, for example, from the Eaſt, they ſhall retein the Waters and prohibit the reflux or ebbing; whereupon the ſecond and third reply of the flux or tide overtaking the former, at the hours prefixed, they will ſwell very high; and being thus born up for ſome dayes, by the ſtrength of the Winds, they ſhall riſe more than uſual, making extraordinary inundations.

The cauſe why, in ſome narrow Channels, we ſee the Sea-waters run alwayes one way.

We ought alſo, (and this ſhall ſerve for a ſeventh Probleme) to take notice of another cauſe of motion dependant on the great abundance of the Waters of great Rivers that diſcharge themſelves into Seas of no great capacity, whereupon in the Straits or *Boſphori* that communicate with thoſe Seas, the Waters are ſeen to run always one way: as it happeneth in the *Thracian Boſphorus* below *Conſtantinople*, where the water alwayes runneth from the *Black-Sea*, towards the *Propontis*: For in the ſaid *Black-Sea* by reaſon of its ſhortneſſe, the principal cauſes of ebbing and flowing are but of ſmall force. But, on the contrary, very great Rivers falling into the ſame, thoſe huge defluxions of water being to paſſe and diſgorge themſelves by the Straight, the *courſe is there very notable and alwayes towards the South. Where moreover we ought to take notice, that the ſaid Straight or Channel, albeit very narrow, is not ſubject to perturbations, as the Straight of *Scilla* and *Carybdis*; for that that hath the *Black-Sea* above towards the North, and the *Propontis*, the *Ægean*, and the *Mediterranean* Seas joyned unto it, though by a long tract towards the South; but now, as we have obſerved; the Seas, though of never ſo great length, lying North and South, are not much ſubject to ebbings and flowings; but becauſe the *Sicilian* Straight is ſituate between the parts of the Mediterrane diſtended for a long tract or diſtance from Weſt to Eaſt, that is, according to the courſe of the fluxes and refluxes; therefore in this the agitations are very great; and would be much more violent between *Hercules Pillars*, in caſe the Straight of *Gibraltar* did open leſſe; and thoſe of the Straight of *Magellanes* are reported to be extraordinary violent.

* Or current.

This is what, for the preſent, cometh into my mind to ſay unto you about the cauſes of this firſt period diurnal of the Tide, and its various accidents, touching which, if you have any thing to offer, you may let us hear it, that ſo we may afterwards proceed to the other two periods, monethly and annual.

SIMP.

SIMP. In my opinion, it cannot be denied, but that your diſcourſe carrieth with it much of probability, arguing, as we ſay, *ex ſuppoſitione*, namely, granting that the Earth moveth with the two motions aſſigned it by *Copernicus*: but if that motion be diſproved, all that you have ſaid is vain, and inſignificant: and for the diſproval of that *Hypotheſis*, it is very manifeſtly hinted by your Diſcourſe it ſelf. You, with the ſuppoſition of the two Terreſtrial motions, give a reaſon of the ebbing and flowing; and then again, arguing circularly, from the ebbing and flowing, draw the reaſon and confirmation of thoſe very motions; and ſo proceeding to a more ſpecious Diſcourſe, you ſay that the Water, as being a fluid body, and not tenaciouſly annexed to the Earth, is not conſtrained punctually to obey every of its motions, from which you afterwards infer its ebbing and flowing. Now I, according to your own method, argue the quite contrary, and ſay; the Air is much more tenuous, and fluid than the Water, and leſſe annexed to the Earths ſuperficies, to which the Water, if it be for nothing elſe, yet by reaſon of its gravity that preſſeth down upon the ſame more than the light Air, adhereth; therefore the Air is much obliged to follow the motions of the Earth: and therefore were it ſo, that the Earth did move in that manner, we the inhabitants of it, and carried round with like velocity by it, ought perpetually to feel a Winde from the Eaſt that beateth upon us with intolerable force. And that ſo it ought to fall out, quotidian experience aſſureth us: for if with onely riding poſt, at the ſpeed of eight or ten miles an hour in the tranquil Air, the incountering of it with our face ſeemeth to us a Winde that doth not lightly blow upon us, what ſhould we expect from our rapid courſe of 800. or a thouſand miles an hour, againſt the Air, that is, free from that motion? And yet, notwithſtanding we cannot perceive any thing of that nature.

The Hypotheſis of the Earths mobility taken in favour of the Tide, oppoſed.

SALV. To this objection that hath much of likelihood in it, I reply, that its true, the Air is of greater tenuity and levity; and, by reaſon of its levity, leſſe adhereht to the Earth than Water ſo much more grave and †bulky; but yet the conſequence is falſe that you infer from theſe qualities; namely, that upon account of that its levity, tennity, and leſſe adherence to the Earth, it ſhould be more exempt than the Water from following the Terreſtrial Motions; ſo as that to us, who abſolutely partake of of them, the ſaid exemption ſhould be ſenſible and manifeſt; nay, it happeneth quite contrary; for, if you well remember, the cauſe of the ebbing and flowing of the Water aſſigned by us, conſiſteth in the Waters not following the unevenneſſe of the motion of its Veſſel, but retaining the *impetus* conceived before, without

The anſwer to the objections made againſt the motion of the Terreſtrial Globe.

† Corpulenta.

without diminiſhing or increaſing it according to the preciſe rate of its diminiſhing or increaſing in its Veſſel. Becauſe therefore that in the conſervation and retention of the *impetus* before conceived, the diſobedience to a new augmentation or diminution of motion conſiſteth, that moveable that ſhall be moſt apt for ſuch a retention, ſhall be alſo moſt commodious to demonſtrate the effect that followerh in conſequence of that retention. Now how much the Water is diſpoſed to maintain ſuch a conceived agitation; though the cauſes ceaſe that impreſs the ſame, the experience of the Seas extreamly diſturbed by impetuous Winds ſheweth us; the Billows of which, though the Air be grown calm, and the Wind laid, for a long time after continue in motion: As the Sacred Poet pleaſantly ſings,

The Water more apt to conſerve an impetus conceived, then the Air.

Qual l'alto Egeo, &c.———

Light bodies eaſier to be moved than heavy, but leſs apt to conſerve the motion.

And that long continuing rough after a ſtorm, dependeth on the gravity of the water: For, as I have elſewhere ſaid, light bodies are much eaſier to be moved than the more grave, but yet are ſo much the leſs apt to conſerve the motion imparted, when once the moving cauſe ceaſeth. Whence it comes that the Aire, as being of it ſelf very light and thin, is eaſily mov'd by any very ſmall force, yet it is withall very unable to hold on its motion, the Mover once ceaſing. Therefore, as to the Aire which environs the Terreſtrial Globe, I would ſay, that by reaſon of its adherence, it is no leſſe carried about therewith then the Water; and eſpecially that part which is contained in its veſſels; which veſſels are the valleys encloſed with Mountains. And we may with much more reaſon affirm that this ſame part of the Air is carried round, and born forwards by the rugged parts of the Earth, than that the higher is whirl'd about by the motion of the Heavens, as ye *Peripatetick*s maintain.

Its more rational that the Air be commoved by the rugged ſurface of the Earth, than by the Celeſtial motion.

The revolution of the Earth confirmed by a new argument taken from the Air.

What hath been hitherto ſpoken, ſeems to me a ſufficient anſwer to the allegation of *Simplitius*; yet nevertheleſs with a new inſtance and ſolution, founded upon an admirable experiment, I will ſuperabundantly ſatisfie him, and confirm to *Sagredus* the mobility of the Earth. I have told you that the Air, and in particular that part of it which aſcendeth not above the tops of the higheſt Mountains, is carried round by the uneven parts of the Earths ſurface: from whence it ſhould ſeem, that it muſt of conſequence come to paſſe, that in caſe the ſuperficies of the Earth were not uneven, but ſmooth and plain, no cauſe would remain for drawing the Air along with it, or at leaſt for revolving it with ſo much uniformity. Now the ſurface of this our Globe, is not all craggy and rugged, but there are exceeding great tracts very

even,

even, to wit, the ſurfaces of very vaſt Seas, which being alſo far remote from the continuate ledges of Mountains which environ it, ſeem to have no faculty of carrying the ſuper-ambient Air along therewith: and not carrying it about, we may perceive what will of conſequence enſue in thoſe places.

SIMP. I was about to propoſe the very ſame difficulty, which I think is of great validity.

SALV. You ſay very well *Simplicius*, for from the not finding in the Air that which of conſequence would follow, did this our Globe move round; you argue its immoveableneſſe. But in caſe that this which you think ought of neceſſary conſequence to be found, be indeed by experience proved to be ſo; will you accept it for a ſufficient teſtimony and an argument for the mobility of the ſaid Globe?

SIMP. In this caſe it is not requiſite to argue with me alone, for if it ſhould ſo fall out, and that I could not comprehend the cauſe thereof, yet haply it might be known by others.

SALV. So that by playing with you, a man ſhall never get, but be alwayes on the loſing hand; and therefore it would be better to give over: Nevertheleſs, that we may not cheat our third man we will play on. We ſaid even now, and with ſome addition we reitterate it, that the Ayr as if it were a thin and fluid body, and not ſolidly conjoyned with the Earth, ſeem'd not to be neceſſitated to obey its motion; unleſſe ſo far as the craggineſs of the terreſtrial ſuperficies, tranſports and carries with it a part thereof contigious thereunto; which doth not by any great ſpace exceed the greateſt altitude of Mountains: the which portion of Air ought to be ſo much leſs repugnant to the terreſtrial converſion, by how much it is repleat with vapours, fumes, and exhalations, matters all participating of terrene qualities, and conſequently apt of their own nature to the ſame motions. But where there are wanting the cauſes of motion, that is, where the ſurface of the Globe hath great levels, and where there is leſs mixture of the terrene vapours, there the cauſe whereby the ambient Air is conſtrained to give entire obedience to the terreſtrial converſion will ceaſe in part; ſo that in ſuch places, whilſt the Earth revolveth towards the Eaſt, there will be continually a wind perceived which will beat upon us, blowing from the Eaſt towards the Weſt: and ſuch gales will be the more ſenſible, where the revolution of the Globe is moſt ſwift; which will be in places more remote from the Poles, and approaching to the greateſt Circle of the diurnal converſion. But now *de facto* experience much confirmeth this Phyloſophical argumentation; for in the ſpatious Seas, and in their parts moſt remote from Land, and ſituate under the Torrid Zone, that is bounded by the Tropicks, where there are none of thoſe

The vaporous parts of the earth, partake of its motions.

Conſtant gales within the Tropicks blow towards the West.

ſame terreſtrial evaporations, we finde a perpetual gale move from the Eaſt with ſo conſtant a blaſt, that ſhips by favour thereof ſail proſperouſly to the *West-India's*. And from the ſame coaſting along the *Mexican* ſhore, they with the ſame felicity paſs the *Pacifick* Ocean towards the *India's*; which to us are Eaſt, but to them are Weſt. Whereas on the contrary the Courſe from thence towards the Eaſt is difficult and uncertain, and not to be made by the ſame Rhumb, but muſt vere more to Land-ward, to recover other Winds, which we may call accidentary and tumultuary, produced from other Principles, as thoſe that inhabit the continent find by experience. Of which productions of Winds, the Cauſes are many and different, which ſhall not at this time be mentioned. And theſe accidentary Winds are thoſe which blow indifferently from all parts of the Earth, and make rough the Seas remote from the Equinoctial, and environed by the rugged Surface of the Earth; which is as much as to ſay environ'd with thoſe perturbations of Air, that confound that primary Gale. The which, in caſe theſe accidental impediments were removed, would be continually felt, and eſpecially upon the Sea. Now ſee how the effect of the Water and Air ſeem wonderfully to accord with the Celeſtial obſervations, to confirm the mobility of our Terreſtrial Globe.

*The courſe to the West-*India's *eaſie, the return difficult.*

Winds from Land make rough the Seas.

Another obſervation taken from the Air in confirmation of the motion of the Earth.

SAGR. I alſo for a final cloſe will relate to you one particular, which as I believe is unknown unto you, and which likewiſe may ſerve to confirm the ſame concluſion: You *Salviatus* alledged, That Accident which Sailers meet with between the Tropicks; I mean that perpetual Gale of Winde that beats upon them from the Eaſt, of which I have an account from thoſe that have many times made the Voyage: And moreover (which is very obſervable) I underſtand that the Mariners do not call it a *Wind*, but by another * name, which I do not now remember, taken haply from its ſo fixed and conſtant Tenor; which when they have met with, they tie up their ſhrouds and other cordage belonging to the Sails, and without any more need of touching them, though they be in a ſleep, they can continue their courſe. Now this conſtant Trade-wind was known to be ſuch by its continual blowing without interruption; for if it were interrupted by other Windes, it would not have been acknowledged for a ſingular Effect, and different from the reſt: from which I will infer, That it may be that alſo our Mediterranean Sea doth partake of the like accident; but it is not obſerved, as being frequently altered by the confluence of other windes. And this I ſay, not without good grounds, yea upon very probable conjectures which came unto my knowledge, from that which tendred it ſelf to my notice on occaſion of the voyage that I made into *Syria*, going Conſul for this Nation

* Which Wind with our Engliſh Mariners is called the *Trade-wind.*

to

to *Aleppo*, and this it is: That keeping a particular account and memorial of the dayes of the departure and arrival of the Ships in the Ports of *Alexandria*, of *Alexandretta*, and this of *Venice*; in comparing ſundry of them, which I did for my curioſity, I found that in exactneſs of account the returns hither, that is the voiages from Eaſt to Weſt along the Mediterrane, are made in leſs time then the contrary courſes by 25. in the Hundred: So that we ſee that one with another, the Eaſtern windes are ſtronger then the Weſtern.

The voiages in the Mediterrane from Eaſt to Weſt are made in ſhorter times than from Weſt to Eaſt.

SALV. I am very glad I know this particular, which doth not a little make for the confirmation of the Earths mobility. And although it may be alledged, That all the Water of the Mediterrane runs perpetually towards the Straits-mouth, as being to diſimbogue into the Ocean, the waters of as many Rivers, as do diſcharge themſelves into the ſame; I do not think that that current can be ſo great, as to be able of it ſelf alone to make ſo notable a difference: which is alſo manifeſt by obſerving that the water in the *Pharo* of *Sicily* runneth back again no leſs towards the Eaſt, than it runneth forwards towards the Weſt.

SAGR. I, that have not as *Simplicius*, an inclination to ſatisfie any one beſides my ſelf, am ſatisfied with what hath been ſaid as to this firſt particular: Therefore *Salviatus*, when you think it fit to proceed forward, I am prepared to hear you.

SALV. I ſhall do as you command me, but yet I would fain hear the opinion alſo of *Simplicius*, from whoſe judgement I can argue how much I may promiſe to my ſelf touching theſe diſcourſes from the *Peripatetick* Schools, if ever they ſhould come to their ears.

SIMP. I deſire not that my opinion ſhould ſerve or ſtand for a meaſure, whereby you ſhould judge of others thoughts; for as I have often ſaid, I am inconſiderable in theſe kinde of ſtudies, and ſuch things may come into the mindes of thoſe that are entered into the deepeſt paſſages of Philoſophy, as I could never think of; as having (according to the Proverb) ſcarce kiſt her Maid: yet nevertheleſs, to give you my ſudden thoughts, I ſhall tell you, That of thoſe effects by you recounted, and particularly the laſt, there may in my judgement very ſufficient Reaſons be given without the Earths mobility, by the mobility of the Heavens onely; never introducing any novelty more, than the inverſion of that which you your ſelf propoſe unto us. It hath been received by the *Peripatetick* Schools, that the Element of Fire, and alſo a great part of the Aire is carried about according to the Diurnal converſion from Eaſt to Weſt, by the contact of the Concave of the Lunar Orb, as by the Veſſel their container. Now without going out of your track, I will that we determine the Quantity of

It is demonſtrated inverting the argument, that the perpetual motion of the Air from Eaſt to Weſt cometh from the motion of Heaven.

It is demonſtrated inverting the argument, that the perpetual motion of the Air from Eaſt to Weſt, cometh from the motion of Heaven.

the Aire which partaketh of that motion to diſtend ſo low as to the Tops of the higheſt Hills, and that likewiſe they would reach to the Earth, if thoſe Mountains did not impede them, which agreeth with what you ſay: For as you affirm, the Air, which is invironed by ledges of Mountains, to be carried about by the aſperity of the moveable Earth; we on the contrary ſay, That the whole Element of Air is carried about by the motion of Heaven, that part only excepted which lyeth below thoſe bodies, which is hindred by the aſperity of the immoveable Earth. And whereas you ſaid, That in caſe that aſperity ſhould be removed, the Air would alſo ceaſe to be whirld about; we may ſay, That the ſaid aſperity being removed, the whole Aire would continue its motion. Whereupon, becauſe the ſurfaces of ſpacious Seas are ſmooth, and even; the Airs motion ſhall continue upon thoſe, alwaies blowing from the Eaſt: And this is more ſenſibly perceived in Climates lying under the Line, and within the Tropicks, where the motion of Heaven is ſwifter; and like as that Celeſtial motion is able to bear before it all the Air that is at liberty, ſo we may very rationally affirm that it contributeth the ſame motion to the Water moveable, as being fluid and not connected to the immobility of the Earth: And with ſo much the more confidence may we affirm the ſame, in that by your confeſſion, that motion ought to be very ſmall in reſect of the efficient Cauſe; which begirting in a natural day the whole Terreſtrial Globe, paſſeth many hundreds of miles an hour, and eſpecially towards the Equinoctial; whereas in the currents of the open Sea, it moveth but very few miles an hour. And thus the voiages towards the Weſt ſhall come to be commodious and expeditious, not onely by reaſon of the perpetual Eaſtern Gale, but of the courſe alſo of the Waters; from which courſe alſo perhaps the Ebbing and Flowing may come, by reaſon of the different ſcituation of the Terreſtrial Shores: againſt which the Water coming to beat, may alſo return backwards with a contrary motion, like as experience ſheweth us in the courſe of Rivers; for according as the Water in the unevenneſs of the Banks, meeteth with ſome parts that ſtand out, or make with their Meanders ſome Reach or Bay, here the Water turneth again, and is ſeen to retreat back a conſiderable ſpace. Upon this I hold, That of thoſe effects from which you argue the Earths mobility, and alledge it as a cauſe of them, there may be aſſigned a cauſe ſufficiently valid, retaining the Earth ſtedfaſt, and reſtoring the mobility of Heaven.

The motion of the Water dependeth on the motion of Heaven.

The flux and reflux may depend on the diurnal motion of Heaven.

SALV. It cannot be denied, but that your diſcourſe is ingenious, & hath much of probability, I mean probability in appearance, but not in reality & exiſtence: It conſiſteth of two parts: In the firſt it aſſignes

aſſignes a reaſon of the continual motion of the Eaſtern Winde and alſo of a like motion in the Water. In the ſecond, It would draw from the ſame Sourſe the cauſe of the Ebbing and Flowing. The firſt part hath (as I have ſaid) ſome appearance of probability, but yet extreamly leſs then that which we take from the Terreſtrial motion. The ſecond is not onely wholly improbable, but altogether impoſſible and falſe. And coming to the firſt, whereas it is ſaid that the Concave of the Moon carrieth about the element of Fire, and the whole Air, even ito the tops of the higher Mountains. I anſwer firſt, that it is dubious whether there be any element of Fire: But ſuppoſe there be, it is much doubted of the Orbe of the Moon, as alſo of all the reſt; that is, Whether there be any ſuch ſolid bodies and vaſt, or elſs, Whether beyond the Air there be extended a continuate expanſion of a ſubſtance of much more tenuity and purity than our Air, up and down which the Planets go wandring, as now at laſt a good part of thoſe very Phyloſophers begin to think: But be it in this or in that manner, there is no reaſon for which the Fire, by a ſimple contract to a ſuperficies, which you your ſelf grant to be ſmooth and terſe, ſhould be according to its whole depth carried round in a motion different from its natural inclination; as hath been defuſely proved, and with ſenſible reaſons demonſtrated by† *Il Sagr giatore*: Beſides the other improbability of the ſaid motions transfuſing it ſelf from the ſubtileſt Fire throughout the Air, much more denſe; and from that alſo again to the Water. But that a body of rugged and mountainous ſurface, by revolving in it ſelf, ſhould carry with it the Air contiguous to it, and againſt which its promontaries beat, is not onely probable but neceſſary, and experience thereof may be daily ſeen; though without ſeeing it, I believe that there is no judgement that doubts thereof. As to the other part, ſuppoſing that the motion of Heaven did carry round the Air, and alſo the Water; yet would that motion for all that have nothing to do with the Ebbing and Flowing. For being that from one onely and uniform cauſe, there can follow but one ſole and uniform effect; that which ſhould be diſcovered in the Water, would be a continuate and uniform courſe from Eaſt to Weſt; and in that a Sea onely, which running compaſs environeth the whole Globe. But in determinate Seas, ſuch as is the Mediterrane ſhut up in the Eaſt, there could be no ſuch motion. For if its Water might be driven by the courſe of Heaven towards the Weſt, it would have been dry many ages ſince: Beſides that our Water runneth not onely towards the Weſt, But returneth backwards towards the Eaſt, and that in ordinal Periods: And whereas you ſay by the example of Rivers, that though the courſe of the Sea were Originally that onely from

A reaſon of the continual motion of the Air and Water may be given, making the Earth moveable, then by making it immoveable.

Its improbable that the element of Fire ſhould be carried round by the Concave of the Moon.

† A Treatiſe of our Author formerly cited.

The Ebbing and Flowing cannot depend on the motion of Heaven.

from Eaſt to Weſt, yet nevertheleſs the different Poſition of the Shores may make part of the Water regurgitate, and return backwards: I grant it you, but it is neceſſary that you take notice my *Simplicius*, that where the Water upon that account returneth backwards, it doth ſo there perpetually; and where it runneth ſtraight forwards, it runneth there alwayes in the ſame manner; for ſo the example of the Rivers ſhewes you: But in the caſe of the ebbing and flowing, you muſt finde and give us ſome reaſon why it doth in the ſelf ſame place run one while one way, and another while another; Effects that being contrary & irregular, can never be deduced from any uniform and conſtant Cauſe: And this Argument, that overthrows the Hypotheſis of the motion contributed to the Sea from the Heavens diurnal motion, doth alſo confute that Poſition of thoſe who would admit the ſole diurnal motion of the Earth; and believe that they are able with that alone to give a reaſon of the Flux and Reflux: Of which effect ſince it is irregular, the cauſe muſt of neceſſity be irregular and alterable.

SIMP. I have nothing to reply, neither of my own, by reaſon of the weakneſs of my underſtanding; nor of that of others, for that the Opinion is ſo new: But I could believe that if it were ſpread amongſt the Schools, there would not want Phyloſophers able to oppoſe it.

SAGR. Expect ſuch an occaſion; and we in the mean time if it ſeem good to *Salviatus*, will proceed forward.

SALV. All that which hath been ſaid hitherto, pertaineth to the diurnal period of the ebbing and flowing; of which we have in the firſt place demonſtrated in general the primary and univerſal Cauſe, without which, no ſuch effect would follow: Afterw*ds* paſſing to the particular Accidents, various, and in a certain ſort irregular, that are obſerved therein: We have handled the ſecondary and concommitant Cauſes upon which they depend. Now follow the two other Periods, Monethly, and Annual, which do not bring with them new and different Accidents, other than thoſe already conſidered in the diurnal Period; but they operate on the ſame Accidents, by rendring them greater and leſſer in ſeveral parts of the Lunar Moneth, and in ſeveral times of the Solar Year; as if that the Moon and Sun did each conceive it ſelf apart in operating and producing of thoſe Effects; a thing that totally claſheth with my underſtanding, which ſeeing how that this of Seas is a local and ſenſible motion, made in an immenſe maſs of Water, it cannot be brought to ſubſcribe to Lights, to temperate Heats, to predominacies by occult Qualities, and to ſuch like vain Imaginations, that are ſo far from being, or being poſſible to be Cauſes of the Tide; that on the contrary

trary, the Tide is the cauſe of them, that is, of bringing them into the brains more apt for loquacity and oſtentation, than for the ſpeculation and diſcovering of the more abſtruſe ſecrets of Nature; which kind of people, before they can be brought to prononnce that wiſe, ingenious, and modeſt ſentence, *I know it not*, ſuffer to eſcape from their mouths and pens all manner of extravagancies. And the onely obſerving, that the ſame Moon, and the ſame Sun operate not with their light with their motion, with great heat, or with temperate, on the leſſer reeeptacles of Water, but that to effect their flowing by heat, they muſt be reduced to little leſſe than boiling, and in ſhort, we not being able artificially to imitate any way the motions of the Tide, ſave only by the motion of the Veſſel, ought it not to ſatisfie every one, that all the other things alledged, as cauſes of thoſe effects, are vaine fancies, and altogether eſtranged from the Truth. I ſay, therefore, that if it be true, that of one effect there is but one ſole primary cauſe, and that between the cauſe and effect, there is a firm and conſtant connection; it is neceſſary that whenſoever there is ſeen a firm and conſtant alteration in the effect, there be a firm and conſtant alteration in the cauſe. And becauſe the alterations that happen in the ebbing and flowing in ſeveral parts of the Year and Moneths, have their periods firm and conſtant, it is neceſſary to ſay, that a regular alteration in thoſe ſame times happeneth in the primary cauſe of the ebbings and flowings. And as for the alteration that in thoſe times happens in the ebbings and flowings conſiſteth onely in their greatneſs; that is, in the Waters riſing and falling more or leſſe, and in running with greater or leſſe *impetus*; therefore it is neceſſary, that that which is the primary cauſe of the ebbing and flowing, doth in thoſe ſame determinate times increaſe and diminiſh its force. But we have already concluded upon the inequality and irregularity of the motion of the Veſſels containing the Water to be the primary cauſe of the ebbings and flowings. Therefore it is neceſſary, that that irregularity, from time to time, correſpondently grow more irregular, that is, grow greater and leſſer. Now it is requiſite, that we call to minde, that the irregularity, that is, the different velocity of the motions of the Veſſels, to wit, of the parts of the Terreſtrial Superficies, dependeth on their moving with a compound motion, reſulting from the commixtion of the two motions, Annual and Diurnal, proper to the whole Terreſtrial Globe; of which the Diurnal converſion, by one while adding to, and another while ſubſtracting from, the Annual motion, is that which produceth the irregularity in the compound motion; ſo that, in the additions and ſubſtractions, that the Diurnal revolution maketh from the Annual motion, con-

The alterations in the effects argue alteration in the cauſe.

The cauſes at large aſſigned of the Periods Monethly and Annual of the ebbings and flowings.

The monethly and annual alterations of the tide can depend upon nothing, ſave on the alteration of the additions & ſubſtractions of the diurnal period from the annual.

conſiſteth the original cauſe of the irregular motion of the Veſſels, and conſequently of the Ebbing and Flowing: inſomuch that if theſe additions and ſubſtractions ſhould alwayes proceed in the ſame proportion, in reſpect of the Annual motion, the cauſe of the Ebbing and Flowing would indeed continue, but yet ſo as that they would perpetually return in the ſelf ſame manner: But we are to finde out the cauſe of making the ſame Ebbings and Flowings in divers times greater and leſſer: Therefore we muſt (if we will retain the identity of the cauſe) find the alteration in theſe additions and ſubſtractions, that make them more & leſs potent, in producing thoſe effects which depend thereupon. But I ſee not how that potency and impotence can be introduced, unleſſe by making the ſame additions and ſubſtractions, one while greater, and another while leſſer; ſo that the acceleration and the retardment of the compound motion, may be made, ſometimes in greater, and ſometimes in leſſer proportion.

SAGR. I feel my ſelf very gently led, as it were, by the hand, and though I finde no rubs in the way, yet nevertheleſſe, like a blind-man, I ſee not whether your Clue leadeth me, nor can I imagine where ſuch a Journey will end.

SALV. Though there be a great difference between my ſlow pac't Philoſophy, and your more nimble Reaſon, yet nevertheleſſe, in this particular which we are now upon, I do not much wonder, if the apprehenſiveneſſe of your wit be a little obſcured by the dark and thick miſt that hides the mark, at which we aime: and that which leſſeneth my admiration is, the remembrance of the many hours, many dayes, yea more, many nights that I have conſumed in this contemplation, and of the many times that, deſpairing to bring it to a period, I have, for an incouragement of my ſelf, indeavoured to believe, by the example of the unfortunate *Orlando*, that that might not poſſibly be true, which yet the teſtimony of ſo many credible men ſet before my eyes: wonder not, therefore, if this once, contrary to your cuſtome, you do not foreſee what I intend: and if you will needs admire, I believe that the event, as far as I can judge unexpected, will make you ceaſe your wonderment.

SAGR. I thank God, that he did not permit that deſperation of yours to end in the *Exit* that is fabled of the miſerable *Orlando*, nor in that which haply is no leſſe fabulouſly related of *Ariſtotle*, , that ſo neither my ſelf nor others ſhould be deprived of the diſcovery of a thing, as abſtruſe as it was deſirable: I beſeech you, therefore, to ſatisfie my eager appetite as ſoon as you can.

SALV. I am ready to ſerve you: We were upon an inquiry in what manner the additions and ſubſtractions of the Terreſtri-

all

all converſion from the Annual motion, could be made, one while in a greater, and another while in a leſſer proportion; which diverſity, and no other thing, could be aſſigned for the cauſe of the alterations, Monethly and Annual, that are ſeen in the greatneſſe of the Ebbings and Flowings. I will now conſider how this proportion of the additions and ſubſtractions of the Diurnal Revolution, and Annual motion may grow greater and leſſer three ſeveral wayes. One is by increaſing and diminiſhing the velocity of the Annual motion, retaining the additions and ſubſtractions made by the Diurnal converſion in the ſame greatneſſe, becauſe the Annual motion being about three times greater, that is, more velocious than the Diurnal motion (conſidered likewiſe in the Grand Circle) if we increaſe it anew, the additions and ſubſtractions of the Diurnal motion will occaſion leſſe alteration therein: but, on the other ſide, making it more ſlow, it will be altered in greater proportion, by that ſame diurnal motion, juſt as the adding or ſubſtracting four degrees of velocity from one that moveth with twenty degrees, altereth his courſe leſſe, than thoſe very four degrees would do, added or ſubſtracted from one that ſhould move onely with ten degrees. The ſecond way would be, by making the additions and ſubſtractions greater and leſſer, retaining the annual motion in the ſame velocity; which is as eaſie to be underſtood, as it is manifeſt, that a velocity *v.gr.* of 20. degr. is more altered by the addition or ſubſtraction of 10. deg. than by the addition or ſubſtraction of 4. The third way would be, in caſe theſe two were joyned together, diminiſhing the annual motion, & increaſing the diurnal additions and ſubſtractions. Hitherto, as you ſee, it was no hard matter to attain, but yet it proved to me very hard to find by what means this might be effected in Nature. Yet in the end, I finde that ſhe doth admirably make uſe thereof, and in wayes almoſt incredible: I mean, admirable and incredible to us, but not to her, who worketh even thoſe very things, which, to our capacity, are of infinite wonder, with extraordinary facility and ſimplicity; and that which it is hard for us to underſtand, is eaſie for her to effect. Now to proceed, having ſhewn that the proportion between the additions and ſubſtractions of the Diurnal converſion and Annual motion may be made greater and leſſer, two wayes, (and I ſay two, becauſe the third is comprized in the two firſt) I adde, that Nature maketh uſe of them both: and farthermore, I ſubjoyn, that if ſhe did make uſe but of one alone, it would be neceſſary to take away one of the two Periodical alterations. That of the Monethly Period would ceaſe, if the annual motion ſhould not alter. And in caſe the additions and ſubſtractions of the diurnal revolution ſhould continually

Three wayes of altering the proportion of the additions of the diurnal Revolution to the annual motion.

That which to us is hard to be underſtood, is with Nature eaſie to be effected.

If the Diurnal motion ſhould not alter, the annual Period would ceaſe

be equal, the alterations of the annual Period would fail.

SAGR. It ſeems then, that the Monethly alteration of ebbings and flowings dependeth on the alteration of the annual motion of the Earth? And the annual alteration of thoſe ebbings and flowings do, it ſeems, depend on the additions and ſubſtractions of the diurnal converſion? And here now I finde my ſelf worſe puzzled than before, and more out of hope of being able to comprehend how this intricacy may be, which is more inextricable, in my judgment, than the Gordian knot. And I envy *Simplicius*, from whoſe ſilence I argue that he doth apprehend the whole buſineſſe, and is acquit of that confuſion which greatly puzzleth my brains.

SIMP. I believe verily, *Sagredus*, that you are put to a a ſtand; and I believe that I know alſo the cauſe of your confuſion, which, if I miſtake not, riſeth from your underſtanding part of thoſe particulars but even now alledged by *Salviatus*, and but a part. It is true likewiſe that I find my ſelf free from the like confuſion; but not for that cauſe as you think, to wit, becauſe I apprehend the whole, nay it happens upon the quite contrary account; namely, from my not comprehending any thing; and confuſion is in the plurality of things, and not in nothing.

SAGR. You ſee *Salviatus*, how a few checks given to *Simplicius* in the dayes preceding, have rendered him gentle, and brought him from the *caprtol* to the *amble*. But I beſeech you without farther delay, put us both out of ſuſpence.

SALV. I will endeavour it to the utmoſt of my harſh way of expreſſing my ſelf, the obtuſeneſſe of which, the acuteneſſe of your wit ſhall ſupply. The accidents of which we are to enquire the cauſes are two: The firſt reſpecteth the varieties that happen in the ebbings and flowings in the Monethly Period; and the othr relateth to the Annual. We will firſt ſpeak of the Monethly, and then treat of the Annual; and it is convenient that we reſolve them all according to the Fundamentals and Hypotheſis already laid down, without introducing any novelty either in Aſtronomy, or in the Univerſe, in favour of the ebbings and flowings; therefore let us demonſtrate thar of all the ſeveral accidents in them obſerved, the cauſes reſide in the things already known, and received for true and undoubted. I ſay therefore, that it is a truly natural, yea neceſſary thing, that one and the ſame moveable made to move round by the ſame moving virtue in a longer time, do make its courſe by a greater circle, rather than by a leſſer; and this is a truth received by all, and confirmed by all experiments, of which we will produce a few. In the wheel-clocks, and particularly in the great ones, to moderate

The true Hypotheſis may diſpatch its revolutions in a ſhorter time, in leſſer circles than in greater; the which is proved by two examples.

The firſt example.

derate the time, the Artificers that make them accomodate a certain voluble staffe horozontally, and at each end of it they fasten two Weights of Lead, and when the time goeth too slow, by the onely removing those Leads a little nearer to the centre of the staffe, they render its vibrations more frequent; and on the contrary to retard it, it is but drawing those Weights more towards the ends; for so the vibrations are made more seldome, and consequently the intervals of the hours are prolonged.

The second example.

Here the moventive tie is the same, namely the counterpoise, the moveables are those same Weights of lead, and their vibrations are more frequent when they are neerer to the centre, that is, when they move by lesser circles. Hanging equal Weights at unequal cords, and being removed from their perpendicularity, letting them go, we shall see those that are pendent at the shorter cords, to make their vibrations under shorter times, as those that move by lesser circles. Again, let such a kind of Weight be fastened to a cord, which cord let play upon a staple fastened in the Seeling, and do you hold the other end of the cord in your hand, and having given the motion to the pendent Weight, whilst it is making its vibrations, pull the end of the cord that you hold in your hand, so that the Weight may rise higher and higher: In its rising you shall see the frequency of its vibrations encrease, in regard that they are made successively by lesser and lesser circles. And here I desire you to take notice of two particulars worthy to be observed. One is that the vibrations of one of those plummets are made with such a necessity under such determinate times, that it is altogether impossible to cause them to be made under other times, unlesse it be by prolonging, or abreviating the cord; of which you may also at this very instant ascertain your selves by experience, tying a stone to a pack-threed, and holding the other end in your hand, trying whether you can ever by any artifice be able to swing it this way and that way in other than one determinate time, unlesse by lengthening or shortening the string, which you will find to be absolutely impossible. The other particular truly admirable is, that the self same *pendulum* makes its vibrations with one and the same frequency, or very little, and as it were insensibly different, whether they be made by very great, or very small arches of the self-same circumference. I mean that whether we remove the *pendulum* from perpendicularity one, two, or three degrees onely, or whether we remove it 70. 80. nay to an entire quadrant, it being let go, will in the one case and in the other make its vibrations with the same frequency, as well the former where it is to move by an arch of but four or six degrees, as the second, where it is to passe arches of 160. or more

Two particular notable accidents in the pendulum *and their vibrations.*

degrees. Which may the better be ſeen, by hanging two weights at two ſtrings of equal length, and then removing them from perpendicularity, one a little way, and the other very far; the which being ſet at liberty, will go & return under the ſame times, the one by arches very ſmall, & the other by very great ones, from whence followeth the concluſion of an admirable Problem; which is, That a Quadrant of a Circle being given (take a little diagram of the ſame, [in *Fig.* 3.]) as for inſtance A B erect to the Horizon, ſo as that it reſt upon the plain touching in the point B. and an Arch being made with a Hoop well plained and ſmoothed in the concave part, bending it according to the curvity of the Circumference A D B. So that a Bullet very round and ſmooth may freely run to and again within it (the rim of a Sieve is very proper for the experiment) I ſay, that the Bullet being put in any whatever place, neer or far from the loweſt term B. As for inſtance, putting it in the point C, or here in D, or in E; and then let go, it will in equal times, or inſenſibly different arrive at the term B, departing from C, or from D, or from E, or from whatever other place; an accident truly wonderfull. We may add another accident no leſs ſtrange than this, which is, That moreover by all the cords drawn from the point B to the points C, D, E; and to any other whatſoever, taken not onely in the Quadrant B A, but in all the whole circumference of the Circle the ſaid moveable ſhall deſcend in times abſolutely equal; inſomuch that it ſhall be no longer in deſcending by the whole Diameter erect perpendicularly upon the point B, then it ſhall in deſcending by B. C. although it do ſublend but one ſole degree, or a leſſer Arch. Let us add the other wonder, which is, That the motions of the falling bodies made by the Arches of the Quadrant A B; are made in ſhorter times than thoſe that are made by the cords of thoſe ſame Arches; ſo that the ſwifteſt motion, and made by a moveable in the ſhorteſt time, to arrive from the point A, to the term B, ſhall be that which is made, not by the right line A, B, (although it be the ſhorteſt of all thoſe that can be drawn between the points A. B.) but by the circumference A D B. And any point being taken in the ſaid Arch; as for example: The point D. and two cords drawn A D, and D. B. the moveable departing from the point A, ſhall in a leſs time come to B, moving by the two cords A D and D B. than by the ſole cord A, B. But the ſhorteſt of all the times ſhall be that of the fall by the Arch A D B. And the ſelf ſame accidents are to be underſtood of all the other leſſer Arches taken from the lowermoſt term B. upwards.

Admirable Problems of moveables deſcending by the Quadrant of a Circle, and of thoſe deſcending by all the cords of the whole Circle.

SAGR. No more, no more; for you ſo confund and fill me with Wonders, and diſtract my thoughts ſo many ſeveral wayes, that

that I fear I ſhall have but a ſmall part of it left free and diſingaged, to apply to the principal matter that is treated of, and which of it ſelf is but even too obſcure and intricate: So that I intreat you to vouchſafe me, having once diſpatcht the buſineſs of the ebbings and flowings, to do this honour to my houſe (and yours) ſome other dayes, and to diſcourſe upon the ſo many other Problems that we have left in ſuſpence; and which perhaps are no leſs curious and admirable, than this that hath been diſcuſſed theſe dayes paſt, and that now ought to draw to a concluſion.

SALV. I ſhall be ready to ſerve you, but we muſt make more than one or two Seſſions; if beſides the other queſtions reſerved to be handled apart, we would diſcuſſe thoſe many that pertain to the local motion, as well of natural moveables, as of the rejected: an Argument largely treated of by our *Lyncean Accademick*. But turning to our firſt purpoſe, where we were about to declare, That the bodies moving circularly by a movent virtue, which continually remaineth the ſame, the times of the circulations were prefixt and determined, and impoſſible to be made longer or ſhorter, having given examples, and produced experiments thereof, ſenſible, and feaſible, we may confirm the ſame truth by the experiences of the Celeſtial motions of the Planets; in which we ſee the ſame rule obſerved; for thoſe that move by greater Circles, confirm longer times in paſſing them. A moſt pertinent obſervation of this we have from the *Medicæan* Planets, which in ſhort times make their revolutions about *Jupiter*: Inſomuch that it is not to be queſtioned, nay we may hold it for ſure and certain, that if for example, the Moon continuing to be moved by the ſame movent faculty, ſhould retire by little and little in leſſer Circles, it would acquire a power of abreviating the times of its Periods, according to that *Pendulum*, of which in the courſe of its vibrations, we by degrees ſhortned the cord, that is contracted the Semidiameter of the circumferences by it paſſed. Know now that this that I have alledged an example of it in the Moon, is ſeen and verified eſſentially in fact. Let us call to mind, that it hath been already concluded by us, together with *Copernicus*, That it is not poſſible to ſeparate the Moon from the Earth, about which it without diſpute revolveth in a Moneth: Let us remember alſo that the Terreſtrial Globe, accompanyed alwayes by the Moon, goeth along the circumference of the Grand Orb about the Sun in a year, in which time the Moon revolveth about the Earth almoſt thirteen times; from which revolution it followeth, that the ſaid Moon ſometimes is found near the Sun; that is, when it is between the Sun and the Earth, and ſometimes much more remote, that is, when the Earth is ſituate between the

The Earths annual motion by the Ecliptick, unequal by means of the Moons motion.

the Moon and Sun; neer, in a word, at the time of its conjunction and change; remote, in its Full and Oppoſition; and the greateſt vicinity differ the quantity of the Diameter of the Lunar Orb. Now if it be true that the virtue which moveth the Earth and Moon, about the Sun, be alwayes maintained in the ſame vigour; and if it be true that the ſame moveable moved by the ſame virtue, but in circles unequal, do in ſhorter times paſſe like arches of leſſer circles, it muſt needs be granted, that the Moon when it is at a leſſe diſtance from the Sun, that is in the time of conjunction, paſſeth greater arches of the Grand Orb, than when it is at a greater diſtance, that is in its Opppſition and Full. And this Lunar inequality muſt of neceſſity be imparted to the Earth alſo; for if we ſhall ſuppoſe a right line produced from the centre of the Sun by the centre of the Terreſtrial Globe, and prolonged as far as the Orb of the Moon, this ſhall be the ſemidiameter of the Grand Orb, in which the Earth, in caſe it were alone, would move uniformly, but if in the ſame ſemidiameter we ſhould place another body to be carried about, placing it one while between the Earth and Sun, and another while beyond the Earth, at a greater diſtance from the Sun, it is neceſſary, that in this ſecond caſe the motion common to both, according to the circumference of the great Orb by means of the diſtance of the Moon, do prove a little ſlower than in the other caſe, when the Moon is between the Earth and Sun, that is at a leſſer diſtance. So that in this buſineſſe the very ſame happeneth that befals in the time of the clock; that lead which is placed one while farther from the centre, to make the vibrations of the ſtaffe or ballance leſſe frequent, and another while nearer, to make them thicker, repreſenting the Moon. Hence it may be manifeſt, that the annual motion of the Earth in the Grand Orb, and under the Ecliptick, is not uniform, and that its irregularity proceedeth from the Moon, and hath its Monethly Periods and Returns. And becauſe it hath been concluded, that the Monethly and Annual Periodick alterations of the ebbings and flowings, cannot be deduced from any other cauſe than from the altered proportion between the annual motion and the additions and ſubſtractions of the diurnal converſion; and that thoſe alterations might be made two wayes, that is by altering the annual motion, keeping the quantity of the additions unaltered, or by changing of the bigneſſe of theſe, reteining the uniformity of annual motion. We have already found the firſt of theſe, depending on the irregularity of the annual motion occaſioned by the Moon, and which hath its Monethly Periods. It is therefore neceſſary, that upon that account the ebbings and flowings have a Monethly Period in which they do grow greater

greater and leſſer. Now you ſee that the cauſe of the Monethly Period reſideth in the annual motion; and withal you ſee how much the Moon is concerned in this buſineſs, and how it is therewith interrupted apart, without having any thing to do with either, with Seas or Waters.

SAGR. If one that never had ſeen any kinde of Stairs or Lader, were ſhewed a very high Tower, and asked if ever he hoped to climb to the top of it, I verily believe that he would anſwer he did not, not conceiving how one ſhould come thither any way except by flying; but ſhewing him a ſtone of but a foot high, and asking him whether he thought he could get to the top of that, I am certain that he would anſwer he could; and farther, that he would not deny, but that it was not onely one, but ten, twenty, and an hundred times eaſier to climb that: But now if he ſhould be ſhewed the Stairs, by means whereof, with the facility by him granted, it is poſſible to get thither, whither he a little before had affirmed it was impoſſible to aſcend, I do think that laughing at himſelf he would confeſs his dulneſs of apprehenſion. Thus, *Salviatus*, have you ſtep by ſtep ſo gently lead me, that, not without wonder, I finde that I am got with ſmall pains to that height which I deſpaired of arriving at. 'Tis true; that the Staircaſe having been dark, I did not perceive that I was got nearer to, or arrived at the top, till that coming into the open Air I diſcovered a great Sea, and ſpacious Country: And as in aſcending one ſtep, there is no labour; ſo each of your propoſitions by it ſelf ſeemed to me ſo plain, that thinking I heard but little or nothing that was new unto me, I conceived that my benefit thereby had been little or none at all: Whereupon I was the more amazed at the unexpected *exit* of this diſcourſe, that hath guided me to the knowledge of a thing which I held impoſſible to be demonſtrated. One doubt onely remains, from which I deſire to be freed, and this it is; Whether that if the motion of the Earth together with that of the Moon under the Zodiack are irregular motions, thoſe irregularities ought to have been obſerved and taken notice of by *Aſtronomers*, which I do not know that they are: Therefore I pray you, who are better acquainted with theſe things than I, to free me from this doubt, and tell me how the caſe ſtands.

Many things may remain as yet unobſerved in Aſtronomy.

SALV. You ask a rational queſtion, and anſwering to the Objection, I ſay; That although *Aſtronomy* in the courſes of many ages hath made a great progreſs in diſcovering the conſtitution and motions of the Celeſtial bodies, yet is it not hitherto arrived at that height, but that very many things remain undecided, and haply many others alſo undiſcovered. It is to be ſuppoſed that the firſt obſervers of Heaven knew no more but one motion common

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to all the Stars, as is this diurnal one: yet I believe that in few dayes they perceived that the Moon was inconſtant in keeping company with the other Stars; but yet withal, that many years paſt, before that they diſtinguiſhed all the Planets: And in particular, I conceit that *Saturn* by its ſlowneſs, and *Mercury* by reaſon of its ſeldom appearing, were the laſt that were obſerved to be wandring and errant. It is to be thought that many more years run out before the ſtations and retrogradations of the three ſuperiour Planets were known, as alſo their approximations and receſſions from the Earth, neceſſary occaſions of introducing the Eccentrix and Epicicles, things unknown even to *Ariſtotle*, for that he makes no mention thereof. *Mercury*, and *Venus*, with their admirable apparitions; how long did they keep Aſtronomers in ſuſpence, before that they could reſolve (not to ſpeak of any other of their qualities) upon their ſituation? Inſomuch that the very order onely of the Mundane bodies, and the integral ſtructure of the parts of the Univerſe by us known, hath been doubted of untill the time of *Copernicus*, who hath at laſt given us notice of the true conſtitution, and real ſyſteme, according to which thoſe parts are diſpoſed; ſo that at length we are certain that *Mercury*, *Venus*, and the other Planets do revolve about the Sun; and that the Moon revolveth about the Earth. But how each Planet governeth it ſelf in its particular revolution, and how preciſely the ſtructure of its Orb is framed; which is that which is vulgarly called the *Theory* of the *Planets*, we cannot as yet undoubtedly reſolve. *Mars*, that hath ſo much puzled our Modern Aſtronomers, is a proof of this: And to the Moon her ſelf there have been aſſigned ſeveral Theories, after that the ſaid *Copernicus* had much altered it from that of *Ptolomy*. And to deſcend to our particular caſe, that is to ſay, to the apparent motion of the Sun and Moon; touching the former, there hath been obſerved a certain great irregularity, whereby it paſſeth the two ſemicircles of the Ecliptick, divided by the points of the Equinoxes in very different times; in paſſing one of which, it ſpendeth about nine dayes more than in paſſing the other; a difference, as you ſee, very great and notable. But if in paſſing ſmall arches, ſuch for example as are the twelve Signs, he maintain a moſt regular motion, or elſe proceed with paces, one while a little more ſwift, and another more ſlow, as it is neceſſary that it do, in caſe the annual motion belong to the Sun onely in appearance, but in reality to the Earth in company with the Moon, it is what hath not hitherto been obſerved, nor it may be, ſought. Touching the Moon in the next place, whoſe reſtitutions have been principally lookt into an account of the Eclipſes, for which it is ſufficient to have an exact knowledge of its motion about the Earth,

Saturn for its ſlowneſs, and Mercury for its rareneſs of appearing were amongſt thoſe that were laſt obſerved.

Particular ſtructures of the Orbs of the Planets not yet well reſolved.

The Sun paſſeth one half of the Zodiack nine days ſooner than the other.

The Moons motion principally ſought in the account of Eclipſes.

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it hath not been likewiſe with a perfect curioſity inquired, what its courſe is thorow the particular arches of the Zodiack. That therefore the Earth and Moon in running through the Zodiack, that is round the Grand Orb, do ſomewhat accellerate at the Moons change, and retard at its full, ought not to be doubted; for that the ſaid difference is not manifeſt, which cometh to be unobſerved upon two accounts; Firſt, Becauſe it hath not been lookt for. Secondly, Becauſe that its poſſible it may not be very great. Nor is there any need that it ſhould be great, for the producing the effect that we ſee in the alteration of the greatneſs of ebbings and flowings. For not onely thoſe alterations, but the Tides themſelves are but ſmall matters in reſpect of the grandure of the ſubjects on which they work; albeit that to us, and to our littleneſs they ſeem great. For the addition or ſubduction of one degree of velocity where there are naturally 700, or 1000, can be called no great alteration, either in that which conferreth it, or in that Which receiveth it: the Water of our Mediterrane carried about by the diurnal revolution, maketh about 700 miles an hour, (which is the motion common to the Earth and to it, and therefore not perceptible to us)& that which we ſenſibly diſcern to be made in the ſtreams or currents, is not at the rate of full one mile an hour, (I ſpeak of the main Seas, and not of the Straights) and this is that which altereth the firſt, naturall, and grand motion; and this motion is very great in reſpect of us, and of Ships: for a Veſſel that in a ſtanding Water by the help of Oares can make *v. g.* three miles an hour, in that ſame current will row twice as far with the ſtream as againſt it: A notable difference in the motion of the Boat, though but very ſmall in the motion of the Sea, which is altered but its ſeven hundredth part. The like I ſay of its riſing, and falling one, two, or three feet; and ſcarcely four or five in the utmoſt bounds of a ſtreight, two thouſand, or more miles long, and where there are depths of hundreds of feet; this alteration is much leſs than if in one of the Boats that bring us freſh Water, the ſaid Water upon the arreſt of the Boat ſhould riſe at the Prow the thickneſs of a leaf. I conclude therefore that very ſmall alterations in reſpect of the immenſe greatneſs, and extraordinary velocity of the Seas, is ſufficient to make therein great mutations in relation to our ſmallneſs, and to our accidents.

Ebbings and flowings are petty things in comparison of the vaſtneſs of Seas, and of the velocity of the motion of the Terreſtrial Globe.

SAGR. I am fully ſatisfied as to this particular; it remains to declare unto us how thoſe additions and ſubſtractions derived from the diurnal *Vertigo* are made one while greater, and another while leſſer; from which alterations you hinted that the annual period of the augmentations and diminutions of the ebbings and flowings did depend.

The cauſes of the inequality of the additions and ſubſtractions of the diurnal converſion from the annual motion.

SALV. I will uſe my utmoſt endeavours to render my ſelf intelligible, but the difficulty of the accident it ſelf, and the great attention of mind requiſite for the comprehending of it, conſtrains me to be obſcure. The unequalities of the additions and ſubſtractions, that the diurnal motion maketh to or from the annual dependeth upon the inclination of the Axis of the diurnal motion upon the plane of the Grand Orb, or, if you pleaſe, of the Ecliptick; by means of which inclination the Equinoctial interſecteth the ſaid Ecliptick, remaining inclined and oblique upon the ſame according to the ſaid inclination of Axis. And the quantity of the additions importeth as much as the whole diameter of the ſaid Equinoctial, the Earths centre being at the ſame time in the Solſtitial points; but being out of them it importeth leſſe and leſſe, according as the ſaid centre ſucceſſively approacheth to the points of the Equinoxes, where thoſe additions are leſſer than in any other places. This is the whole buſineſſe, but wrapt up in the obſcurity that you ſee.

SAGR. Rather in that which I do no not ſee; for hitherto I comprehend nothing at all.

SALV. I have already foretold it. Nevertheleſſe we will try whether by drawing a Diagram thereof, we can give ſome ſmall light to the ſame; though indeed it might better be ſet forth by ſolid bodies than by bare Schemes; yet we will help our ſelves with Perſpective and fore-ſhortning. Let us draw therefore, as before, the circumference of the Grand Orb, [*as in Fig.* 4.] in which the point A is underſtood to be one of the Solſtitials, and the diameter A P the common Section of the Solſtitial Colure, and of the plane of the Grand Orb or Ecliptick; and in that ſame point A let us ſuppoſe the centre of the Terreſtrial Globe to be placed, the Axis of which C A B, inclined upon the Plane of the Grand Orb, falleth on the plane of the ſaid Colure that paſſeth thorow both the Axis of the Equinoctial, and of the Ecliptick. And for to prevent confuſion, let us only draw the Equinoctial circle, marking it with theſe characters D G E F, the common ſection of which, with the plane of the grand Orb, let be the line D E, ſo that half of the ſaid Equinoctial D F E will remain inclined below the plane of the Grand Orb, and the other half D G E elevated above. Let now the Revolution of the ſaid Equinoctial be made, according to the order of the points D G E F, and the motion of the centre from A towards E. And becauſe the centre of the Earth being in A, the Axis C B (which is erect upon the diameter of the Equinoctial D E) falleth, as hath been ſaid, in the Solſtitial Colure, the common Section of which and of the Grand Orb, is the diameter P A, the ſaid line P A ſhall

be

be perpendicular to the ſame D E, by reaſon that the Colure is erect upon the grand Orb; and therefore the ſaid D E, ſhall be the Tangent of the grand Orb in the point A. So that in this Poſition the motion of the Centre by the arch A E; that is, of one degree every day differeth very little; yea, is as if it were made by the Tangent D A E. And becauſe by means of the diurnal motion the point D, carried about by G, unto E, encreaſeth the motion of the Centre moved almoſt in the ſame line D E, as much as the whole diameter D E amounts unto; and on the other ſide diminiſheth as much, moving about the other ſemicircle E F D. The additions and ſubductions in this place therefore, that is in the time of the ſolſtice, ſhall be meaſured by the whole diameter D E.

Let us in the next place enquire, Whether they be of the ſame bigneſs in the times of the Equinoxes; and tranſporting the Centre of the Earth to the point I, diſtant a Quadrant of a Circle from the point A. Let us ſuppoſe the ſaid Equinoctial to be G E F D, its common ſection with the grand Orb D E, the Axis with the ſame inclination C B; but the Tangent of the grand Orb in the point I ſhall be no longer D E, but another which ſhall cut that at right Angles; and let it be this marked H I L, according to which the motion of the Centre I, ſhall make its progreſs, proceeding along the circumference of this grand Orb. Now in this ſtate the Additions and Subſtractions are no longer meaſured by the diameter D E, as before was done; becauſe that diameter not diſtending it ſelf according to the line of the annual motion H L, rather cutting it at right angles, thoſe terms D E, do neither add nor ſubſtract any thing; but the Additions and Subſtractions are to be taken from that diameter that falleth in the plane that is erect upon the plane of the grand Orb, and that interſects it according to the line H L; which diameter in this caſe ſhall be this G F and the Adjective, if I may ſo ſay, ſhall be that made by the point G, about the ſemicircle G E F, and the Ablative ſhall be the reſt made by the other ſemicircle F D G. Now this diameter, as not being in the ſame line H L of the annual motion, but rather cutting it, as we ſee in the point I, the term G being elevated above, and E depreſſed below the plane of the grand Orb, doth not determine the Additions and Subſtractions according to its whole length, but the quantity of thoſe firſt ought to be taken from the part of the line H L, that is intercepted between the perpendiculars drawn upon it from the terms G F; namely, theſe two G S, and F V: So that the meaſure of the additions is the line S V leſſer then G F, or then D E; which was the meaſure of the additions in the Solſtice A. And ſo ſucceſſively, according as the centre of the Earth ſhall be conſtituted

ſtituted in other points of the Quadrant A I, drawing the Tangents in the ſaid points, and the perpndiculars upon the ſame falling from the terms of the diameters of the Equinoctial drawn from the erect planes by the ſaid Tangents to the plane of the grand Orb; the parts of the ſaid Tangents (which ſhall continually be leſſer towards the Equinoctials, and greater towards the Solſtices) ſhall give us the quantities of the additions and ſubſtractions. How much in the next place the leaſt additions differ from the greateſt, is eaſie to be known, becauſe there is the ſame difference betwixt them, as between the whole Axis or Diameter of the Sphere, and the part thereof that lyeth between the Polar-Circles; the which is leſs than the whole diameter by very near a twelfth part, ſuppoſing yet that we ſpeak of the additions and ſubſtractions made in the Equinoctial; but in the other Parallels they are leſſer, according as their diameters do diminiſh.

This is all that I have to ſay upon this Argument, and all perhaps that can fall under the comprehenſion of our knowledge, which, as you well know, may not entertain any concluſions, ſave onely thoſe that are firm and conſtant, ſuch as are the three kinds of Periods of the ebbings and flowings; for that they depend on cauſes that are invariable, ſimple, and eternal. But becauſe that ſecondary and particular cauſes, able to make many alterations, intermix with theſe that are the primary and univerſal; and theſe ſecondary cauſes being part of them inconſtant, and not to be obſerved; as for example, The alteration of Winds, and part (though terminate and fixed) unobſerved for their multiplicity, as are the lengths of the Straights, their various inclinations towards this or that part, the ſo many and ſo different depths of the Waters, who ſhall be able, unleſs after very long obſervations, and very certain relations, to frame ſo expeditious Hiſtories thereof, as that they may ſerve for Hypotheſes, and certain ſuppoſitions to ſuch as will by their combinations give adequate reaſons of all the appearances, and as I may ſay, Anomalie, and particular irregularities that may be diſcovered in the motions of the Waters? I will content my ſelf with advertiſing you, that the accidental cauſes are in nature, and are able to produce many alterations; for the more minute obſervations, I remit them to be made by thoſe that frequent ſeveral Seas: and onely by way of a concluſion to this our conference, I will propoſe to be conſidered, how that the preciſe times of the fluxes and refluxes do not onely happen to be altered by the length of Straights, and by the difference of depths; but I believe that a notable alteration may alſo proceed from the comparing together of ſundry tarcts of Sea, different in greatneſs; and in poſition, or, if you will, inclination; which difference happeneth exactly here in the *Adriatick* Gulph,

Gulph, leſſe by far than the reſt of the Mediterrane, and placed in ſo different an inclination, that whereas that hath its bounds that incloſeth it on the Eaſtern part, as are the Coaſts of *Syria*, this is ſhut up in its more Weſterly part: and becauſe the ebbings and flowings are much greater towards the extremities, yea, becauſe the Seas riſings and fallings are there onely greateſt, it may probably happen that the times of Flood at *Venice* may be the time of low Water in the other Sea, which, as being much greater, and diſtended more directly from Weſt to Eaſt, cometh in a certain ſort to have dominion over the *Adriatick*: and therefore it would be no wonder, in caſe the effects depending on the primary cauſes, ſhould not hold true in the times that they ought, and that correſpond to the periods in the *Adriatick*, as it doth in the reſt of the Mediterrane. But theſe Particularities require long Obſervations, which I neither have made as yet, nor ſhall I ever be able to make the ſame for the future.

SAGR. You have, in my opinion, done enough in opening us the way to ſo lofty a ſpeculation, of which, if you had given us no more than that firſt general Propoſition that ſeemeth to me to admit of no reply, where you declare very rationally, that the Veſſels containing the Sea-waters continuing ſtedfaſt, it would be impoſſible, according to the common courſe of Nature, that thoſe motions ſhould follow in them which we ſee do follow; and that, on the other ſide, granting the motions aſcribed, for other reſpects, by *Copernicus* to the Terreſtrial Globe, theſe ſame alterations ought to enſue in the Seas, if I ſay you had told us no more, this alone in my judgment, ſo far exceeds the vanities introduced by ſo many others, that my meer looking on them makes me nauſeate them, and I very much admire, that among men of ſublime wit, of which nevertheleſs there are not a few, not one hath ever conſidered the incompatibility that is between the reciprocal motion of the Water contained, and the immobility of the Veſſel containing, which contradiction ſeemeth to me now ſo manifeſt.

One ſingle motion of the terreſtrial Globe ſufficeth not to produce the Ebbing & Flowing

SALV. It is more to be admired, that it having come into the thoughts of ſome to refer the cauſe of the Tide to the motion of the Earth, therein ſhewing a more than common apprehenſion, they ſhould, in afterwards driving home the motion cloſe with no ſide; and all, becauſe they did not ſee that one ſimple and uniform motion, as *v.gr.* the ſole diurnal motion of the Terreſtrial Globe, doth not ſuffice, but that there is required an uneven motion, one while accelerated, and another while retarded: for when the motion of the Veſſels are uniforme, the waters contained will habituate themſelves thereto, without ever making any alteration. To ſay alſo (as it is related of an ancient Mathe-

The opinion of Seleucus *the Mathematician cenſured.*

Mathematician) that the motion of the Earth meeting with the motion of the Lunar Orb, the concurrence of them occaſioneth the Ebbing and Flowing, is an abſolute vanity, not onely becauſe it is not expreſt, nor ſeen how it ſhould ſo happen, but the falſity is obvious, for that the Revolution of the Earth is not contrary to the motion of the Moon, but is towards the ſame way. So that all that hath been hitherto ſaid, and imagined by others, is, in my judgment, altogether invalid. But amongſt all the famous men that have philoſophated upon this admirable effect of Nature, I more wonder at *Kepler* than any of the reſt, who being of a free and piercing wit, and having the motion aſcribed to the Earth, before him, hath for all that given his ear and aſſent to the Moons predominancy over the Water, and to occult properties, and ſuch like trifles.

Kepler *is with reſpect blamed.*

SAGR. I am of opinion, that to theſe more ſpaculative perſons the ſame happened, that at preſent befalls me, namely, the not underſtanding the intricate commixtion of the three Periods Annual, Monethly, and Diurnal; And how their cauſes ſhould ſeem to depend on the Sun, and on the Moon, without the Suns or Moons having any thing to do with the Water; a buſineſſe, for the full underſtanding of which I ſtand in need of a little longer time to conſider thereof, which the novelty and difficulty of it hath hitherto hindred me from doing: but I deſpair not, but that when I return in my ſolitude and ſilence to ruminate that which remaineth in my fancy, not very well digeſted, I ſhall make it my own. We have now, from theſe four dayes Diſcourſe, great atteſtations, in favour of the *Copernican* Syſteme, amongſt which theſe three taken: the firſt, from the Stations and Retrogradations of the Planets, and from their approaches, and receſſions from the Earth; the ſecond, from the Suns revolving in it ſelf, and from what is obſerved in its ſpots; the third, from the Ebbing and Flowing of the Sea do ſhew very rational and concluding.

SALV. To which alſo haply, in ſhort, one might adde a fourth, and peradventure a fifth; a fourth, I ſay, taken from the fixed ſtars, ſeeing that in them, upon exact obſervations, thoſe minute mutations appear, that *Copernicus* thought to have been inſenſible. There ſtarts up, at this inſtant, a fifth novelty, from which one may argue mobility in the Terreſtrial Globe, by means of that which the moſt Illuſtrious *Signore Cæſare*, of the noble Family of the *Marſilii* of *Bologna*, and a *Lyncean* Academick, diſcovereth with much ingenuity, who in a very learned Tract of his, ſheweth very particularly how that he had obſerved a continual mutation, though very ſlow in the Meridian line, of which Treatiſe, at length, with amazement, peruſed by me,

Sig. Cæſare Marſilius *obſerveth the Meridian, to be moveable.*

I hope he will communicate Copies to all thoſe that are Students of Natures Wonders.

SAGR. This is not the firſt time that I have heard ſpeak of the exquiſite Learning of this Gentleman, and of his ſhewing himſelf a zealous Patron of all the Learned, and if this, or any other of his Works ſhall come to appear in publique, we may be aforehand aſſured, that they will be received, as things of great value.

SALV. Now becauſe it is time to put an end to our Diſcourſes, it remaineth, that I intreat you, that if, at more leaſure going over the things again that have been alledged you meet with any doubts, or ſcruples not well reſolved, you will excuſe my overſight, as well for the novelty of the Notion, as for the weakneſſe of my wit, as alſo for the grandure of the Subject, as alſo finally, becauſe I do not, nor have pretended to that aſſent from others, which I my ſelf do not give to this conceit, which I could very eaſily grant to be a *Chymæra*, and a meer paradox; and you *Sagredus*, although in the Diſcourſes paſt you have many times, with great applauſe, declared, that you were pleaſed with ſome of my conjectures, yet do I believe, that that was in part more occaſioned by the novelty than by the certainty of them, but much more by your courteſie, which did think and deſire, by its aſſent, to procure me that content which we naturally uſe to take in the approbation and applauſe of our own matters: and as your civility hath obliged me to you; ſo am I alſo pleaſed with the ingenuity of *Simplicius*. Nay, his conſtancy in maintaining the Doctrine of his Maſter, with ſo much ſtrength & undauntedneſs, hath made me much to love him. And as I am to give you thanks, *Sagredus*, for your courteous affection; ſo of *Simplicius*, I ask pardon, if I have ſometimes moved him with my too bold and reſolute ſpeaking: and let him be aſſured that I have not done the ſame out of any inducement of ſiniſter affection, but onely to give him occaſion to ſet before us more lofty fancies that might make me the more knowing.

SIMP. There is no reaſon why you ſhould make all theſe excuſes, that are needleſſe, and eſpecially to me, that being accuſtomed to be at Conferences and publique Diſputes, have an hundred times ſeen the Diſputants not onely to grow hot and angry at one another, but likewiſe to break forth into injurious words, and ſometimes to come very neer to blows. As for the paſt Diſcourſes, and particulatly in this laſt, of the reaſon of the Ebbing and Flowing of the Sea, I do not, to ſpeak the truth, very well apprehend the ſame, but by that ſlight *Idea*, what ever it be, that I have formed thereof to my ſelf, I confeſſe that your conceit ſeemeth to me far more ingenuous than any of all thoſe

thoſe that I ever heard beſides, but yet nevertheleſſe I eſteem it not true and concluding: but keeping alwayes before the eyes of my mind a ſolid Doctrine that I have learn't from a moſt learned and ingenuous perſon, and with which it is neceſſary to ſit down; I know that both you being asked, Whether God, by his infinite Power and Wiſdome might confer upon the Element of Water the reciprocal motion which we obſerve in the ſame in any other way, than by making the containing Veſſel to move; I know, I ſay, that you will anſwer, that he might, and knew how to have done the ſame many wayes, and thoſe unimaginable to our ſhallow underſtanding: upon which I forthwith conclude, that this being granted, it would be an extravagant boldneſſe for any one to goe about to limit and confine the Divine Power and Wiſdome to ſome one particular conjecture of his own.

SALV. This of yours is admirable, and truly Angelical Doctrine, to which very exactly that other accords, in like manner divine, which whilſt it giveth us leave to diſpute, touching the conſtitution of the World, addeth withall (perhaps to the end, that the exerciſe of the minds of men might neither be diſcouraged, nor made bold) that we cannot find out the works made by his hands. Let therefore the Diſquiſition permitted and ordain'd us by God, aſſiſt us in the knowing, and ſo much more admiring his greatneſſe, by how much leſſe we finde our ſelves too dull to penetrate the profound Abyſſes of his infinite Wiſdome.

SAGR. And this may ſerve for a final cloſe of our four dayes Diſputations, after which, if it ſeem good to *Salviatus*, to take ſome time to reſt himſelf, our curioſity muſt, of neceſſity, grant him the ſame, yet upon condition, that when it is leſſe incommodious for him, he will return and ſatisfie my deſire in particular concerning the Problemes that remain to be diſcuſt, and that I have ſet down to be propounded at one or two other Conferences, according to our agreement: and above all, I ſhall very impatiently wait to hear the Elements of the new Science of our *Academick* about the natural and violent local Motions. And in the mean time, we may, according to our cuſtome, ſpend an hour in taking the Air in the *Gondola* that waiteth for us.

FINIS.

Fig: 1.

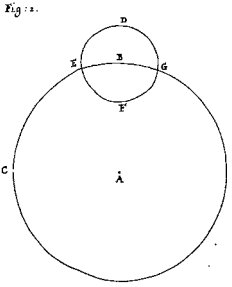


Fig: 2.

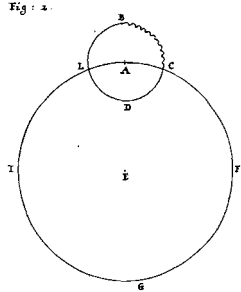


Fig: 4.

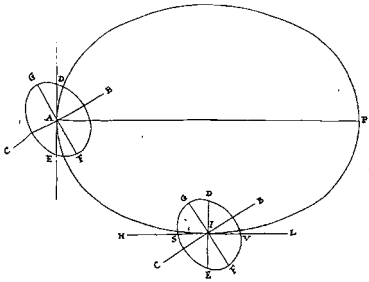
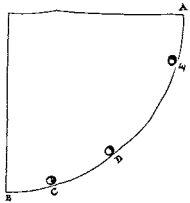


Fig: 3.



Place this Place
at the end of
the fourth

Dialogue.

THE
Ancient and Modern
DOCTRINE
OF
Holy Fathers,
AND
Iudicious Divines,

CONCERNING

The rash citation of the Testimony of SACRED SCRIPTURE, in Conclusions meerly Natural, and that may be proved by Sensible Experiments, and Necessary Demonstrations.

Written, some years since, to Gratifie The most SERENE CHRISTINA LOTHARINGA, *Arch-Dutchess* of *TUSCANY*;

By GALILÆO GALILÆI, A Gentleman of *Florence*, and Chief Philosopher and Mathematician to His most Serene Highness the Grand *DUKE*.

And now rendred into English from the Italian,
BY
THOMAS SALUSBURY.

Naturam Rerum invenire, difficile; & ubi inveneris, indicare in vulgus, nefas. Plato.

LONDON,
Printed by WILLIAM LEYBOURN, 1661.

are obſcure and hard to be underſtood by the meer help of ratiocination; where treating (as we) of a certain natural concluſion concerning Celeſtial Bodies, he thus writes: (a) *But now having evermore a reſpect to the moderation of pious Gravity, we ought to believe nothing unadviſedly in a doubtful point; leſt we conceive a prejudice againſt that, in favour to our Errour, which Truth hereafter may diſcover to be no wiſe contrary to the Sacred Books either of the Old, or New Teſtament.*

(a) *Nunc autem, ſervatâ ſemper moderatione piæ gravitatis, nihil credere de re obſcurâ temerè debemus, ne fortè, quod poſtea veritas patefecerit, quamvis Libris Sanctis, ſive Teſtamenti Veteris, ſive Novi, nullo modo eſſe poſſit adverſum, tamen propter amorem noſtri erroris, oderimus.* Lib. 2. Geneſi ad Literam in fine.

It hath ſince come to paſs, that Time hath by degrees diſcovered to every one the truths before by me indicated: and together with the truth of the fact, a diſcovery hath been made of the difference of humours between thoſe who ſimply and without paſſion did refuſe to admit ſuch like *Phænomena* for true, and thoſe who to their incredulity had added ſome diſcompoſed affection: For as thoſe who were better grounded in the Science of Aſtronomy, and Natural Philoſophy, became ſatisfied upon my firſt intimation of the news; ſo all thoſe who ſtood not in the Negative, or in doubt for any other reaſon, but becauſe it was an unlookt-for-Novelty, and becauſe they had not an occaſion of ſeeing a ſenſible experiment thereof, did by degrees come to ſatisfie themſelves: But thoſe, who beſides the love they bore to their firſt Errour, have I know not what imaginary intereſs to render them diſaffected; not ſo much towards the things, as towards the Author of them, not being able any longer to deny them, conceal themſelves under an obſtinate ſilence; and being exaſperated more than ever by that whereby thoſe others were ſatisfied and convinced, they divert their thoughts to other projects, and ſeek to prejudice me ſome other wayes: of whom I profeſs that I would make no more account than I have done of thoſe who heretofore have contradicted me (at whom I alwaies laugh, as being aſſured of the iſſue that the buſineſs is to have) but that I ſee that thoſe new Calumnies and Perſecutions do not determine in our greater or leſſer Learning (in which I will ſcarce pretend to any thing) but extend ſo far as to attempt to aſperſe me with Crimes which ought to be, and are more abhorred by me than Death it ſelf: Nor ought I to content my ſelf that they are known to be unjuſt by thoſe onely who know me and them, but by all men whatſoever. They perſiſting therefore in their firſt Reſolution, Of ruining me and whatſoever is mine, by all imaginable waies; and knowing how that I in my Studies of Aſtronomy and Philoſophy hold, as to the Worlds Syſteme, That the Sun, without changing place, is ſituate in the Centre of the Converſion of the Celeſtial Orbes; and that the Earth, convertible about its own Axis, moveth it ſelf about the Sun: And moreover underſtanding, that I proceed to maintain this Poſition

ſition, not onely by refuting the Reaſons of *Ptolomy* and *Ariſtotle*, but by producing many on the contrary; and in particular, ſome Phyſical pertaining to Natural Effects, the cauſes of which perhaps can be by no other way aſſigned; and others Aſtronomical depending upon many circumſtances and encounters of new Diſcoveries in Heaven, which manifeſtly confute the Ptolomaick Syſteme, and admirably agree with and confirm this other Hypotheſis: and poſſibly being aſhamed to ſee the known truth of other Poſitions by me aſſerted, different from thoſe that have been commonly received; and therefore diſtruſting their defence ſo long as they ſhould continue in the Field of Philoſophy: for theſe reſpects, I ſay, they have reſolved to try whether they could make a Shield for the fallacies of their Arguments of the Mantle of a feigned Religion, and of the Authority of the Sacred Scriptures, applyed by them with little judgment to the confutation of ſuch Reaſons of mine as they had neither underſtood, nor ſo much as heard.

And firſt, they have indeavoured, as much as in them lay, to divulge an opinion thorow the Univerſe, that thoſe Propoſitions are contrary to the Holy Letters, and conſequently Damnable and Heretical: And thereupon perceiving, that for the moſt part, the inclination of Mans Nature is more prone to imbrace thoſe enterprizes, whereby his Neighbour may, although unjuſtly, be oppreſſed, than thoſe from whence he may receive juſt incouragement; it was no hard matter to find thoſe Complices, who for ſuch (that is, for Damnable and Heretical) did from their Pulpits with unwonted confidence preach it, with but an unmerciful and leſs conſiderate injury, not only to this Doctrine, and to its followers, but to all Mathematicks and Mathematicians together. Hereupon aſſuming greater confidence, and vainly hoping that that Seed which firſt took root in their unſound mindes, might ſpread its branches, and aſcend towards Heaven, they went ſcattering rumours up and down among the People, That it would, ere long be condemned by Supreme Authority: and knowing that ſuch a *Cenſure* would ſupplant not onely theſe two Concluſions of the VVorlds Syſteme, but would make all other Aſtronomical and Phyſical Obſervations that have correſpondence and neceſſary connection therewith to become damnable, to facilitate the buſineſs they ſeek all they can to make this opinion (at leaſt among the vulgar) to ſeem new, and peculiar to my ſelf, not owning to know that *Nicholas Copervicus* was its Authour, or rather Reſtorer and Confirmer: a perſon who was not only a Catholick, but a Prieſt, Canonick, and ſo eſteemed, that there being a Diſpute in the *Lateran Council*, under *Leo X.* touching the correction of the Eccleſiaſtick Calender

lendar, he was ſent for to *Rome* from the remoteſt parts of *Germany*, for to aſſiſt in this Reformation, which for that time was left imperfect, onely becauſe as then the true meaſure of the Year and Lunar Moneth was not exactly known: whereupon it was given him in charge by the Biſhop of *Sempronia*, at that time Super-intendent in that Affair, to ſearch with reiterated ſtudies and pains for greater light and certainty, touching thoſe Cœleſtial Motions. Upon which, with a Labour truly *Atlantick*, and with his admirable Wit, ſetting himſelf again to that Study, he made ſuch a progreſs in theſe Sciences, and reduced the knowledge of the Cœleſtial Motions to ſuch exactneſſe, that he gained the title of an Excellent *Aſtronomer*. And, according unto his Doctrine, not only the Calendar hath been ſince regulated, but the Tables of all the Motions of the Planets have alſo been calculated: and having reduced the ſaid Doctrine into ſix Books, he publiſhed them to the World at the inſtance of the Cardinal of *Capua*, and of the Biſhop of *Culma*. And in regard that he had re-aſſumed this ſo laborious an enterprize by the order of The Pope; he dedicated his Book *De Revolutionibus Cœleſtibus* to His Succeſſour, namely *Paul* III. which, being then alſo Printed, hath been received by The Holy Church, and read and ſtudied by all the World, without any the leaſt umbrage of ſcruple that hath ever been conceived at his Doctrine; The which, whilſt it is now proved by manifeſt Experiments and neceſſary Demonſtrations to have been well grounded, there want not perſons that, though they never ſaw that ſame Book intercept the reward of thoſe many Labours to its Authour, by cauſing him to be cenſured and pronounced an Heretick; and this, only to ſatisfie a particular diſpleaſure conceived, without any cauſe, againſt another man, that hath no other intereſt in *Copernicus*, but only as he is an approver of his Doctrine.

Now in regard of theſe falſe aſperſions, which they ſo unjuſtly ſeek to throw upon me, I have thought it neceſſary for my juſtification before the World (of whoſe judgment in matters of Religion and Reputation I ought to make great eſteem) to diſcourſe concerning thoſe Particulars, which theſe men produce to ſcandalize and ſubvert this Opinion, and in a word, to condemn it, not only as falſe, but alſo as Heretical; continually making an Hipocritical Zeal for Religion their Shield; going about moreover to intereſt the Sacred Scriptures in the Diſpute, and to make them in a certain ſenſe Miniſters of their deceiptful purpoſes: and farthermore deſiring, if I miſtake not, contrary to the intention of them, and of the Holy Fathers to extend (that I may not ſay abuſe) their Authority, ſo as that even in Concluſions meerly Natural, and not *de Fide*, they would have us altogether

leave

leave Senſe and Demonſtrative Reaſons, for ſome place of Scripture which ſometimes under the apparent words may contain a different ſenſe. Now I hope to ſhew with how much greater Piety and Religious Zeal I proceed, than they do, in that I propoſe not, that the Book of *Copernicus* is not to be condemned, but that it is not to be condemned, as they would have it; without underſtanding it, hearing it, or ſo much as ſeeing it; and eſpecially he being an Author that never treateth of matters of Religion or Faith; nor by Reaſons any way depending on the Authority of Sacred Scriptures whereupon he may have erroniouſly interpreted them; but alwaies inſiſts upon Natural Concluſions belonging to the Celeſtial Motions, handled with Aſtronomical and Geometrical Demonſtrations. Not that he had not a reſpect to the places of the Sacred Leaves, but becauſe he knew very well that his ſaid Doctrine being demonſtrated, it could not contradict the Scriptures, rightly, and according to their true meaning underſtood. And therefore in the end of his Epiſtle Dedicatory, ſpeaking to The Pope, he ſaith thus: (*b*) *If there ſhould chance to be any Mataeologiſts, who though ignorant in all the Mathematicks, yet pretending a skill in thoſe Learnings, ſhould dare, upon the authority of ſome place of Scripture wreſted to their purpoſe, to condemn and cenſure this my Hypotheſis, I value them not, but ſhall ſlight their inconſiderate Judgement. For it is not unknown, that* Lactantius (*otherwiſe a Famous Author, though mean Mathematician*) *writeth very childiſhly touching the Form of the Earth, when he ſcoffs at thoſe who affirm the Earth to be in Form of a Globe. So that it ought not to ſeem ſtrange to the Ingenious, if any ſuch ſhould likewiſe now deride us. The Mathematicks are written for Mathematitians, to whom (if I deceive not my ſelf) theſe Labours of mine ſhall ſeem to add ſomething, as alſo to the Common-weale of the Church, whoſe Government is now in the hands of Your Holineſs.*

And of this kinde do theſe appear to be who indeavour to perſwade that *Copernicus* may be condemned before his Book is read; and to make the World believe that it is not onely lawfull but commendable ſo to do, produce certain Authorities of the Scripture, of Divines, and of Councils; which as they are by me had in reverence, and held of Supream Authority, inſomuch that I ſhould eſteem it high temerity for any one to contradict them whilſt they are uſed according to the Inſtitutes of Holy Church, ſo I believe that it is no errour to ſpeak, ſo long as one hath reaſon to ſuſpect that a perſon hath a deſire, for ſome concern of his own, to produce and alledge them, to purpoſes different from thoſe that are in the moſt Sacred intention of The Holy Church. Therefore I not onely proteſt (and my ſincerity ſhall manifeſt it ſelf)

(*c*) *Si fortaſſe erunt Mataeologi, qui cum omnium Mathematicum ignari ſint, tamen de iis judicium aſſumunt, propter aliquem locum Scripturæ, malè ad ſuum propoſitum, detortum, auſi fuerint hoc meum inſtitutum reprehendere ac inſectari, illos nihil moror, adeò ut etiam illorum judicium, tanquam temerarium contemnam. Non enim obſcurum eſt, Lactantium, celebrem alioqui Scriptorem, ſed Mathematicum parvum, admodum pueriliter de forma Terræ loqui, cùm deridet eos, qui Terram, Globi formam habere prodiderunt. Itaque non debet mirum videri ſtudioſis, ſi qui tales, nos etiam videbunt. Mathemata Mathematicis ſcribuntur; quibus & hi noſtri labores, (ſi me non fallit opinio) videbuntur etiam Reipublicæ Eccleſiaſtica conducere aliquid, cujus Principatum Tua Sanctitas nunc tenet.*

ſelf) that I intend to ſubmit my ſelf freely to renounce thoſe errors, into which, through ignorance, I may run in this Diſcourſe of matters pertaining to Religion; but I farther declare, that I deſire not in theſe matters to engage diſpute with any one, although it ſhould be in points that are diſputable: for my end endeth onely to this, That if in theſe conſiderations, beſides my own profeſſion, amongſt the errours that may be in them, there be any thing apt to give others an hint of ſome Notion beneficial to the Holy Church, touching the determining about the *Copernican* Syſteme, it may be taken and improved as ſhall ſeem beſt to my Superiours: If not, let my Book be torn and burnt; for that I do neither intend, nor pretend to gain to my ſelf any fruit from my writings, that is not Pious and Catholick. And moreover although that many of the things that I obſerve have been ſpoken in my own hearing, yet I ſhall freely admit and grant to thoſe that ſpake them, that they never ſaid them, if ſo they pleaſe, but confeſs that I might have been miſtaken: And therefore what I ſay, let it be ſuppoſed to be ſpoken not by them, but by thoſe which were of this opinion.

The motive therefore that they produce to condemn the Opinion of the Mobility of the Earth, and Stability of the Sun, is, that reading in the Sacred Leaves, in many places, that the Sun moveth, that the Earth ſtandeth ſtill; and the Scripture not being capable of lying, or erring, it followeth upon neceſſary conſequence, that the Poſition of thoſe is Erronious and Heretical, who maintain that the Sun of it ſelf is immoveable, and the Earth moveable.

Touching this Reaſon I think it fit in the firſt place, to conſider, That it is both piouſly ſpoken, and prudently affirmed, That the Sacred Scripture can never lye, when ever its true meaning is underſtood: Which I believe none will deny to be many times very abſtruce, and very different from that which the bare ſound of the words ſignifieth. Whence it cometh to paſs, that if ever any one ſhould conſtantly confine himſelf to the naked Grammatical Sence, he might, erring himſelf, make not only Contradictions and Propoſitions remote from Truth to appear in the Scriptures, but alſo groſs Hereſies and Blaſphemies: For that we ſhould be forced to aſſign to God feet, and hands, and eyes, yea more corporal and humane affections, as of Anger, of Repentance, of Hatred, nay, and ſometimes the Forgetting of things paſt, and Ignorance of thoſe to come: Which Propoſitions, like as (ſo the Holy Ghoſt affirmeth) they were in that manner pronounced by the Sacred Scriptures, that they might be accommodated to the Capacity of the Vulgar, who are very rude and unlearned; ſo likewiſe, for the ſakes of thoſe that deſerve to be diſtinguiſhed

ſtinguiſhed from the Vulgar, it is neceſſary that grave and skilful Expoſitors produce the true ſenſes of them, and ſhew the particular Reaſons why they are dictated under ſuch and ſuch words. And this is a Doctrine ſo true and common amongſt Divines, that it would be ſuperfluous to produce any atteſtation thereof.

Hence methinks I may with much more reaſon conclude, that the ſame holy Writ, when ever it hath had occaſion to pronounce any natural Concluſion, and eſpecially, any of thoſe which are more abſtruce, and difficult to be underſtood, hath not failed to obſerve this Rule, that ſo it might not cauſe confuſion in the minds of thoſe very people, and render them the more contumacious againſt the Doctrines that were more ſublimely myſterious: For (like as we have ſaid, and as it plainly appeareth) out of the ſole reſpect of condeſcending to Popular Capacity, the Scripture hath not ſcrupled to ſhadow over moſt principal and fundamental Truths, attributing, even to God himſelf, qualities extreamly remote from, and contrary unto his Eſſence. Who would poſitively affirm that the Scripture, laying aſide that reſpect, in ſpeaking but occaſionally of the Earth, of the Water, of the Sun, or of any other Creature, hath choſen to confine it ſelf, with all rigour, within the bare and narrow literal ſenſe of the words? And eſpecially, in mentioning of thoſe Creatures, things not at all concerning the primary Inſtitution of the ſame Sacred Volume, to wit, the Service of God, and the ſalvation of Souls, and in things infinitely beyond the apprehenſion of the Vulgar?

This therefore being granted, methinks that in the Diſcuſſion of Natural Problemes, we ought not to begin at the authority of places of Scripture; but at Senſible Experiments and Neceſſary Demonſtrations: For, from the Divine Word, the Sacred Scripture and Nature did both alike proceed; the firſt, as the Holy Ghoſts Inſpiration; the ſecond, as the moſt obſervant Executrix of Gods Commands: And moreover it being convenient in the Scriptures (by way of condeſcenſion to the underſtanding of all men) to ſpeak many things different, in appearance, and ſo far as concernes the naked ſignification of the words, from abſolute truth: But on the contrary, Nature being inexorable and immutable, and never paſſing the bounds of the Laws aſſigned her, as one that nothing careth whether her abſtruſe reaſons and methods of operating be, or be not expoſed to the Capacity of Men; I conceive that that, concerning Natural Effects, which either Senſible Experience ſets before our eyes, or Neceſſary Demonſtrations do prove unto us, ought not, upon any account, to be called into queſtion, much

leſs condemned upon the teſtimony of Texts of Scripture, which may, under their words, couch Senſes ſeemingly contrary thereto; In regard that every Expreſſion of Scripture is not tied to ſo ſtrict conditions, as every Effect of Nature: Nor doth God leſs admirably diſcover himſelf unto us in Nature's Actions, than in the Scriptures Sacred Dictions. Which peradventure *Tertullian* intended to expreſs in thoſe words: (c) *We conclude, God is known; firſt, by Nature, and then again more particularly known by Doctrine: by Nature, in his Works; by Doctrine, in his Word preached.*

Nos definimus, Deum, primò Naturâ cognoſcendum; Deinde, Doctrinâ recognoſcendum: Naturâ ex operibus; Doctrinâ ex prædicationibus. Tertul. adver. Marcion. lib. 1. cap. 18.

But I will not hence affirm, but that we ought to have an extraordinary eſteem for the Places of Sacred Scripture, nay, being come to a certainty in any Natural Concluſions, we ought to make uſe of them, as moſt appoſite helps to the true Expoſition of the ſame Scriptures, and to the inveſtigation of thoſe Senſes which are neceſſarily conteined in them, as moſt true, and concordant with the Truths demonſtrated.

This maketh me to ſuppoſe, that the Authority of the Sacred Volumes was intended principally to perſwade men to the belief of thoſe Articles and Propoſitions, which, by reaſon they ſurpaſs all humane diſcourſe, could not by any other Science, or by any other means be made credible, than by the Mouth of the Holy Spirit it ſelf. Beſides that, even in thoſe Propoſitions, which are not *de Fide*, the Authority of the ſame Sacred Leaves ought to be preferred to the Authority of all Humane Sciences that are not written in a Demonſtrative Method, but either with bare Narrations, or elſe with probable Reaſons; and this I hold to be ſo far convenient and neceſſary, by how far the ſaid Divine Wiſdome ſurpaſſeth all humane Judgment and Conjecture. But that that ſelf ſame God who hath indued us with Senſes, Diſcourſe, and Underſtanding hath intended, laying aſide the uſe of theſe, to give the knowledg of thoſe things by other means, which we may attain by theſe, ſo as that even in thoſe Natural Concluſions, which either by Senſible Experiments or Neceſſary Demonſtrations are ſet before our eyes, or our Underſtanding, we ought to deny Senſe and Reaſon, I do not conceive that I am bound to believe it; and eſpecially in thoſe Sciences, of which but a ſmall part, and that divided into Concluſions is to be found in the Scripture: Such as, for inſtance, is that of *Aſtronomy*, of which there is ſo ſmall a part in Holy Writ, that it doth not ſo much as name any of the Planets, except the Sun and the Moon, and once or twice onely *Venus* under the name of *Lucifer*. For if the Holy Writers had had any intention to perſwade People to believe the Diſpoſitions and Motions of the Cœleſtial Bodies; and that conſequently we are ſtill to derive that know-

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ledge from the Sacred Books they would not, in my opinion, have ſpoken ſo little thereof, that it is as much as nothing, in compariſon of the infinite admirable Concluſions, which in that Science are comprized and demonſtrated Nay, that the Authours of the Holy Volumes did not only not pretend to teach us the Conſtitutions and Motions of the Heavens and Stars, their Figures, Magnitudes, and Diſtances, but that intentionally (albeit that all theſe things were very well known unto them) they forbore to ſpeak of them, is the opinion of the Moſt Holy & Moſt Learned Fathers: and in S. *Auguſtine* we read the following words. (c) *It is likewiſe commonly asked, of what Form and Figure we may believe Heaven to be, according to the Scriptures: For many contend much about thoſe matters, which the greater prudence of our Authors hath forborn to ſpeak of, as nothing furthering their Learners in relation to a bleſſed life; and, (which is the chiefeſt thing) taking up much of that time which ſhould be ſpent in holy exerciſes. For what is it to me whether Heaven, as a Sphere, doth on all ſides environ the Earth, a Maſs ballanced in the middle of the World; or whether like a Diſh it doth onely cover or overcaſt the ſame? But becauſe belief of Scripture is urged for that cauſe, which we have oft mentioned, that is, That none through ignorance of Divine Phraſes; when they ſhall find any thing of this nature in, or hear any thing cited out of our Bibles which may ſeem to oppoſe manifeſt Concluſions, ſhould be induced to ſuſpect their truth, when they admoniſh, relate, & deliver more profitable matters Briefly be it ſpoken, touching the Figure of Heaven, that our Authors knew the truth: But the H. Spirit would not, that men ſhould learn what is profitable to none for ſalvation.*

(c) *Quæri etiam ſolet, quæ forma & figura Cæli credenda ſit ſecundum Scripturas noſtras: Multi enim multum diſputant de iis rebus, quas majori prudentia noſtri Autores omiſerunt, ad beatam vitam non profuturas diſcentibus, & occupantes (quod primum eſt) multum prolixa, & rebus ſalubribus impendenda temporum ſpatia. Quid enim ad me pertinet, utrum Cælum, ſicut Sphæra, undique concludat Terram, in media Mundi mole libratam; an eam ex una parte deſuper, velut diſcus, operiat? Sed quia de Fide agitur Scripturarum, propter illam cauſam, quam non ſemel commemoravimus, Ne ſciliæt quiſquam eloquia divina non intelligens, cum de his rebus tale aliquid vel invenerit in Libris Noſtris, vel ex illis audiverit, quod perceptis aſſertionibus adverſari videatur, nullo modo eis, cetera utilia monentibus, vel narrantibus, vel prænuntiantibus, credat: Breviter diſcendum eſt, de figura Cæli, hoc ſciſſe Autores noſtros, quod veritas habet: Sed Spiritum Dei, qui per ipſos loquebatur, noluiſſe iſta docere homines, nulli ad ſalutem profutura.* D. Auguſt. Lib. 2. De Gen. ad literam, Cap. 9. Idem etiam legitur apud *Petrum Lombardum* Magiſtrum Sententiarum.

And the ſame intentional ſilence of theſe ſacred Penmen in determining what is to be believed of theſe accidents of the Celeſtial Bodies, is again hinted to us by the ſame Father in the enſuing 10. Chapter upon the Queſtion, Whether we are to believe that Heaven moveth, or ſtandeth ſtill, in theſe words: (d) *There are ſome of the Brethren that ſtart a queſtion concerning the motion of Heaven, Whether it be fixed, or moved: For if it be moved (ſay they) how is it a Firmament? If it ſtand ſtill, how do theſe Stars which are held to be fixed go round from Eaſt to Weſt, the more Northern performing ſhorter Circuits near the Pole; ſo that Heaven, if there be another Pole, to us unknown, may ſeem to revolve upon ſome other Axis; but if there be not another Pole, it may be thought to move as a Diſcus? To whom I reply, That*

(d) *De Motu etiam Cæli, nonnulli fratres quæſtionem movent, utrum ſtet, an moveatur; quia ſi movetur, inquiunt, quomodo Firmamentum eſt? Si autem ſtat, quomodo Sydera quæ in ipſo fixa creduntur, ab Oriente in Occidentem circui-*

these points require many ſubtil and profound Reaſons, for the making out whether they be really ſo, or no; the undertakeing and diſcuſſing of which is neither conſiſtent with my leaſure, nor their duty, whom I deſire to inſtruct in the neceſſary matiers more directly conducing to their ſalvation, and to the benefit of The Holy Church.

From which (that we may come nearer to our particular caſe) it neceſſarily followeth, that the Holy Ghoſt not having intended to teach us, whether Heaven moveth or ſtandeth ſtill; nor whether its Figure be in Form of a Sphere, or of a Diſcus, or diſtended *in Planum*: Nor whether the Earth be contained in the Centre of it, or on one ſide; he hath much leſs had an intention to aſſure us of other Concluſions of the ſame kinde, and in ſuch a manner, connected to theſe already named, that without the dedermination of them, one can neither affirm one or the other part; which are, The determining of the Motion and Reſt of the ſaid Earth, and of the Sun. And if the ſame Holy Spirit hath purpoſely pretermitted to teach us thoſe Propoſitions, as nothing concerning his intention, that is, our ſalvation; how can it be affirmed, that the holding of one part rather than the other, ſhould be ſo neceſſary, as that it is *de Fide*, and the other erronious? Can an Opinion be Heretical, and yet nothing concerning the ſalvation of ſouls? Or can it be ſaid that the Holy Ghoſt purpoſed not to teach us a thing that concerned our ſalvation? I might here inſert the Opinion of an Eccleſiaſtical * Perſon, raiſed to the degree of *Eminentiſſimo*, to wit, *That the intention of the Holy Ghoſt, is to teach us how we ſhall go to Heaven, and not how Heaven goeth.*

But let us return to conſider how much neceſſary Demonſtrations, and ſenſible Experiments ought to be eſteemed in Natural Concluſions; and of what Authority Holy and Learned Divines have accounted them, from whom amongſt an hundred other atteſtations, we have theſe that follow: (e) *We muſt alſo carefully heed and altogether avoid in handling the Doctrine of* Moſes, *to avouch or ſpeak any thing affirmatively and confidently which contradicteth the manifeſt Experiments and Reaſons of Philoſophy, or other Sciences. For ſince all Truth is agreeable to Truth, the Truth of Holy Writ cannot be contrary to the ſolid Reaſons and Experiments of Humane Learning.*

And in St. *Auguſtine* we read: (f) *If any one ſhall object the Authority of Sacred Writ, againſt clear and manifeſt Reaſon, he that doth ſo, knows not what he undertakes: For he objects againſt*

cunt, Septentrionalibus breviores gyros juxta cardinem peragentibus; ut Cælum, ſi eſt alius nobis occultus cardo, ex alio vertice, ſicut Sphæra; ſi autem nullus alius cardo eſt, vel uti diſcus rotari videatur? Quibus reſpondeo, Multum ſubtilibus & laborioſis rationibus iſta perquiri, ut vere percipiatur, utrum ita, an non ita ſit, quibus inundis atque tractandis, nec mihi jam tempus eſt, nec illis eſſe debet, quos ad ſalutem ſuam, è Sanctæ Eccleſiæ neceſſaria utilitate cupimus informari:

* Card. Baronius.

Spiritui ſancto mentem fuiſſe, nos docere, quomodo ad Cælum eatur: non autem, quomodo Cælum gradiatur. Cardinal. Bar.

(e) *Illud etiam diligenter cavendum, & omnino fugiendum eſt, ne in tractanda Moſis Doctrina, quicquam affirmate & aſſeveranter ſentiamus & dicamus, quod repugnet manifeſtis experimentis & rationibus Philoſophiæ, vel aliarum Diſciplinarum. Namque cum Verum omne ſemper cum Vero congruat, non poteſt Veritas Sacrarum Litterarum, Veris Rationibus & Experimentis Humanarum Doctrinarum eſſe contraria.* Peter. in Gen. circa Principium.

(f) *Si manifeſtæ certæque Rationi, velut ſanctarum Litterarum objicitur autors-*

againſt the Truth, not the ſenſe of the Scripture (which is beyond his comprehenſion) but rather his own; nor what is in it, but what, finding it in himſelf, he fancyed to be in it.

ritas, non intelligit, qui hoc facit; & non Scripturæ ſenſum (ad quem penetrare non potuit) ſed ſuum potius objecit veritati: nec id quod in ea, ſed quod in ſeipſo velut pro ea invenit, opponit. Epiſt. 7. ad Marcellinum.

This granted, and it being true, (as hath been ſaid) that two Truths cannot be contrary to each other, it is the office of a Judicious Expoſitor to ſtudy to finde the true Senſes of Sacred Texts, which undoubtedly ſhall accord with thoſe Natural Concluſions, of which manifeſt Senſe and Neceſſary Demonſtrations had before made us ſure and certain. Yea, in regard that the Scriptures (as hath been ſaid) for the Reaſons alledged, admit in many places Expoſitions far from the Senſe of the words; and moreover, we not being able to affirm, that all Interpreters ſpeak by Divine Inſpiration; For (if it were ſo) then there would be no difference between them about the Senſes of the ſame places; I ſhould think that it would be an act of great prudence to make it unlawful for any one to uſurp Texts of Scripture, and as it were to force them to maintain this or that Naturall Concluſion for truth, of which Sence, & Demonſtrative, and neceſſary Reaſons may one time or other aſſure us the contrary. For who will preſcribe bounds to the Wits of men? Who will aſſert that all that is ſenſible and knowable in the World is already diſcovered and known? Will not they that in other points diſagree with us, confeſs this (and it is a great truth) that *Ea quæ ſcimus, ſint minima pars eorum quæ ignoramus*? That thoſe Truths which we know, are very few, in compariſon of thoſe which we know not? Nay more, if we have it from the Mouth of the Holy Ghoſt, that *Deus tradidit Mundum diſputationi eorum, ut non inveniat homo opus, quod operatus eſt Deus ab initio ad finem:* One ought not, as I conceive, to ſtop the way to free Philoſophating, touching the things of the World, and of Nature, as if that they were already certainly found, and all manifeſt: nor ought it to be counted raſhneſs, if one do not ſit down ſatisfied with the opinions now become as it were commune; nor ought any perſons to be diſpleaſed, if others do not hold, in natural Diſputes to that opinion which beſt pleaſeth them; and eſpecially touching Problems that have, for thouſands of years, been controverted amongſt the greateſt Philoſophers, as is the Stability of the Sun, and Mobility of the Earth, an opinion held by *Pythagoras*, and by his whole Sect; by *Heraclides Ponticus*, who was of the ſame opininion; by *Phylolaus*, the Maſter of *Plato*; and by *Plato* himſelf, as *Ariſtotle* relateth, and of which *Plutarch* writeth in the life of *Numa*, that the ſaid *Plato*, when he was grown old, ſaid, It is a moſt abſurd thing to think otherwiſe: The ſame was believed by *Ariſtarchus Samius*, as we have it in *Archimedes*; and probably by *Archimedes* himſelf;

Eccleſiaſt. cap. 3.

ſelf; by *Nicetas* the Philoſopher, upon the teſtimony of *Scicero*, and by many others. And this opinion hath, finally, been amplified, and with many Obſervations and Demonſtrations confirmed by *Nicholaus Copernicus*. And *Seneca*, a moſt eminent Philoſopher, in his Book *De Cometis*, advertizeth us that we ought, with great diligence, ſeek for an aſſured knowledge, whether it be Heaven, or the Earth, in which the Diurnal Converſion reſides.

And for this cauſe, it would probably be prudent and profitable counſel, if beſides the Articles which concern our Salvation, and the eſtabliſhment of our Faith (againſt the ſtability of which there is no fear that any valid and ſolid Doctrine can ever riſe up) men would not aggregate and heap up more, without neceſſity: And if it be ſo, it would certainly be a prepoſterous thing to introduce ſuch Articles at the requeſt of perſons who, beſides that we know not that they ſpeak by inſpiration of Divine Grace, we plainly ſee that there might be wiſhed in them the underſtanding which would be neceſſary firſt to enable them to comprehend, and then to diſcuſs the Demonſtrations wherewith the ſubtiler Sciences proceed in confirming ſuch like Concluſions. Nay, more I ſhould ſay, (were it lawful to ſpeak my judgment freely on this Argument) that it would haply more ſuit with the *Decorum* and Majeſty of thoſe Sacred Volumes, if care were taken that every ſhallow and vulgar Writer might not authorize his Books (which are not feldome grounded upon fooliſh fancies) by inſerting into them Places of Holy Scripture, interpreted, or rather diſtorted to Senſes as remote from the right meaning of the ſaid Scripture, as they are neer to deriſion, who not without oſtentation flouriſh out their Writings therewith. Examples of ſuch like abuſes there might many be produced, but for this time I will confine my ſelf to two, not much beſides theſe matters of *Aſtronomy*: One of which, is that of thoſe Pamphlets which were publiſhed againſt the *Medicean* Planets, of which I had the fortune to make the diſcovery; againſt the exiſtence of which there were brought many places of Sacred Scripture: Now, that all the World ſeeth them to be Planets, I would gladly hear with what new interpretations thoſe very Antagoniſts do expound the Scripture, and excuſe their own ſimplicity. The other example is of him who but very lately hath Printed againſt *Aſtronomers* and *Philoſophers*, that the Moon doth not receive its light from the Sun, but is of its own nature reſplendent: which imagination he in the cloſe confirmeth, or, to ſay better, perſwadeth himſelf that he confirmeth by ſundry Texts of Scripture, which he thinks cannot be reconciled unleſſe his opinion ſhould be true and neceſſary. Nevertheleſſe,

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the Moon of it ſelf is Tenebroſe, and yet it is no leſſe lucid than the Splendor of the Sun.

Hence it is manifeſt, that theſe kinde of Authors, in regard they did not dive into the true Sence of the Scriptures, would (in caſe their authority were of any great moment) have impoſed a neceſſity upon others to believe ſuch Concluſions for true as were repugnant to manifeſt Reaſon, and to Senſe. Which abuſe *Deus avertat*, that it do not gain Countenance and Authority; for if it ſhould, it would in a ſhort time be neceſſary to proſcribe and inhibit all the Contemplative Sciences. For being that by nature the number of ſuch as are very unapt to underſtand perfectly both the Sacred Scriptures, and the other Sciences is much greater than that of the skilfull and intelligent; thoſe of the firſt ſort ſuperficially-running over the Scriptures, would arrogate to themſelves an Authority of decreeing upon all the Queſtions in Nature, by vertue of ſome Word by them miſunderſtood, and produced by the Sacred Pen-men to another purpoſe: Nor would the ſmall number of the Intelligent be able to repreſs the furious Torrent of thoſe men, who would finde ſo many the more followers, in that the gaining the reputation of Wiſe men without pains or Study, is far more grateful to humane Nature, than the conſuming our ſelves with reſtleſs contemplations about the moſt painfull Arts. Therefore we ought to return infinite thanks to Almighty God, who of his Goodneſs freeth us from this fear, in that he depriveth ſuch kinde of perſons of all Authority and, repoſeth the Conſulting, Reſolving, and Decreeing upon ſo important Determinations in the extraordinary Wiſdom and Candor of moſt Sacred Fathers; and in the Supream Authority of thoſe, who being guided by his Holy Spirit, cannot but determin Holily: So ordering things, that of the levity of thoſe other men, there is no account made. This kinde of men are thoſe, as I believe, againſt whom, not without Reaſon, Grave, and Holy Writers do ſo much inveigh; and of whom in particular S. *Hierom* writeth: (g) *This* (Scilicet *the Sacred Scripture*) *the talking old woman, the doting old man, the talkative Sophiſter, all venture upon, lacerate, teach, and that before they have learnt it. Others induced by Pride, diving into hard words*, Philoſophate *amongſt Women, touching the Holy Scriptures. Others* (*Oh ſhameful!*) *Learn of Women what they teach to Men; and, as if this were nothing, in a certain facility of words, I may ſay of confidence, expound to others what they underſtand not themſelves. I forbear to ſpeak of thoſe of my own Profeſſion, who, if after Humane Learning they chance to attain to the Holy Scriptures, and tickle the ears of the people with affected and Studied expreſſions, they affirm that all they ſay, is to be entertained as the Law of God; and*

(g) *Hanc* (*Scilicet Sacram Scripturam*) *garrula anus, hanc delirus ſenex, hanc Sophiſta verboſus, hanc univerſi præſumunt, lacerant, docent, antequam diſcant: Alij, adducto ſupercilio, grandia verba trutinantes, inter mulierculas, de Sacris Litteris Philoſophantur. Alij diſcunt, proh pudor! à fœminis, quod viros docent,*

and not stooping to learn what the Prophets and Apostles held, they force incongruous testimonies to their own Sense: As if it were the genuine, and not corrupt way of teaching to deprave Sentences, and Wrest the Scripture according to their own singular and contradictory humour.

I will not rank among these same secular Writers any *Theologists*, whom I repute to be men of profound Learning, and sober Manners, and therefore hold them in great esteem and veneration: Yet I cannot deny but that I have a certain scruple in my mind, and consequently am desirous to have it removed, whilst I hear that they pretend to a power of constraining others by Authority of the Scriptures to follow that opinion in Natural Disputations, which they think most agreeth with the Texts of that: Holding withall, that they are not bound to answer the Reasons and Experiments on the contrary: In Explication and Confirmation of which their judgement they say, That *Theologie* being the Queen of all the Sciences, she ought not upon any account to stoop to accomodate her self to the Positions of the rest, less worthy, and inferior to her: But that they ought to refer themselves to her (as to their Supream Empress) and change and alter their Conclusions, according to *Theological* Statutes and Decrees. And they further add, That if in the inferior Science there should be any Conclusion certain by vertue of Demonstrations or experiments, to which there is found in Scripture another Conclusion repugnant; the very Professors of that Science ought of themselves to resolve their Demonstrations, and discover the falacies of their own Experiments, without repairing to Theologers and Textuaries, it not suiting (as hath been said) with the dignity of *Theologie* to stoop to the investigation of the falacies of the inferior Sciences: But it sufficeth her, to determine the truth of the Conclusion with her absolute Authority, and by her infallibility. And then the Natural Conclusions in which they say that we ought to bide by the meer Authority of the Scripture, without glossing, or expounding it to Senses different from the Words, they affirm to be Those of which the Scripture speaketh alwaies in the same manner; and the Holy Fathers all receive, and expound to the same Sense.

Now as to these Determinations, I have had occasion to consider some particulars (which I will purpose) for that I was made cautious thereof, by those who understand more than I in these businesses, and to whose judgements I alwaies submit my self. And first I could say, that there might possibly a certain kinde of equivocation interpose, in that they do not distinguish the preheminences whereby Sacred *Theologie* meriteth the Title of Queen.

For

& ne parum hoc sit, quadam facilitate verborum, imo audaciâ, edisserunt aliis, quod ipsi non intelligunt. Taceo de mei similibus, qui si fortè ad Scripturas Sanctas, post seculares litteras venerint, & sermone compositio, aurem populi mulserint; quicquid dixerint, hoc legem Dei putant: nec scire dignantur, quid Prophetæ, quid Apostoli senserint, sed ad sensum suum, incongrua aptant testimonia: Quasi grande sit, & non vitiosissimum docendi genus, depravare sententias, & ad voluntatem suam Scripturam trahere repugnantem. Jeron. Epist. ad *Paul.* 103.

For it might be called ſo, either becauſe that that which is taught by all the other Sciences, is found to be comprized and demonſtrated in it, but with more excellent means, and with more ſublime Learning; in like manner, as for example; The Rules of meaſuring of Land, & of Accountantſhip are much more excellently contained in the Arithmatick and Geometry of *Euclid*, than in the Practiſes of Surveyours and Accomptants: Or becauſe the Subject about which *Theologie* is converſant, excelleth in Dignity all the other Subjects, that are the Matters of other Sciences: As alſo becauſe its Documents are divulged by nobler waies. That the Title and Authority of Queen belongeth to *Theologie* in the firſt Senſe, I think that no Theologers will affirm, that have but any inſight into the other Sciences; of which there are none (as I believe) that will ſay that Geometry, Aſtronomy Muſick, and Medicine are much more excellently and exactly contained in the Sacred Volumes, than in the Books of *Archimedes*, in *Ptolomy*, in *Boetius*, and in *Galen*. Therefore it is probable that the Regal Preheminence is given her upon the ſecond account, namely, By reaſon of the Subject, and the admirable communicating of the Divine Revelations in thoſe Concluſions which by other means could not be conceived by men, and which chiefly concern the acquiſt of eternal Beatitude. Now if *Theologie* being converſant about the loftieſt Divine Contemplation, and reſiding for Dignity in the Regal Throne of the Sciences, (whereby ſhe becometh of higheſt Authority) deſcendeth not to the more mean and humble Speculations of the inferior Sciences: Nay; (as hath been declared above) hath no regard to them, as not concerning Beatitude; the Profeſſors thereof ought not to arrogate to themſelves the Authority to determin of Controverſies in thoſe Profeſſions which have been neither practiſed nor ſtudied by them. For this would be as if an Abſolute Prince, knowing that he might freely command, and cauſe himſelf to be obeyed, ſhould (being neither Phiſitian nor Architect) undertake to adminiſter Medicines, and erect Buildings after his own faſhion, to the great endangering af the lives of the poor Patients, and to the manifeſt deſtruction of the Edifices.

Again, to command the very Profeſſors of *Aſtronomy*, that they of themſelves ſee to the confuting of their own Obſervations and Demonſtrations, as thoſe that can be no other but Falacies and Sophiſmes, is to enjoyn a thing beyond all poſſibility of doing: For it is not onely to command them that they do not ſee that which they ſee, and that they do not underſtand that which they underſtand; but that in ſeeking, they finde the contrary of that which they happen to meet with. Therefore before that this is to be done, it would be neceſſary that they were

ſhewed the way how to make the Powers of the Soul to command one another, and the inferior the Superior; ſo that the imagination and will might, and ſhould believe contrary to what the Intellect underſtands: I ſtill mean in Propoſitions purely Natural, and which are not *de Fide*, and not in the Supernatural, which are *de Fide*.

I would entreat theſe Wiſe and Prudent Fathers, that they would withal diligence conſider the difference that is between Opinable and Demonſtrative Doctrines: To the end, that well weighing in their minds with what force Neceſſary Illations oblige, they might the better aſcertain themſelves, that it is not in the Power of the Profeſſors of Demonſtrative Sciences to change their Opinions at pleaſure, and apply themſelves one while to one ſide, and another while to another; and that there is a great difference between commanding a Methametitian or a Philoſopher, and the diſpoſing of a Lawyer or a Merchant; and that the demonſtrated Concluſions touching the things of Nature and of the Heavens cannot be changed with the ſame facility, as the Opinions are touching what is lawful or not in a Contract, Bargain, or Bill of Exchange. This difference was well underſtood by the Learned and Holy Fathers, as their having been at great pains to confute many Arguments, or to ſay better, many Philoſophical Fallacies, doth prove unto us; and as may expreſly be read in ſome of them, and particularly we have in S. *Auguſtine* the following words: (g) *This is to be held for an undoubted Truth, That we may be confident, that whatever the Sages of this World have demonſtrated touching Natural Points, is no waies contrary to our Bibles; And in caſe they teach any thing in their Books that is contrary to the Holy Scriptures, we may without any ſcruple conclude it to be moſt falſe; And according to our ability let us make the ſame appear: And let us ſo keep the Faith of our Lord, in whom are hidden all the Treaſures of Wiſdom; that we be neither ſeduced with the Loquacity of falſe Philoſophy, nor ſcared by the ſuperſtition of a counterfeit Religion.*

(g) *Hoc indubitanter tenendum eſt, ut quicquid Sapientes hujus Mundi, de Naturâ rerum veraciter demonſtrare potuerint, oſtendamus, noſtris libris non eſſe contrarium: quicquid autem illi, in ſuis voluminibus, contrarium Sacris Litteris docent, ſine ulla dubitatione credamus, id falſiſſimum eſſe, & quoquo modo poſſumus, etiam oſtendamus; atque ita teneamus Fidem Domini noſtri, in quâ ſunt abſconditi omnes theſauri Sapientiæ, ut neque falſa Philoſophiæ loquacitate ſeducamur, neque ſimulatæ Religionis ſuperſtitione terreamur.* Gen. ad Litteram. *lib* 1. Cap. 25.

From which words, I conceive that I may collect this Doctrine, namely, That in the Books of the Wiſe of this World, there are contained ſome Natural truths that are ſolidly demonſtrated, and others again that are barely taught; and that as to the firſt ſort, it is the Office of wiſe Divines to ſhew that they are not contrary to the Sacred Scriptures; As to the reſt, taught, but not neceſſarily demonſtrated, if they ſhall contain any thing contrary to the Sacred Leaves, it ought to be held undoubtedly falſe, and ſuch it ought by all poſſible waies to be demonſtrated.

If therefore Natural Concluſions veritably demonſtrated, are

not

not to be poſtpoſed to the Places of Scripture, but that it ought to be ſhewn how thoſe Places do not interfer with the ſaid Concluſions; then its neceſſary before a Phyſical Propoſition be condemned, to ſhew that it is not neceſſarily demonſtrated; and this is to be done not by them who hold it to be true, but by thoſe who judge it to be falſe. And this ſeemeth very reaſonable, and agreeable to Nature; that is to ſay, that they may much more eaſily find the fallacies in a Diſcourſe, who believe it to be falſe, than thoſe who account it true and concludent. Nay, in this particular it will come to paſſe, that the followers of this opinion, the more that they ſhall turn over Books, examine the Arguments, repeat the Obſervations, and compare the Experiments, the more ſhall they be confirmed in this belief. And your Highneſs knoweth what happened to the late Mathematick Profeſſor in the Univerſity of *Piſa*, Who betook himſelf in his old age to look into the Doctrine of *Copernicus*, with hope that he might be able ſolidly to confute it (for that he held it ſo far to be falſe, as that he had never ſtudied it) but it was his fortune, that as ſoon as he had underſtood the grounds, proceedings, and demonſtrations of *Copernicus*, he found himſelf to be perſwaded, and of an oppoſer became his moſt confident Defender. I might alſo nominate other * Mathematicians, who being moved by my laſt Diſcoveries, have confeſſed it neceſsary to change the formerly received Conſtitution of the World, it not being able by any means to ſubſiſt any longer.

* P. Clavius the Jeſuite.

If for the baniſhing this Opinion and Hypotheſis out of the World, it were enough to ſtop the mouth of one alone, as it may be they perſwade themſelves who meaſuring others judgements by their own, think it impoſſible that this Doctrine ſhould be able to ſubſiſt and finde any followers, this would be very eaſie to be done, but the buſineſs ſtandeth otherwiſe: For to execute ſuch a determination, it would be neceſſary to prohibite not onely the Book of *Copernicus*, and the Writings of the other Authors that follow the ſame opinion, but to interdict the whole Science of *Aſtronomy*; and which is more, to forbid men looking towards Heaven, that ſo they might not ſee *Mars* and *Venus* at one time neer to the Earth, and at another farther off, with ſuch a difference that the latter is found to be fourty times, and the former ſixty times bigger in ſurface at one time than at another; and to the end, that the ſame *Venus* might not be diſcovered to be one while round, and another while forked, with moſt ſubtil hornes: and many other ſenſible Obſervations which can never by any means be reconciled to the *Ptolomaick* Syſteme, but are unanſwerable Arguments for the *Copernican*.

But the prohibiting of *Copernicus* his Book, now that by many

new Obſervations, and by the application of many of the Learned to the reading of him, his Hypotheſis and Doctrine doth every day appear to be more true, having admitted and tolerated it for ſo many years, whilſt he was leſſe followed, ſtudied, and confirmed, would ſeem, in my judgment, an affront to Truth, and a ſeeking the more to obſcure and ſuppreſſe her, the more ſhe ſheweth her ſelf clear and perſpicuous.

The aboliſhing and cenſuring, not of the whole Book, but onely ſo much of it as concerns this particular opinion of the *Earths Mobility*, would, if I miſtake not, be a greater detriment to ſouls, it being an occaſion of great ſcandal, to ſee a Poſition proved, and to ſee it afterwards made an Hereſie to believe it.

The prohibiting of the whole Science, what other would it be but an open contempt of an hundred Texts of the Holy Scriptures, which teach us, That the Glory, and the Greatneſſe of Almighty God is admirably diſcerned in all his Works, and divinely read in the Open Book of Heaven? Nor let any one think that the Lecture of the lofty conceits that are written in thoſe Leaves finiſh in only beholding the Splendour of the Sun, and of the Stars, and their riſing and ſetting, (which is the term to which the eyes of bruits and of the vulgar reach) but there are couched in them myſteries ſo profound, and conceipts ſo ſublime, that the vigils, labours, and ſtudies of an hundred and an hundred acute Wits, have not yet been able thorowly to dive into them after the continual diſquiſition of ſome thouſands of years. But let the Unlearned believe, that like as that which their eyes diſcern in beholding the aſpect of a humane body, is very little in compariſon of the ſtupendious Artifices, which an exquiſite and curious Anatomiſt or Philoſopher finds in the ſame when he is ſearching for the uſe of ſo many Muſcles, Tendons, Nerves, and Bones; and examining the Offices of the Heart, and of the other principal Members, ſeeking the ſeat of the vital Faculties, noting and obſerving the admirable ſtructures of the Inſtruments of the Senſes, and, without ever making an end of ſatisfying his curioſity and wonder, contemplating the Receptacles of the Imagination, of the Memory, and of the Underſtanding; So that which repreſents it ſelf to the meer ſight, is as nothing in compariſon and proportion to the ſtrange Wonders, that by help of long and accurate Obſervations the Wit of Learned Men diſcovereth in Heaven. And this is the ſubſtance of what I had to conſider touching this particular.

In the next place, as to thoſe that adde, That thoſe Natural Propoſitions of which the Scripture ſtill ſpeaks in one conſtant tenour, and which the Fathers all unanimouſly receive in the ſame ſenſe, ought to be accepted according to the naked and literal

literal ſenſe of the Words, without gloſſes and interpretations; and received and held for moſt certain and true; and that conſequently the Mobility of the Sun, and Stability of the Earth, as being ſuch, are *de Fide* to be held for true, and the contrary opinion to be deemed Heretical: I ſhall propoſe to conſideration, in the firſt place, That of Natural Propoſitions, ſome there are, of which all humane Science and Diſcourſe can furniſh us only with ſome plauſible opinion, and probable conjecture rather than with any certain and demonſtrative knowledge; as for example, whether the Stars be animated: Others there are, of which we have, or may confidently believe that we may have, by Experiments, long Obſervations, and Neceſſary Demonſtrations an undubitable aſſurance; as for inſtance, whether the Earth and Heavens move, or not; whether the Heavens are Spherical, or otherwiſe. As to the firſt ſort, I doubt not in the leaſt, that if humane Ratiocinations cannot reach them, and that conſequently there is no Science to be had of them, but only an Opinion or Belief, we ought fully and abſolutely to comply with the meer Verbal Senſe of the Scripture: But as to the other Poſitions, I ſhould think (as hath been ſaid above) That we are firſt to aſcertain our ſelves of the fact it ſelf, which will aſſiſt us in finding out the true ſenſes of the Scriptures; which ſhall moſt certainly be found to accord with the fact demonſtrated, for two truths can never contradict each other. And this I take to be a Doctrine orthodox and undoubted, for that I finde it written in Saint *Auguſtine*, who ſpeaking to our point of the Figure of Heaven, and what it is to be believed to be, in regard that which Aſtronomers affirm concerning it ſeemeth to be, contrary to the Scripture, (they holding it to be rotund, and the Scripture calling it as it were a * Curtain, determineth that we are not at all to regard that the Scripture contradicts Aſtronomers; but to believe its Authority, if that which they ſay ſhall be falſe, and founded only on the conjectures of humane infirmity: but if that which which they affirm be proved by indubitable Reaſons, this Holy Father doth not ſay, that the Aſtronomers are to be enjoyned, that they themſelves reſolving and renouncing their Demonſtrations do declare their Concluſion to be falſe, but ſaith, that it ought to be demonſtrated, That what is ſaid in Scripture of a Curtain is not contrary to their true Demonſtrations. Theſe are his words: (*h*) *But ſome object; How doth it appear, that the ſaying in our Bibles*, Who ſtretcheth out the Heaven as a Curtain, *maketh not againſt thoſe who maintain the Heavens to be in figure of a Sphere? Let it be ſo, if that be falſe which they affirme: For that is truth which is ſpoke by Divine Authority, rather than that*

* *Pelle*, a Skin in the Original, but in our Bibles a Curtain.

(h) *Sed ait aliquis, quomodo non eſt contrarium iis, qui figuram Sphæræ Cælo tribunt, quod ſcriptum eſt in Libris Noſtris*, Qui extendit Cœlum, ſicut pellem?

that which proceeds from Humane Infirmity. But if peradventure they should be able to prove their Position by such Experiments as puts it out of question, it is to be proved, that what is said in Scripture concerning a Curtain, doth in no wise contradict their manifest Reasons.

He proceedeth afterwards to admonish us that we ought to be no less careful and observant in reconciling a Text of Scripture with a demonstrated Natural Proposition, than with another Text of Scripture which should sound to a contrary Sense. Nay methinks that the circumspection of this Saint is worthy to be admired and imitated, who even in obscure Conclusions, and of which we may assure our selves that we can have no knowledge or Science by humane demonstration, is very reserved in determining what is to be believed, as we see by that which he writeth in the end of his second Book, *de Genesi ad Litteram*, speaking whether the Stars are to be believed animate: (i) *Which particular, although (at present) it cannot easily be comprehended, yet I suppose in our farther Progress of handling the Scriptures, we may meet with some more pertinent places, upon which it will be permitted us (if not to determin any thing for certain, yet) to suggest somewhat concerning this matter, according to the dictates of Sacred Authority. But now, the moderation of pious gravity being always observed, we ought to receive nothing rashly in a doubtful point, least perhaps we reject that out of respect to our Errour, which hereafter Truth may discover, to be in no wise repugnant to the Sacred Volumes of the Old and New Testament.*

By this and other places (if I deceive not my self) the intent of the Holy Fathers appeareth to be, That in Natural questions, and which are not *de Fide*, it is first to be considered, whether they be indubitably demonstrated, or by sensible Experiments known; or whether such a knowledge and demonstration is to be had; which having obtained, and it being the gift of God, it ought to be applyed to find out the true Sences of the Sacred Pages in those places, which in appearance might seem to speak to a contrary meaning: Which will unquestionably be pierced into by Prudent Divines, together with the occasions that moved the Holy Ghost, (for our exercise, or for some other reason to me unknown) to veil it self sometimes under words of different significations.

As to the other point, Of our regarding the Primary Scope of those Sacred Volumes, I cannot think that their having spoken always in the same tenour, doth any thing at all disturb this Rule. For if it hath been the Scope of the Scripture by way of condescention to the capacity of the Vulgar at any time, to expres

Sit sanè contrarium, si falsum est, quod illi dicant: hoc enim verum est, quod Divina dicit authoritas, potius quam illud, quod humana infirmitas conficit. Sed si forte illud talibus illis documentis probare potuerint, ut dubitari inde non debeat: demonstrandum est, hoc quod apud nos est de Pelle dictum, veris illis rationibus non esse contrarium.

(i) *Quod licet in praesenti facile non possit comprehendi; arbitror tamen, in processu tractandarum Scripturarum, opportuniora loca posse occurrere, ubi nobis de hac re, secundum Sanctae auctoritatis Litteras, etsi non ostendere certum aliquid, tamen credere licebit. Nunc autem, servatâ semper moderatione piae gravitatis, nihil credere de re obscurâ temere debemus; ne fortè, quòd postea veritas patefecerit, quamvis Libris Sanctis, sive Testamenti veteris, sive, novi nullo modo esse possit aeversum, tamen propter amorem nostri erroris, oderimus.*

Id. D Aug. in Gen. *ad Litteram*, lib. 1. *in fine.*

preſs a Propoſition in words, that bear a ſenſe different from the Eſſence of the ſaid Propoſition; why might it not have obſerved the ſame, and for the ſame reſpect, as often as it had occaſion to ſpeak of the ſame thing? Nay I conceive, that to have done otherwiſe, would but have encreaſed the confuſion, and diminiſhed the credit that theſe Sacred Records ought to have amongſt the Common People.

Again, that touching the Reſt and Motion of the Sun and Earth, it was neceſſary, for accommodation. to Popular Capacity, to aſſert that which the Litteral ſenſe of the Scripture importeth, experience plainly proveth: For that even to our dayes people far leſs rude, do continue in the ſame Opinion upon Reaſons, that if they were well weighed and examined, would be found to be extream trivial, and upon Experiments, either wholly falſe, or altogether beſides the purpoſe. Nor is it worth while to go about to remove them from it, they being incapable of the contrary Reaſons that depend upon too exquiſite Obſervations, and too ſubtil Demonſtrations, grounded upon Abſtractions, which, for the comprehending of them, require too ſtrong an Imagination. Whereupon, although that the Stability of Heaveu, and Motion of the Earth ſhould be more than certain and demonſtrated to the Wiſe; yet nevertheleſs it would be neceſſary, for the conſervation of credit amongſt the Vulgar, to affirm the contrary: For that of a thouſand ordinary men, that come to be queſtioned concerning theſe particulars, its probable that there will not be found ſo much as one that will not anſwer that he thinketh, and ſo certainly he doth, that the Sun moveth, and the Earth ſtandeth ſtill. But yet none ought to take this common Popular Aſſent to be any Argument of the truth of that which is affirmed: For if we ſhould examine theſe very men touching the grounds and motives by which they are induced to believe in that manner; and on the other ſide ſhould hear what Experiments and Demonſtrations perſwade thoſe few others to believe the contrary, we ſhould finde theſe latter to be moved by moſt ſolid Reaſons, and the former by ſimple appearances, and vain and ridiculous occurrences. That therefore it was neceſſary to aſſign Motion to the Sun, and Reſt to the earth, leſt the ſhallow capacity of the Vulgar ſhould be confounded, amuſed, and rendred obſtinate and contumacious, in giving credit to the principal Articles, and which are abſolutely *de fide*, it is ſufficiently obvious. And if it was neceſſary ſo to do, it is not at all to be wondred at, that it was with extraordinary Wiſdom ſo done, in the Divine Scriptures.

But I will alledge further, That not onely a reſpect to the Incapacity of the Vulgar, but the current Opinion of thoſe times made

made the Sacred Writers, in the points that were not neceſſary to ſalvation, to accommodate themſelves more to the received uſe, than to the true Eſſence of things: Of which S. *Hierom* treating, writeth: (k) *As if many things were not ſpoken in the Holy Scriptures according to the judgement of thoſe times in which they were acted, and not according to that which truth contained.* And elſewhere, the ſame Saint: (l) *It is the cuſtome for the Pen-men of Scripture, to deliver their Judgments in many things, according to the common received opinion that their times had of them.* And * S. *Thomas Aquinas* in *Job* upon thoſe words, *Qui extendit Aquilonem ſuper vacuum, & appendit Terram ſuper nihilum*: Noteth that the Scripture calleth that ſpace *Vacuum* and *Nihilum*, which imbraceth and invironeth the Earth, and which we know, not to be empty, bat filled with Air; Nevertheleſſe, ſaith he, The Scripture to comply with the apprehenſion of the Vulgar, who think that in that ſame ſpace there is nothing, calleth it *Vacuum* and *Nihilum*. Here the words of S. *Thomas*, *Quod de ſuperiori Hæmiſphærio Cœli nihil nobis apparet, niſi ſpatium aëre plenum, quod vulgares homines reputant Vacuum; loquitur enim ſecundum exiſtimationem vulgarium hominum, prout eſt mos in Sacra Scriptura.* Now from this Place I think one may very Logically argue, That the Sacred Scripture for the ſame reſpect had much more reaſon to phraſe the Sun moveable, and the Earth immoveable. For if we ſhould try the capacity of the Common People, we ſhould find them much more unapt to be perſwaded of the ſtability of the Sun, and Motion of the Earth, than that the ſpace that environeth it is full of Air. Therefore if the ſacred Authors, in this point, which had not ſo much difficulty to be beat into the capacity of the Vulgar, have notwithſtanding forborn to attempt perſwading them unto it, it muſt needs ſeem very reaſonable that in other Propoſitions much more abſtruſe they have obſerved the ſame ſtile. Nay *Copernicus* himſelf, knowing what power an antiquated cuſtome and way of conceiving things become familiar to us from our infancy hath in our Fancy, that he might not increaſe confuſion and difficulty in our apprehenſions, after he had firſt demonſtrated, That the Motions which appear to us to belong to the Sun, or to the Firmament, are really in the Earth; in proceeding afterwards to reduce them into Tables, and to apply them to uſe, he calleth them the Motions of the Sun, and of the Heaven that is above the Planets; expreſly terming them the Riſing and Serting of the Sun and Stars; and mutations in the obliquity of the Zodiack, and variations in the points of the Equinoxes, the Middle Motion, *Anomalia*, *Proſthaphæreſis* of the Sun; and ſuch other things; which do in reality belong to the Earth: But becauſe

(k) *Quaſi non multa in Scripturis Sanctis dicantur juxta opinionem illius temporis quo geſta referunt, & non juxta quod rei veritas continebat.* D. Hiero. in c. 28. Jerem.

(l) *Conſuetudinis Scripturarum eſt, ut opiniorem multarum rerum ſic narret Hiſtoricus, quomodo eo tempore ab omnibus credebatur.* In cap. 13. Matth.

* D. Thomas, in cap. 26. Job. v. 7.

cauſe being joyned to it, and conſequently having a ſhare in every of its motions, we cannot immediately diſcern them in her, but are forced to refer them to the Celeſtial Bodies in which they appear; therefore we call them as if they were made there, where they ſeem to us to be made. Whence it is to be noted how neceſſary it is to accommodate our diſcourſe to our old and accuſtomed manner of underſtanding.

That, in the next place, the common conſent of Fathers, in receiving a Natural Propoſition of Scripture, all in the ſame ſenſe ought to Authorize it ſo far, as to make it become a matter of Faith to believe it to be * ſo, I ſhould think that it ought at moſt to be underſtood of thoſe Concluſions onely, which have beenby the ſaid Fathers diſcuſſed, and ſifted with all poſſible diligence, and debated on the one ſide, and on the other, and all things in the end concurring to diſprove the one, and prove the other. But the Mobility of the Earth, and Stability of the Sun, are not of this kinde; For, that the ſaid Opinion was in thoſe times totally buried, and never brought amongſt the Queſtions of the Schools, and not conſidered, much leſs followed by any one: So that it is to be believed that it never ſo much as entered into the thought of the Fathers to diſpute it, the Places of Scripture, their own Opinion, and the aſſent of men having all concurred in the ſame judgement, without the contradiction of any one, ſo far as we can finde.

* Namely, according to the Literal Senſe.

Beſides, it is not enough to ſay that the Fathers all admit the ſtability of the Earth, &c. Therefore to believe it is a matter of Faith: But its neceſſary to prove that they have condemned the contrary Opinion: For I may affirm and bide by this; That their not having occaſion to make ſatisfaction upon the ſame, and to diſcuſs it, hath made them to omit and admit it, onely as current, but not as reſolved and proved. And I think I have very good Reaſon for what I ſay; For either the Fathers did make reflection upon this Concluſion as controverted, or not: If not, then they could determin nothing concerning it, no not in their private thoughts; and their incogitance doth not oblige us to receive thoſe Precepts which they have not, ſo much as in their intentions enjoyned. But if they did reflect and conſider thereon, they would long ſince have condemned it, if they had judged it erroneous; which we do not find that they have done. Nay, after that ſome Divines have began to conſider it, we find that they have not deem'd it erroneous; as we read in the Commentaries of *Didacus a Stunica* upon *Job*, in *Cap.9,v.6.* on the words, *Qui commovet Terram de loco ſuo*, &c. Where he at large diſcourſeth upon the *Copernican* Hypotheſis, and concludeth, *That the Mobility of the Earth, is not contrary to Scripture.*

Withal, I may juſtly queſtion the truth of that determination, namely, That the Church enjoyneth us to hold ſuch like Natural

Concluſions as matters of Faith, onely becauſe they bear the ſtamp of an unanimous Interpretation of all the Fathers: And I do ſuppoſe that it may poſſibly be, that thoſe who hold in this manner, might poſſibly have gone about in favour of their own Opinion, to have amplified the Decretal of the Councils; which I cannot finde in this caſe to prohibit any other, ſave onely, *Perverting to Senſes contrary to that of Holy Church, or of the concurrent conſent of Fathers, thoſe places; and thoſe onely that do pertain either to Faith or Manners, or concern our edification in the Doctrine of Chriſtianity: And thus ſpeaks the Council of Trent. Seſſ* 4. But the Mobility or Stability of the Earth, or of the Sun, are not matters of Faith, nor contrary to Manners, nor is there any one, that for the eſtabliſhing of this Opinion, will pervert places of Scripture in oppoſition to the Holy Church, or to the Fathers: Nay, Thoſe who have writ of this Doctrine, did never make uſe of Texts of Scripture; that they might leave it ſtill in the breaſts of Grave and Prudent Divines to interpret the ſaid Places, according to their true meaning.

Concil. Trid. Seſſ. 4.

And how far the Decrees of Councills do comply with the Holy Fathers in theſe particulars, may be ſufficiently manifeſt, in that they are ſo far from enjoyning to receive ſuch-like Natural Concluſions for matters of Faith, or from cenſuring the contrary Opinions as erronious; that rather reſpecting the Primitive and primary intention of the Holy Church, they do adjudge it unprofitable to be buſied in examining the truth thereof. Let your Highneſs be pleaſed to hear once again what S. *Auguſtine* anſwers to thoſe Brethren who put the Queſtion, Whether it be true that Heaven moveth, or ſtandeth ſtill? (*) *To theſe I anſwer, That Points of this nature require a curious and profound examination, that it may truly appear whether they be true or falſe; a work inconſiſtent with my leaſure to undertake or go thorow with, nor is it any way neceſſary for thoſe, whom we deſire to inform of the things that more nearly concern their own ſalvation and The Churches Benefit.*

(*) *His reſpondeo, multum ſubtiliter, & laboriosis rationibus, iſta perquiri, ut vere percipiatur, utrum ita, an non ita ſit: quibus inculcandis atque tractandis, nec mihi jam tempus eſt, nec illis eſſe debet, quos ad ſalutem ſuam, Sanctæ Eccleſiæ neceſſariam utilitatem cupimus informari.*

But yet although in Natural Propoſitions we were to take the reſolution of condemning or admitting them from Texts of Scripture unanimouſly expounded in the ſame ſenſe by all the Fathers, yet do I not ſee how this Rule can hold in our Caſe; for that upon the ſame Places we read ſeveral Expoſitions in the Fathers; (*m*) *Dionyſius Areopagita* ſaying, *That the Primum Mobile, and not the Sun ſtand ſtill.* Saint *Auguſtine* is of the ſame Opinion; (*n*) *All the Celeſtial Bodies were immoveable.* And with them concurreth *Abulenſis.* But which is more, amongſt the Jewiſh Authors (whom *Joſephus* applauds) ſome have held, (*o*) *That the*

(*m*) *Non Solem, ſed Primum Mobile immotum conſtitiſſe:* Dionyſ. Areop.

(*n*) *Omnia corpora Celeſtia, immota ſubſtitiſſe:*

The Sun did not really ſtand ſtill, but ſeemed ſo to do, during the ſhort time in which Iſrael gave the overthrow to their Enemies. So for the Miracle in the time of *Hezekiah*, *Paulus Burgenſis* is of opinion that it was not wrought on the Sun, but on the Diall. But that, in ſhort, it is neceſſary to Gloſſe and Interpret the words of the Text in *Joſhua*, when ever the Worlds Syſteme is in diſpute, I ſhall ſhew anon. Now finally, granting to theſe Gentlemen more than they demand, to wit, That we are wholly to acquieſce in the judgment of Judicious Divines, and that in regard that ſuch a particular Diſquiſition is not found to have been made by the Ancient Fathers, it may be undertaken by the Sages of our Age, who having firſt heard the Experiments, Obſervations, Reaſons, and Demonſtrations of Philoſopners and Aſtronomers, on the one ſide, and on the other (ſeeing that the Controverſie is about Natural Problems, and Neceſſary *Dilemma's*, and which cannot poſſibly be otherwiſe than in one of the two manners in controverſie) they may with competent certainty determine what Divine Inſpirations ſhall dictate to them. But that without minutely examining and diſcuſſing all the Reaſons on both ſides; and without ever comming to any certainty of the truth of the Caſe, ſuch a Reſolution ſhould be taken, Is not to be hoped from thoſe who do not ſtick to hazzard the Majeſty and Dignity of the Sacred Scripture, in defending the reputation of their vain Fancies; Nor to be feared from thoſe who make it their whole buſineſſe, to examine with all intenſneſs, what the Grounds of this Doctrine are; and that only in an Holy Zeal for Truth, the Sacred Scriptures, and for the Majeſty, Dignity, and Authority, in which every Chriſtian ſhould indeavour to have them maintained. Which Dignity, who ſeeth not that it is with greater Zeal deſired and procured by thoſe who, abſolutely ſubmitting themſelves to the Holy Church, deſire, not that this, or that opinion may be prohibited, but onely that ſuch things may be propoſed to conſideration, as may the more aſcertain her in the ſafeſt choice, than by thoſe who being blinded by their particular Intereſt, or ſtimulated by malitious ſuggeſtions, preach that ſhe ſhould, without more ado, thunder out Curſes, for that ſhe had power ſo to do: Not conſidering that all that may be done is not alwayes convenient to be done. The Holy Fathers of old were not of this opinion, but rather knowing of how great prejudice, and how much againſt the primary intent of the Catholick Church, it would be to go about from Texts of Scripture to decide Natural Concluſions, touching which, either Experiments or neceſſary Demonſtrations, might in time to come evince the contrary, of that which the naked ſenſe of the Words ſoundeth, they have

(o) *Solem revera non ſubſtitiſſe immotum, ſed pro brevi tempore, intra quod Iſraelitæ, hoſtes ſuos fudérunt, id ita viſum eſſe.* Iſa. Cap. 38.

not only proceeded with great circumſpection, but have left the following Precepts for the inſtruction of others. (p) *In points obſcure and remote from our Sight, if we come to read any thing out of Sacred Writ, that, with a* Salvo *to the Faith that we have imbued, may correſpond with ſeveral conſtructions, let us not ſo farre throw our ſelves upon any of them with a precipitous obſtinacy, as that if, perhaps the Truth being more diligently ſearch't into, it ſhould juſtly fall to the ground, we might fall together with it: and ſo ſhew that we contend not for the ſenſe of Divine Scriptures, but our own, in that we would have that which is our own to be the ſenſe of Scriptures, when as we ſhould rather deſire the Scriptures meaning to be ours.*

(p) *In rebus obſcuris, atque à noſtris oculis remotiſſimis, ſiqua inde ſcripta etiam divina legerimus, quæ poſſint ſalvâ fide, quæ imbuimur, aliis atque aliis patere ſententiis, in nullam earum nos præcipiti affirmatione ita projiciamus, ut ſi forte ailigentiùs diſcuſſa veritas eâ recte labefactaverit, corruamus: non pro ſententia Divinarum Scripturarum, ſed pro noſtra ita dimicantes, ut eam velimus Scripturarum eſſe, quæ noſtra eſt, cum potius eam quæ Scripturarum eſt, noſtram eſſe velle debeamus.* Divus Auguſtin. in Gen. ad Litteram, lib. 2. c. 18. & ſeq.

He goeth on, and a little after teacheth us, that no Propoſition can be againſt the Faith, unleſſe firſt it be demonſtrated falſe; ſaying, (q) *Tis not all the while contrary to Faith, until it be diſproved by moſt certain Truth, which if it ſhould ſo be, the Holy Scripture affirm'd it not, but Humane Ignorance ſuppoſed it.* Whereby we ſee that the ſenſes which we impoſe on Texts of Scripture, would be falſe, when ever they ſhould diſagree with Truths demonſtrated. And therefore we ought, by help of demonſtrated Truth, to ſeek the undoubted ſenſe of Scripture: and not according to the ſound of the words, that may ſeem true to our weakneſſe, to go about, as it were, to force Nature, and to deny Experiments and Neceſſary Demonſtrations.

(q) *Tam diu non eſt contra fidem, donec Veritate certiſſima reſellatur. Quod ſi factum fuerit, non hoc habebat Divina Scriptura, ſed hoc ſenſerat humana Ignorantia.* Ibid.

Let Your Highneſſe be pleaſed to obſerve farther, with how great circumſpection this Holy Man proceedeth, before he affirmeth any Interpretation of Scripture to be ſure, and in ſuch wiſe certain, as that it need not fear the encounter of any difficulty that may procure it diſturbance, for not contenting himſelf that ſome ſenſe of Scripture agreeth with ſome Demonſtration, he ſubjoynes. (r) *But if right Reaſon ſhall demonſtrate this to be true, yet is it queſtionable whether in theſe words of Sacred Scripture the Pen-man would have this to be underſtood, or ſomewhat elſe, no leſſe true. And in caſe the Context of his Words ſhall prove that he intended not this, yet will not that which he would have to be underſtood be therefore falſe, but moſt true, and that which is more profitable to be known.*

(r) *Si autem hoc verum eſſe vera ratio demonſtraverit, adhuc incertum erit, utrum hoc in illis verbis Sanctorum Librorum, Scriptor ſentiri voluerit, an aliquid aliud non minus verum. Quod ſi cætera contextio ſermonis non hoc eum voluiſſe probaverit, non ideo falſum erit aliud, quod ipſe intelligi voluit, ſed & verum, & quod utilius cognoſcatur.*

But that which increaſeth our wonder concerning the circumſpection,

cumſpection, wherewith this Pious Authour proceedeth, is, that not truſting to his obſerving, that both Demonſtrative Reaſons, and the ſenſe that the words of Scripture and the reſt of the Context both precedent and ſubſequent, do conſpire to prove the ſame thing, he addeth the following words.

(*ſ*) *But if the Context do not hold forth any thing that may diſprove this to be the Authors Senſe, it yet remains to enquire, Whether the other may not be intended alſo.* And not yet reſolving to accept of one Senſe, or reject another, but thinking that he could never uſe ſufficient caution, he proceedeth: (*t*) *But if ſo be we finde that the other may be alſo meant, it will be doubted which of them he would have to ſtand; or which in probability he may be thought to aim at, if the true circumſtances on both ſides be weighed.* And laſtly, intending to render a Reaſon of this his Rule, by ſhewing us to what perils thoſe men expoſe the Scriptures, and the Church; who, more reſpecting the ſupport of their own errours, than the Scriptures Dignity, would ſtretch its Authority beyond the Bounds which it preſcribeth to it ſelf, he ſubjoyns the enſuing words, which of themſelves alone might ſuffice to repreſs and moderate the exceſſive liberty, which ſome think that they may aſſume to themſelves: (*u*) *For it many times falls out, that a Chriſtian may not ſo fully underſtand a Point concerning the Earth, Heaven, and the reſt of this Worlds Elements; the Motion, Converſion, Magnitude, and Diſtances of the Stars, the certain defects of the Sun and Moon, the Revolutions of Years and Times, the Nature of Animals, Fruits, Stones, and other things of like nature, as to defend the ſame by right Reaſon, or make it out by Experiments. But its too great an abſurdity, yea moſt pernicious, and chiefly to be avoided, to let an Infidel finde a Chriſtian ſo ſtupid, that he ſhould argue theſe matters; as if they were according to Chriſtian Doctrine; and make him (as the Proverb ſaith) ſcarce able to contain his laughter, ſeeing him ſo far from the Mark. Nor is the matter ſo much that one in an errour ſhould be laught at, but that our Authors ſhould be thought by them that are without, to be of the ſame Opinion, and to the great prejudice of thoſe, whoſe ſalvation we wait for, cenſured and rejected as unlearned. For when they ſhal confute any one of the Chriſtians in that matter, which they themſelvs thorowly underſtand, and ſhall thereupon expreſs their light eſteem of our Books; how ſhall theſe Volumes be believed touching the Reſurrection of the Dead, the Hope of eternal Life, and the Kingdom of Heaven; when, as to theſe Points which admit of preſent Demonſtration, or undoubted Reaſons, they conceive them to be falſly written.*

(*ſ*) *Si autem contextio Scripturæ, hoc voluiſſe intelligi Scriptorem, non repugnaverit, adhuc reſtabit quærere, utrum & aliud non potuerit.*

(*t*) *Quod ſi & aliud potuiſſe invenerimus, incertum erit; quidnam eorum ille voluerit: aut utrumque voluiſſe non inconvenienter creditur, ſi utriuſque ſententiæ certa circumſtantia ſuffragatur.*

(*u*) *Plerumque enim accidit, ut aliquid de Terra, de Cœlo, de ceteris hujus mundi elementis, de motu, converſione, vel etiam magnitudine & intervallis Syderum, de certis defectibus Solis, & Lunæ, de circuitibus annorum & temporum; de Naturis animalium, fruticum, lapidum, atque hujuſmodi ceteris, etiam non Chriſtianus ita noverit, ut certiſſima ratione vel experientiâ teneat. Turpe autem eſt nimis & perniciosum, ac maxime cavendum, ut Chriſtianum de his rebus quaſi ſecundum Chriſtianas litteras loquentem, ita delirare quilibet infidelis audiat, ut, quemadmodum dicitur, toto Cœlo errare conſpiciens, viſu tenere vix poſſit: & non tam moleſtum eſt, quod errans homo derideretur, ſed quod auctores noſtri, ab iis qui foris ſunt, talia ſenſiſſe credantur, & cum magno exitio eorum, de quorum ſalute ſatagimus, tanquam indocti reprehendantur atque reſpuantur. Cum enim quemquam de numero Chriſtianorum ea in re, quam ipſi optime norunt, deprehenderint, & vanam ſententiam ſuam de noſtris libris aſſerent; quo pacto illis Libris credituri ſunt, de Reſurrectione Mortuorum, & de ſpe vitæ æternæ, Regnique Cœlorum; quando de his rebus quas jam experiri, vel indubitatis rationibus percipere potuerunt, fallaciter putaverint eſſe conſcriptos.*

And

And how much the truly Wise and Prudent Fathers are displeased with these men, who in defence of Propositions which they do not understand, do apply, and in a certain sense pawn Texts of Scripture, and afterwards go on to encrease their first Errour, by producing other places less understood than the former. The same Saint declareth in the expressions following: (x) *What trouble and sorrow weak unaertakers bring upon their knowing Brethren, is not to be expressed; since when they begin to be told and convinced of their false and unsound Opinion, by those who have no respect for the Authority of our Scriptures, in defence of what through a fond Temerity, and most manifest falsity, they have urged; they fall to citing the said Sacred Books for proof of it, or else repeat many words by heart out of them, which they conceive to make for their purpose; not knowing either what they say, or whereof they affirm.*

(y) *Quid enim molestia, tristisque ingerant prudentibus fratribus, temerarii praesumptores, satis dici non potest, cum, si quando de falsa & prava opinione sua reprehendi & convinci caperint, ab iis qui nostrorum librorum auctoritate, & apertissima falsitate dixerunt, eosdem libros Sanctos, unde id probent, proferre conantur; vel etiam memoriter, quae ad testimonium valere arbitrantur, multa inde verba pronunciant, non intelligentes, neque quae loquuntur, neque de quibus affirmant.*

In the number of these we may, as I conceive, account those, who, being either unwilling or unable to understand the Demonstrations and Experiments, wherewith the Author and followers of this Opinion do confirm it, run upon all occasions to the Scriptures, not considering that the more they cite them, and the more they persist in affirming that they are very clear, and do admit no other senses, save those which they force upon them, the greater injury they do to the Dignity of them (if we allowed that their judgements were of any great Authority) in case that the Truth coming to be manifestly known to the contrary, should occasion any confusion, at least to those who are separated from the Holy Church; of whom yet she is very solicitous, and like a tender Mother, desirous to recover them again into her Lap. Your Highness therefore may see how præposterously those Persons proceed, who in Natural Disputations do range Texts of Scripture in the Front for their Arguments; and such Texts too many times, as are but superficially understood by them.

But if these men do verily think, & absolutely believe that they have the true sence of Such a particular place of Scripture, it must needs follow of consequence, that they do likewise hold for certain, that they have found the absolute truth of that Natural Conclusion, which they intend to dispute: And that withall, they do know that they have a great advantage of their Adversary, whose Lot it is to defend the part that is false; in regard that he who maintaineth the Truth, may have many sensible experiments, and many necessary Demonstrations on his side; whereas his Antagonist can make use of no other than deceitful appearances, *Paralogisms* and *Sophisms*. Now if they keeping within natural bounds, & producing no other Weapons but those of Philosophy, pretend however, to have so much advantage of their Enemy; why do they afterwards

wards in coming to engage, preſently betake themſelves to a Weapon inevitable & dreadful to terrifie their Opponent with the ſole beholding of it? But if I may ſpeak the truth, I believe that they are the firſt that are affrighted, and that perceiving themſelves unable to bear up againſt the aſſaults of their Adverſary, go about to find out ways how to keep them far enough off, forbidding unto them the uſe of the Reaſon which the Divine Bounty had vouchſafed them, & abuſing the moſt equitable Authority of ſacred Scripture, which rightly underſtood and applyed, can never, according to the common Maxime of Divines, oppoſe the Manifeſt Experiments, or Neceſſary Demonſtrations. But theſe mens running to the Scriptures for a Cloak to their inability to comprehend, not to ſay reſolve the Reaſons alledged againſt them, ought (if I be not miſtaken) to ſtand them in no ſtead: the Opinion which they oppoſe having never as yet been condemned by Holy Church. So that if they would proceed with Candor, they ſhould either by ſilence confeſs themſelves unable to handle ſuch like points, or firſt conſider that it is not in the power of them or others, but onely in that of the Pope, and of Sacred Councils to cenſure a Poſition to be Erroneous: But that it is left to their freedome to diſpute concerning its falſity. And thereupon, knowing that it is impoſſible that a Propoſition ſhould at the ſame time be True and Heretical; they ought, I ſay, to imploy themſelves in that work which is moſt proper to them, namely, in demonſtrating the falſity thereof: whereby they may ſee how needleſſe the prohibiting of it is, its falſhood being once diſcovered, for that none would follow it: or the Prohibition would be ſafe, and without all danger of Scandal. Therefore firſt let theſe men apply themſelves to examine the Arguments of *Copernicus* and others; and leave the condemning of them for Erroneous and Heretical to whom it belongeth: But yet let them not hope ever to finde ſuch raſh and precipitous Determinations in the Wary and Holy Fathers, or in the abſolute Wiſdome of him that cannot erre, as thoſe into which they ſuffer themſelves to be hurried by ſome particular Affection or Intereſt of their own. In theſe and ſuch other Poſitions, which are not directly *de Fide*, certainly no man doubts but His Holineſs hath alwayes an abſolute power of Admitting or Condemning them, but it is not in the power of any Creature to make them to be true or falſe, otherwiſe than of their own nature, and *de facto* they are.

If this paſſage ſeem harſh, the Reader muſt remember that I do but Tranſlate.

Therefore it is in my judgment more diſcretion to aſſure us firſt of the neceſſary and immutable Truth of the Fact, (over which none hath power) than without that certainty by condemning one part to deprive ones ſelf of that authority of freedome

to

to elect, making those Determinations to become necessary, which at present are indifferent and arbitrary, and rest in the will of Supreme Authority. And in a word, if it be not possible that a Conclusion should be declared Heretical, whilst we are not certain, but that it may be true, their pains are in vain who pretend to condemn the Mobility of the Earth and Stability of the Sun, unless they have first demonstrated it to be impossible and false.

It remaineth now, that we consider whether it be true, that the Place in *Joshuah* may be taken without altering the pure signification of the words: and how it can be that the Sun, obeying the command of *Joshuah*, which was, *That it should stand still*, the day might thereupon be much lengthened. Which business, if the Celestial Motions be taken according to the *Ptolomaick* Systeme, can never any wayes happen, for that the Sun moving thorow the Ecliptick, according to the order of the Signes, which is from East to West (which is that which maketh Day and Night) it is a thing manifest, that the Sun ceasing its true and proper Motion, the day would become shorter and not longer; and that on the contrary, the way to lengthen it would be to hasten and velocitate the Suns motion; insomuch that to cause the Sun to stay above the Horizon for some time, in one and the same place, without declining towards the West, it would be necessary to accelerate its motion in such a manner as that it might seem equal to that of the *Primum Mobile*, which would be an accelerating it about three hundred and sixty times more than ordinary. If therefore *Joshuah* had had an intention that his words should be taken in their pure and proper signification, he would have bid the Sun to have accelerated its Motion so, that the Rapture of the *Primum Mobile* might not carry it to the West: but because his words were heard by people which haply knew no other Celestial Motion, save this grand and common one, from East to West, stooping to their Capacity, and having no intention to teach them the Constitution of the Spheres, but only that they should perceive the greatness of the Miracle wrought, in the lengthening of the Day, he spoke according to their apprehension. Possibly this Consideration moved *Dionysius Areopagita* to say that in this Miracle the *Primum Mobile* stood still, and this stopping, all the Celestial Spheres did of consequence stay: of which opinion is S. *Augustine* himself, and *Abulensis* at large confirmeth it. Yea, that *Joshua's* intention was, that the whole Systeme of the Celestial Spheres should stand still, is collected from the command he gave at the same time to the Moon, although that it had nothing to do in the lengthening of the day; and under the injunction laid upon the Moon,

Moon, we are to underſtand the Orbes of all the other Planets; paſſed over in ſilence here, as alſo in all other places of the Sacred Scriptures; the intention of which, was not to teach us the Aſtronomical Sciences. I ſuppoſe therefore, (if I be not deceived) that it is very plain, that if we allow the *Ptolemaick* Syſteme, we muſt of neceſſity interpret the words to ſome ſenſe different from their ſtrict ſignification. Which Interpretation (being admoniſhed by the moſt uſefull precepts of S. *Auguſtine*) I will not affirm to be of neceſſity this above-mentioned, ſince that ſome other man may haply think of ſome other more proper, and more agreeable Senſe.

But now, if this ſame paſſage may be underſtood in the *Copernican* Syſteme, to agree better with what we read in *Joſhuah*, with the help of another Obſervation by me newly ſhewen in the Body of the Sun; I will propound it to conſideration, ſpeaking alwaies with thoſe ſafe Reſerves; That I am not ſo affectionate to my own inventions, as to prefer them before thoſe of other men, and to believe that better and more agreeable to the intention of the Sacred Volumes cannot be produced.

Suppoſing therefore in the firſt place, that in the Miracle of *Joſhuah*, the whole Syſteme of the Celeſtial Revolutions ſtood ſtill, according to the judgement of the afore-named Authors: And this is the rather to be admitted, to the end, that by the ſtaying of one alone, all the Conſtitutions might not be confounded, and a great diſorder needleſly introduced in the whole courſe of Nature: I come in the ſecond place to conſider how the Solar Body, although ſtable in one conſtant place, doth nevertheleſs revolve in it ſelf, making an entire Converſion in the ſpace of a Month, or thereabouts; as I conceive I have ſolidly demonſtrated in my Letters *Delle Machie Solari*: Which motion we ſenſibly ſee to be in the upper part of its Globe, inclined towards the South; and thence towards the lower part, to encline towards the North, juſt in the ſame manner as all the other Orbs of the Planets do. Thirdly, If we reſpect the Nobility of the Sun, and his being the Fountain of Light, by which, (as I neceſſarily demonſtrate) not onely the Moon and Earth, but all the other Planets (all in the ſame manner dark of themſelves) become illuminated; I conceive that it will be no unlogicall Illation to ſay, That it, as the Grand Miniſter of Nature, and in a certain ſenſe the Soul and Heart of the World, infuſeth into the other Bodies which environ it; not onely Light, but Motion alſo; by revolving * in it ſelf: So that in the ſame manner that the motion of the Heart of an Animal ceaſing, all the other motions of its Members would ceaſe; ſo, the Converſion of the Sun ceaſing, the Converſions of all the Planets would ſtand ſtill. And though

* i. e. On its own Axis.

I could produce the teſtimonies of many grave Writers to prove the admirable power and influence of the Sun, I will content my ſelf with one ſole place of Holy *Dioniſius Areopagita* in his Book *de Divinis Nominibus*; who thus writes of the Sun: (*) *His Light gathereth and converts all things to himſelf, which are ſeen, moved, illuſtrated, wax hot, and (in a word) thoſe things which are preſerved by his ſplendor: Wherefore the Sun is called* Hμ&, *for that he collecteth and gathereth together all things diſperſed.* And a little after of the Sun again he adds; (*) *If this Sun which we ſee, as touching the Eſſences and Qualities of thoſe things which fall within our Senſe, being very many and different; yet if he who is one, and equally beſtowes his Light, doth renew, nouriſh, defend, perfect, divide, conjoyn, cheriſh, make fruitfull, encreaſe, change, fix, produce, move, and faſhion all living creatures: And every thing in this Univerſe at his Pleaſure, is partaker of one and the ſame Sun; and the cauſes of many things which participate of him, are equally anticipated in him: Certainly by greater reaſon;* &c. The Sun therefore being the Fountain of Light and, Principle of Motion, God intending, that at the Command of *Joſhua*, all the Worlds Syſteme, ſhould continue many hours in the ſame ſtate, it ſufficeth to make the Sun ſtand ſtill, upon whoſe ſtay (all the other Converſions ceaſing) the Earth, the Moon, the Sun did abide in the ſame Conſtitution as before, as likewiſe all the other Planets: Nor in all that time did the Day decline towards Night, but it was miraculouſly prolonged: And in this manner, upon the ſtanding ſtill of the Sun, without altering, or in the leaſt diſturbing the other Aſpects and mutual Poſitions of the Stars, the Day might be lengthned on Earth; which exactly agreeth with the Litteral ſenſe of the Sacred Text.

But that of which, if I be not miſtaken, we are to make no ſmall account, is, That by help of this *Copernican* Hypotheſis, we have the Litteral, apert, and Natural Senſe of another particular that we read of in the ſame Miracle; which is, That the Sun ſtood ſtill *in Medio Cæli*: Upon which paſſage grave Divines raiſe many queſtions, in regard it ſeemeth very probable, That when *Joſhuah* deſired the lengthning of the Day, the Sun was near ſetting, and not in the Meridian; for if it had been in the Meridian, it being then about the Summer *Solſtice*, and conſequently the dayes being at the longeſt, it doth not ſeem likely that it was neceſſary to pray for the lengthning of the day, to proſecute Victory in a Battail, the ſpace of ſeven hours and more, which remained to Night, being ſufficient for that purpoſe. Upon which Grave Divines have been induced to think that the Sun was near ſetting: And ſo the words themſelves ſeem to found

(*) *Lux ejus colligit, convertitque ad ſe omnia, qua videntur, qua moventur, qua illuſtrantur, qua caleſcunt, & uno nomine ea, qua ab ejus ſplendore continentur. Itaque Sol* Hμ& *dicitur, quod omnia congreget, colligatque diſperſa.*

(*) *Si enim Sol hic quem videmus, eorum qua ſub ſenſum cadunt, eſſentias & qualitates, quaque multa ſint ac diſſimiles, tamen ipſe qui unus eſt, aqua interque lumen fundit, renovat, alit, tuetur, perficit, dividit, conjungit, fovet, facunda reddit, auget, mutat, firmat edit, movet, vitalinq; facit omnia: & unaquaq; res hujus univerſitatis, pro capite ſuo, unius atque ejuſdem Solis eſt particeps, cauſaſque multorum, qua participant, in ſe æquabiliter anticipatas habet, certe majori ratione,* &c.

ſound, ſaying, Ne *movearis Sol*, *ne movearis*. For if it had been in the Meridian, either it had been needleſs to have asked a Miracle, or it would have been ſufficient to have onely praid for ſome retardment. Of this opinion is *Cajetan*, to which ſubſcribeth *Magaglianes*, confirming it by ſaying, that *Joſhua* had that very day done ſo many other things before his commanding the Sun, as were not poſſibly to be diſpatch't in half a day. Whereupon they are forced to read the Words *in Medio Cœli* (to confeſs the truth) with a little harſhneſs, ſaying that they import no more than this: *That the Sun ſtood ſtill, being in our Hemiſphere, that is, above the Horizon.* But (if I do not erre) we ſhall avoid that and all other harſh expoſitions, if according to the *Copernican* Syſteme we place the Sun in the midſt, that is, in the Centre of the Cœleſtial Orbes, and of the Planetary Converſions, as it is moſt requiſite to do. For ſuppoſing any hour of the day (either Noon, or any other, as you ſhall pleaſe neerer to the Evening) the Day was lengthened, and all the Cœleſtial Revolutions ſtayed by the Suns ſtanding ſtill, *In the midſt*, that is, *in the Centre of Heaven*, where it reſides: A Senſe ſo much the more accomodate to the Letter (beſides what hath been ſaid already) in that, if the Text had deſired to have affirmed the Suns Reſt to have been cauſed at Noon-day, the proper expreſſion of it had been to ſay, *It ſtood ſtill at Noon-day*, or *in the Meridian Circle*, and not *in the midſt of Heaven*: In regard that the true and only *Middle* of a Spherical Body (as is Heaven) is the Centre.

Solem ſtetiſſe, dum adhuc in Hemiſphærio noſtro, ſupra ſcilicet Horizontem exiſteret. Cajetan *in loco.*

Again, as to other places of Scripture, which ſeem contrary to this poſition, I do not doubt but that if it were acknowledged for True and Demonſtrated thoſe very Divines who ſo long as they repute it falſe, hold thoſe places incapable of Expoſitions that agree with it would finde ſuch Interpretations for them, as ſhould very well ſuit therewith; and eſpecially if to the knowledge of Divine Learning they would but adde ſome knowledge of the Aſtronomical Sciences: And as at preſent, whilſt they deem it falſe they think they meet in Scripture only with ſuch places as make againſt it, if they ſhall but once have entertained another conceipt thereof, they would meet peradventure as many others that accord with it, and haply would judge, that the Holy Church doth very appoſitly teach, That God placed the Sun in the Centre of Heaven, and that thereupon by revolving it in it ſelf, after the manner of a Wheel, He contributed the ordinary Courſes to the Moon and other Erratick Stars, whilſt that ſhe Sings,

Cœli Deus ſanctiſſime,
Qui lucidum Centrum Poli,

Candore pingis igneo,
Augens decoro lumine,
Quarto die, qui flammeam
Solis rotam conſtituens
Lunæ miniſtras ordinem,
Vagoſque curſus Syderum.

They might ſay, that the Name of *Firmament* very well agreeth, *ad literam*, to the Starry Sphere, and to all that which is above the Planetary Converſions; which according to this Hypotheſis is altogether *firme* and immoveable. *Ad litteram* (the Earth moving circularly) they might underſtand its *Poles*, where it's ſaid, *Nec dum Terram fecerat, & flumina, &* Cardines *Orbis Terræ*, Which *Cardines* or * *Hinges* ſeem to be aſcribed to the Earth in vain, if it be not to turn upon them.

* Or Poles.

FINIS.

AN

ABSTRACT

OF THE

Learned Treatiſe

OF

JOHANNIS KEPLERUS,

The Emperours *Mathematician*:

ENTITULED

His Introduction upon MARS:

IT muſt be confeſſed, that there are very many who are devoted to Holineſſe, that diſſent from the Judgment of *Copernicus*, fearing to give the Lye to the Holy Ghoſt ſpeaking in the Scriptures, if they ſhould ſay, that the Earth moveth, and the Sun ſtands ſtill. But let ſuch conſider, that ſince we judge of very many, and thoſe the moſt principal things by the Senſe of Seeing, it is impoſſible that we ſhould alienate our Speech from this Senſe of our Eyes. Therefore many things daily occur, of which we ſpeak according to the Senſe of Sight, when as we certainly know that the things themſelves are otherwiſe. An Example whereof we have in that Verſe of *Virgil*;

Provehimur portu, Terræque urbeſque recedunt.

So when we come forth of the narrow ſtraight of ſome Valley, we ſay that a large Field diſcovereth it ſelf. So Chriſt to *Peter*, *Duc in altum*; [Lanch forth into the Deep, or on high,] as if the Sea were higher than its Shores; For ſo it ſeemeth to the Eye, but the Opticks ſhew the cauſe of this fallacy. Yet Chriſt uſeth the moſt received Speech, although it proceed from this deluſion of the Eyes. Thus we conceive of the Riſing and Setting

Setting of the Stars, that is to say, of their Aſcenſion and Deſcenſion; when at the ſame time that we affirm the Sun riſeth, others ſay, that it goeth down. See my *Optices Aſtronomicæ, cap.* 10. *fol.* 327. So in like manner, the *Ptolomaicks* affirm, that the Planets *ſtand ſtill*, when for ſome dayes together they ſeem to be fixed, although they believe them at that very time to be moved in a direct line, either downwards to, or upwards from the Earth. Thus the Writers of all Nations uſe the word *Solſtitium*, and yet they deny that the Sun doth really ſtand ſtill. Likewiſe there will never any man be ſo devoted to *Copernicus*, but he will ſay, the Sun entereth into *Cancer* and *Leo*, although he granteth that the Earth enters *Capricorn* or *Aquarius*: And ſo in other caſes of the like nature. But now the Sacred Scriptures, ſpeaking to men of vulgar matters (in which they were not intended to inſtruct men) after the manner of men, that ſo they might be underſtood by men, do uſe ſuch Expreſſions as are granted by all, thereby to inſinuate other things more Myſterious and Divine. What wonder is it then, if the Scripture ſpeaks according to mans apprehenſion, at ſuch time when the Truth of things doth diſſent from the Conception that all men, whether Learned or Unlearned have of them? Who knows not that it is a Poetical alluſion, *Pſal.* 19. where, whilſt under the ſimilitude of the Sun, the Courſe of the Goſpel, as alſo the Peregrination of our Lord Chriſt in this World, undertaken for our ſakes, is deſcribed, *The Sun* is ſaid *to come forth of his Tabernacle* of the Horizon, *as a Bridegroom out of his Chamber, rejoycing as a Giant to run a Race*? Which *Virgil* thus imitates;

Tithono croceum linquens Aurora cubile:

For the firſt Poets were amongſt the Jews. The Pſalmiſt knew that the Sun went not forth of the Horizon, as out of its Tabernacle, & yet it ſeemeth to the Eye ſo to do: Nor did he believe, that the Sun moved, for that it appeared to his ſight ſo to do. And yet he ſaith both, for that both were ſo to his ſeeming. Neither is it to be adjudged falſe in either Senſe: for the perception of the Eyes hath its verity, fit for the more ſecret purpoſe of the Pſalmiſt in ſhadowing forth the current paſſage of the Goſpel, as alſo the Peregrination of the Son of God. *Joſhua* likewiſe mentioneth the Vallies on or in, which the Sun and Moon moved, for that they appeared to him at *Jordan* ſo to do: And yet both theſe Pen-men may obtain their ends. *David*, (and with him *Syracides*) the magnificence of God being made known, which cauſed theſe things to be in this manner repreſented to ſight, or otherwiſe, the myſtical meaning, by means of theſe Viſibles being diſcerned: And *Joſhua*, in that the Sun, as to his Senſe

Senſe of Seeing, ſtaid a whole day in the midſt of Heaven, whereas at the ſame time to others it lay hid under the Earth. But incogitant perſons onely look upon the contrariety of the words, *The Sun ſtood ſtill*, that is, *The Earth ſtood ſtill*; not conſidering that this contradiction is confined within the limits of the Opticks and Aſtronomy: For which cauſe it is not outwardly expoſed to the notice and uſe of men: Nor will they underſtand that the onely thing *Joſhuah* prayed for, was that the Mountains might not intercept the Sun from him; which requeſt he expreſſed in words, that ſuited with his Ocular Senſe: Beſides it had been very unſeaſonable at that time to think of Aſtronomy, or the Errours in Sight; for if any one ſhould have told him that the Sun could not really move upon the Valley of *Ajalon*, , but onely in relation to Senſe, would not *Joſhuah* have replyed, that his deſire was that the day might be prolonged, ſo it were by any means whatſoever? In like manner would he have anſwered if any one had ſtarted a queſtion about the Suns Mobility, and the Earths Motion. But God eaſily underſtood by *Joſhuahs* words what he asked for, and by arreſting the Earths Motion, made the Sun in his apprehenſion ſeem to ſtand ſtill. For the ſumm of *Joſhuahs* Prayer amounts to no more but this, that it might thus appear to him, let it in the mean time *be what it would* of it ſelf. For that its ſo ſeeming, was not in vain and ridiculous, but accompanied with the deſired effect. But read the tenth *Chap.* of my *Book*, that treats of *the Optick part of Aſtronomy*, where thou ſhalt finde the Reaſons why the Sun doth in this manner ſeem to all mens thinking to be moved, and not the Earth; as namely, becauſe the Sun appeareth ſmall, and the Earth bigg. Again, the Motion of the Sun is not diſcerned by the eye, by reaſon of his ſeeming tardity, but by ratiocination onely; in that after ſome time it varieth not its proximity to ſuch and ſuch Mountains. Therefore it is impoſſible that Reaſon, unleſs it be firſt inſtructed, ſhould frame to it ſelf any other apprehenſion, than that the Earth with Heavens Arch placed over it, is as it were a great Houſe, in which, being immoveable, the Sun like a Bird flying in the Air, paſſeth in ſo ſmall a Species out of one Climate into another. Which imagination of all Man-kinde being thus, gave the firſt line in the Sacred Leaves: * *In the beginning* (ſaith *Moſes*) *God created the Heaven and the Earth*; for that theſe two are moſt obvious to the eye. As if *Moſes* ſhould have ſaid thus to Man; This whole Mundane Fabrick which thou ſeeſt, lucid above, and dark, and of a vaſt extent beneath, wherein thou haſt thy being, and with which thou art covered, was created by God.

* Gen. *Chap.* 1. *v.* 1.

In another place Man is queſtioned; *Whether he can finde out the*

the height of Heaven above, or depth of the Earth beneath: for that each of them appeareth to men of ordinary capacity, to have equally an infinite extent. And yet no man that is in his right mind will by these words circumscribe and bound the diligence of Astronomers, whether in demonstrating the most contemptible Minuity of the Earth, in comparison of Heaven, or in searching out Astronomical *Distances*: Since those words speak not of the Rational, but real Dimention; which to a Humane Body, whilst confin'd to the Earth, and breathing in the open Air, is altogether impossible. Read the whole 38. Chapter of *Job*, and compare it with those Points which are disputed in Astronomy, and Physiologie. If any one do alledge from *Psal.* 24. That * *The Earth is founded upon the Seas*, to the end that he may thence infer some new Principle in Philosophy, absurd to hear; as, That the Earth doth float upon the Waters; may it not truly be told him, That he ought not to meddle with the Holy Spirit, nor to bring him with contempt into the School of Physiologie. For the Psalmist, in that place means nothing else but that which men fore-know, and daily see by experience; namely, That the Earth (being lifted up after the separation of the Waters) doth swim between the Grand Oceans, and float about the Sea. Nor is it strange that the expression should be the same where the *Israelites* sing, * *That they sate on the River of Babylon*; that is, *by* the River side. or on the Banks of *Euphrates* and *Tygris*.

* Psal. 24. 2.

Psal. 137. 1.

If any one receive this Reading without scruple, why not the other; that so in those same Texts which are wont to be alledged against the Motion of the Earth, we may in like manner turn our eyes from Natural Philosophy, to the scope and intent of Scripture. *One Generation passeth away*, (saith *Ecclesiastes*) *and another Generation cometh: But the Earth abideth for ever.* * As if *Solomon* did here dispute with Astronomers, and not rather put men in minde of their Mutability; whenas the Earth, Mankindes habitation, doth alwaies remain the same: The Suns Motion doth continually return into what it was at first: The Wind is acted in a Circle, and returns in the same manner: The Rivers flow from their Fountains into the Sea, and return again from thence unto their Fountains: To conclude, The Men of this Age dying, others are born in their room; the Fable of Life is ever the same; there is nothing new under the Sun. Here is no reference to any Physical Opinion. Σωφία is Moral of a thing in it self manifest, and seen by the eyes of all, but little regarded: Tis that therefore which *Solomon* doth inculcate. For who knows not that the Earth is alwaies the same? Who sees not that the Sun doth arise from the East; That the Rivers continually run into the

* Chap. 1. v. 4, to 9.

the Sea; That the viciſſitudes of the Windes return into their primitive State; That ſome men ſucceed others? But who conſidereth that the ſelf-ſame *Scene* of Life is ever acting, by different perſons; and that nothing is *new* in humane affairs? Therefore *Solomon* inſtancing in thoſe things which all men ſee, doth put men in minde of that which many thorowly know, but too ſlightly conſider.

But the 104. *Pſalm* is thought by ſome to contain a Diſcourſe altogether Phyſical, in regard it onely concerns Natural Philoſophy. Now God is there ſaid, *To have laid the Foundations of the Earth, that it ſhould not be removed for ever.* Pſal.104. v.5. But here alſo the Pſalmiſt is far from the Speculation of Phyſical Cauſes: For he doth wholly acquieſce in the Greatneſſe of God, who did all theſe things, and ſings an Hymne to God the Maker of them, in which he runneth over the World in order, as it appeared to his eyes. And if you well conſider this Pſalme, it is a Paraphraſe upon the ſix dayes work of the Creation: For as in it the three firſt dayes were ſpent in the Separation of Regions; the firſt of Light from the exteriour Darkneſs; the ſecond, of the Waters from the Waters, by the interpoſition of the Firmament; the third, of the Sea from Land; when alſo the Earth was cloathed with Herbage and Plants: And the three laſt dayes were ſpent in the filling the Regions thus diſtinguiſhed; the fourth, of Heaven; the fifth, of the Seas and Aire; the ſixth, of the Earth: So here in this Pſalme there are ſo many diſtinct parts proportionable to the Analogy of the ſix dayes Works. For in *Verſe* 2. he cloaths and covereth the Creator with Light (the firſt of Creatures, and work of the firſt day) as with a Garment. The ſecond part beginneth at *Verſe* 3. and treats of the Waters above the Heavens, the extent of Heaven and of Meteors (which the Pſalmiſt ſeemeth to intend by the Waters above) as namely of Clouds, Winds, Whirl-winds, Lightnings. The third part begins at *Verſe* 6. and doth celebrate the Earth as the foundation of all thoſe things which he here conſidereth. For he referreth all things to the Earth, and to thoſe Animals which inhabit it, for that in the judgment of Sight the two principal parts of the World are Heaven and Earth. He therefore here obſerveth that the Earth after ſo many Ages hath not faltered, tired, or decayed; when as notwithſtanding no man hath yet diſcovered upon what it is founded. He goeth not about to teach men what they do not know, but putteth them in minde of what they neglect, to wit, the Greatneſſe and Power of God in creating ſo huge a Maſs ſo firm and ſtedfaſt. If an Aſtronomer ſhould teach that the Earth is placed among the Planets, he

overthroweth not what the Pſalmiſt here ſaith, nor doth he contradict Common Experience; for it is true notwithſtanding, that the Earth, the Structure of God its Architect, doth not decay (as our Buildings are wont to do) by age, or conſume by wormes, nor ſway and leane to this or that ſide; that the Seats and Neſts of Living Creatures are not moleſted; that the Mountains and Shores ſtand immoveable againſt the violence of the Winds and Waves, as they were at the beginning. But the Pſalmiſt addeth a moſt Elegant Hypotheſis of the Separation of the Waters from the Continent or Main-land, and adorns it with the production of Fountains, and the benefits that Springs and Rocks exhibit to Birds and Beaſts. Nor doth he omit the apparelling the Earths Surface, mentioned by *Moſes* amongſt the works of the third Day, but more ſublimely deſcribeth it in his Caſe in expreſſions infuſed from Divine Inſpiration; and flouriſheth out the commemoration of the many commodities which redound from that Exornation for the Nouriſhment and Comfort of Man, and * Covert of Beaſts. The fourth part begins at *Verſe* 20. celebrating the fourth dayes work, *viz.* The Sun and Moon, but chiefly the commodiouſneſſe of thoſe things, which in their Seaſons befall to all Living Creatures and to Man; this being the ſubject matter of his Diſcourſe: So that it plainly appeareth he acted not the part of an Aſtronomer. For if he had, he would not then have omitted to mention the five Planets, than whoſe motion nothing is more admirable, nothing more excellent, nothing that can more evidently ſet forth the Wiſdome of the Creator amongſt the Learned. The fifth part begins, *Verſe* 25. with the fifth Dayes work. And it ſtores the Seas with Fiſhes, and covers them with Ships. The ſixth part is more obſcurely hinted at, *Verſe* 28. and alludeth to the Land-Creatures that were created the ſixth day. And laſtly, he declareth the goodneſſe of God in general, who daily createth and preſerveth all things? So that whatever he ſaid of the World is in relation to Living Creatures; He ſpeaks of nothing but what is granted on all hands; for that it was his intent to extol things known, and not to dive into hidden matters, but to invite men to contemplate the Benefits that redouud unto them from the works of each of theſe dayes.

* Shelter.

And I do alſo beſeech my Reader, not forgetting the Divine Goodneſſe conferred on Mankind; the conſideration of which the Pſalmiſt doth chiefly urge, that when he returneth from the Temple, and enters into the School of *Aſtronomy*, he would with me praiſe and admire the Wiſdome and Greatneſſe of the Creator, which I diſcover to him by a more narrow explication of the Worlds Form, the Diſquiſition of Cauſes, and Detection of

of the Errours of Sight: And ſo he will not onely extoll the Bounty of God in the preſervation of Living Creatures of all kindes, and eſtabliſhment of the Earth; but even in its Motion alſo, which is ſo ſtrange, ſo admirable, he will acknowledge the Wiſdome of the Creator. But he who is ſo ſtupid as not to comprehend the Science of *Aſtronomy*, or ſo weak and ſcrupulous as to think it an offence of Piety to adhere to *Copernicus*, him I adviſe, that leaving the Study of *Aſtronomy*, and cenſuring the opinions of Philoſophers at pleaſure, he betake himſelf to his own concerns, and that deſiſting from further purſuit of theſe intricate Studies, he keep at home and manure his own Ground; and with thoſe Eyes wherewith alone he ſeeth, being elevated towards this to be admired Heaven, let him pour forth his whole heart in thanks and praiſes to God the Creator; and aſſure himſelf that he ſhall therein perform as much Worſhip to God, as the *Aſtronomer*, on whom God hath beſtowed this Gift, that though he ſeeth more clearly with the Eye of his Underſtanding; yet whatever he hath attained to, he is both able and willing to extoll his God above it.

And thus much concerning the Authority of Sacred Scripture. Now as touching the opinions of the Saints about theſe Natural Points. I anſwer in one word, That in Theology the weight of Authority, but in Philoſophy the weight of Reaſon is to be conſidered. Therefore Sacred was *Lactantius*, who denyed the Earths rotundity; Sacred was *Auguſtine*, who granted the Earth to be round, but denyed the *Antipodes*; Sacred is the *Liturgy of our Moderns, who admit the ſmallneſſe of the Earth, but deny its Motion: But to me more ſacred than all theſe is Truth, who with reſpect to the Doctors of the Church, do demonſtrate from Philoſophy that the Earth is both round, circumhabited by *Antipodes*, of a moſt contemptible ſmalneſſe, and in a word, that it is ranked amongſt the Planets.

* Officium

AN ABSTRACT OF

Some passages in the Commentaries of

Didacus à Stunica, OF SALAMANCA

Upon JOB:

The Toledo Edition, Printed by *JOHN RODERICK*, *Anno* 1584, in *Quarto*, Pag. 205. & *seqq.* on these Words, Chap. 9. Verse 6.

Who shaketh the Earth out of her place, and the Pillars thereof Tremble.

THe Sacred Pen-man here sets down another effect whereby God sheweth his Almighty Power, joyned with infinite Wisdom. Which place, though it must be confessed very difficult to understand, might be greatly cleared by the Opinion of the *Pythagorians*, who hold the Earth to be moved of its own Nature, and that the Motion of the Stars can no other way be ascertained, they being so extreamly different in tardity and velocity. Of which judgement was *Philolaus*, and *Heraclides Ponticus*, as *Plutarch* relateth in his Book *De Placitis Philosophorum*: Who were followed by *Numa Pompilius*, and, which I more regard, The Divine *Plato* in his old age; insomuch that he affirmed that it was most absurd to think otherwise, as the same *Plutarch* tells us in his * *Numa*. And *Hypocrates* in his Book *De Flatibus*, calleth the Air τὸ γηΐνιχιον, *i. e.* The Earths Chariot. But in this our

* *In vita ejus.*

our Age, *Copernicus* doth demonſtrate the courſes of the Planets to be according to this Opinion. Nor is it to be doubted but that the Planets Places may be more exactly and certainly aſſigned by his Doctrine, than by *Ptolomies* Great Almogeſt or Syſteme, or the Opinions of any others. For its manifeſt, that *Ptolomy* could never deſcribe either the Motion of the Equinoxes, or aſſign the certain and poſitive beginning of the Year: the which he ingeniouſly confeſſeth in *Lib.* 3. *De Almageſt. Magnum. Ch.* 2. and which he leaveth to be diſcovered in after times by thoſe Aſtronomers, who coming into the World much later than he, might be able to invent ſome way to make more accurate obſervations. And although the * *Alphonſines* & *Thebith Ben Core* have attempted to explain them; yet it appeareth that they have done as much as nothing. For the Poſitions of the *Alphonſines* diſagree amongſt themſelves, as *Ricius* proveth. And although the Reaſon of *Thebith* be more acute, and that thereby he determined the certain beginning of the year, (being that which *Ptolomy* ſought for) yet it is now clear, that the Progreſſions of the Equinoxes are much longer than he conceived they could be. Moreover, the Sun is found to be much nearer to us than it was held to be in times paſt, by above fourty thouſand * *Stadia*, or furlongs. The Cauſe and Reaſon of whoſe Motion, neither *Ptolomy* nor any other Aſtrologers could ever comprehend: And yet the Reaſons of theſe things are moſt plainly explained and demonſtrated by *Copernicus* from the Motion of the Earth, with which he ſheweth that all the other *Phænomena* of the Univerſe do more aptly accord. Which opinion of his is not in the leaſt contradicted by what *Solomon* ſaith in * *Eccleſiaſtes*: *But the Earth abideth for ever.* For that Text ſignifieth no more but this, That although the ſucceſſion of Ages, and generations of Men on Earth, be various; yet the Earth it ſelf is ſtill one and the ſame, and continueth without any ſenſible alteration; For the words run thus: *One Generation paſſeth away, and another Generation cometh; but the Earth abideth for ever.* So that it hath no coherence with its Context, (as Philoſophers ſhew) if it be expounded to ſpeak of the Earths immobility. And although in this Chapter *Eccleſiaſtes*, and in many others, Holy Writ aſcribes Motion to the Sun, which *Copernicus* will have to ſtand fixed in the Centre of the Univerſe; yet it makes nothing againſt his Poſition. For the Motion that belongs to the Earth, is by way of ſpeech aſſigned to the Sun, even by *Copernicus* himſelf, and thoſe who are his followers, ſo that the Revolution of the Earth is often by them phraſed, The Revolution of the Sun. To conclude, No place can be produced out of Holy Scripture, which ſo clearly ſpeaks the Earths Immobility, as this doth its Mo-

* Followers of that Learned Kings Hypotheſis.

* That is 5000 miles; eight of theſe making an *Italian*, or *Engliſh* mile of a 1000. paces, every pace containing 5. Feet.

* Chap. 1. v. 4.

The Motion of the Earth, not againſt Scripture.

Mobility. Therefore this Text, of which we have ſpoken, is eaſily reconciled to this Opinion. And to ſet forth the Wonderful power and Wiſdome of God, who can indue and actuate the Frame of the Whole Earth (it being of a monſtrous weight by Nature) with Motion, this our Divine pen-man addeth; *And the pillars thereof tremble:* As if he would teach us, from the Doctrine laid down, that it is moved from its Foundations.

AN

EPISTLE

Of the Reverend Father

PAOLO ANTONIO FOSCARINI,

A CARMELITE;

Concerning

The PYTHAGORIAN and COPERNICAN Opinion

OF

The Mobility of the EARTH,

AND

Stability of the SUN;

AND

Of the New Syſteme or Conſtitution

OF THE

WORLD.

IN WHICH,

The Authorities of SACRED SCRIPTURE, and ASSERTIONS of DIVINES, commonly alledged againſt this Opinion, are Reconciled.

WRITTEN

To the moſt Reverend FATHER,

SEBASTIANO FANTONI,

General of the Order of CARMELITES.

Engliſhed from the Original,

BY

THOMAS SALUSBURIE.

Si quis indiget ſapientia, poſtulet à Deo. Jacobi 1. verſu. 5.

Optavi, & datus eſt mihi ſenſus.

Sapientiæ 7. verſu. 7.

LONDON,

Printed by WILLIAM LEYBOURN, MDCLXI.

To the Moſt

Reverend Father

SEBASTIANO FANTONI;

General of the Order of

CARMELITES.

IN obedience to the command of the Noble *Signore Vincenzo Carraffa*, a Neapolitan, and Knight of S. *John of Jeruſalem*, (a perſon, to ſpeak the truth, of ſo great Merit, that in him Nobility of Birth, Affability of Manners, Univerſal knowledge of Arts and things, Piety and Vertue do all contend for prehemiſnence) I reſolved with my ſelf to undertake the Defence of the Writings of the New, or rather Renewed, and from the Duſt of Oblivion (in which it hath long lain hid) lately Revived Opinion, *Of the Mobility of the Earth, and Stability of the Sun*, in times paſt found out firſt by *Pythagoras*, and at laſt reduced into Practice by *Copernicus*; who likewiſe hath deduced the Poſition of the Syſteme and Conſtitution of the World and its parts from that Hypotheſis: on which Subject I have formerly writ to You, Moſt Reverend Sir: But in regard I am bound for *Rome* to preach there by your Command; and ſince this Speculation may ſeem more proper for another Treatiſe, to wit, a Volume of *Coſmography*, which I am in hand with, and which I am daily buſie about, that it may come forth in company with my *Compendium of the Liberal Arts*, which I have already finiſhed, rather than now to diſcuſs it by it ſelf, I thought to forbear, imparting what I have done for the preſent; Yet I was deſirous to give, in the mean time, a brief account of this my Determination, and to ſhew You, Moſt Reverend Father, (to whom I owe all my indeavours, and my very ſelf) the Foundations on which this Opinion may be grounded, leaſt, whilſt otherwiſe it is favoured with much probability, it be found in reality to be extreamly repugnant (as at firſt ſight it

ſeems) not onely to Phyſical Reaſons, and Common Principles received on all hands (which cannot do ſo much harm) but alſo (which would be of far worſe conſequence) to many Authorities of ſacred Scripture: Upon which account many at their firſt looking into it, explode it as the moſt fond Paradox and Monſtrous *Capriccio* that ever was heard of. Which thing proceeds only from an antiquated and long confirmed Cuſtome, which hath ſo hardened men in, and habituated them to Vulgar, Plauſible, and for that cauſe by all men (aſwell learned as unlearned) Approved Opinions, that they cannot be removed one ſtep from them: So great is the force of Cuſtome (which not unfitly is ſtiled a ſecond Nature) prevailing over the whole World, that touching things men are rather pleaſed with, delighted in, and deſirous of thoſe, which, though evil and obnoxious, are by uſe made familiar to them, than ſuch, wherewith, though better, they are not accuſtomed and acquainted. So in like manner, and that chiefly, in *Opinions*, which when once they are rooted in the Mind, men ſtart at, and reject all others whatſoever; not only thoſe that are contrary to, but even all that ever ſo little diſagree with or vary from theirs, as harſh to the Ear, diſcoloured to the Eye, unpleaſant to the Smell, nauſeous to the Taſt, rough to the Touch. And no wonder: For Phyſical Truths are ordinarily judged and conſidered by men, not according to their Eſſence, but according to the preſcript of ſome one whoſe deſcription or definition of them gaines him Authority amongſt the vulgar. Which authority nevertheleſs (ſince 'tis no more than humane) ought not to be ſo eſteemed, as that that which doth manifeſtly appear to the contrary, whether from better Reaſons lately found out, or from Senſe it ſelf, ſhould for its ſake be contemned and ſlighted; Nor is Poſterity ſo to be confined, but that it may, and dares, not only proceed farther, but alſo bring to light better and truer Experiments than thoſe which have been delivered to us by the Ancients. For 'the *Genius's* of the Antients, as in Inventions they did not much ſurpaſs the Wits of our times; ſo for the perfecting of Inventions this Age of ours ſeems not only to equal, but far to excell former Ages; Knowledge, whether in the Liberal or Mechanical Arts, daily growing to a greater height. Which Aſſertion might be eaſily proved, were it not that in ſo clear a caſe, there would be more danger of obſcuring, than hopes of illuſtrating it with any farther light.

But (that I may not wholly be ſilent in this point) have not the ſeveral Experiments of Moderns, in many things, ſtopped the mouth of Venerable Antiquity, and proved many of their greateſt and weightieſt Opinions, to be vain and falſe? The Doctrine

of

of the *Antipodes* by many of the Antients of approved Wisdome and Learning was held a Paradox no less absurd than this Our Opinion of the *Earths Motion* may seem to be; as likewise that of the *Habitableneſſe of the Torrid Zone*: Of these Opinions, the first was accounted unpossible by many, but the latter was absolutely denyed by the unanimous consent of all: But later Authors (to the great felicity and perpetual Glory of their Age) have, not so much by Authority, as by accurate diligence and indefatigable study to finde out the truth, proved them both to be undoubtedly true. Thus I affirm that the Antients were deceived, and that in too lightly challenging Credid and Authority for their Inventions, they discovered too much folly. Here for brevities sake I pass by many Dreams lately detected, both of *Aristotle* and other of the antient Philosophers; who in all likelihood if they had dived into the Observations of Modern Writers, and understood their Reasons, would, by changing their Judgements, have given them the precedency, and would have subscribed to their manifest Truth. Hereby we see that we are not to have so high a respect for the Antiens, that whatever they assert should be taken upon trust, and that Faith should be given to their sayings, as if they were Oracles and Truths sent down from Heaven. But yet (which indeed is chiefly to be regarded in these matters) if any thing be found out that is repugnant to Divine Authority, or to the Sacred Leaves, that were dictated by the Holy Ghost, and by His Inspiration expounded by the Holy Doctors of the Church, in this case not onely Humane Reason, but even Sense it self is to submitt: which, though by all manner of weighty Conditions and circumstances it should hold forth any thing contrary to Divine Authority, (which indeed is so plain, that there is no way left to evade the right understanding of it) yet is it to be rejected; and we must conclude our selves deceived by it, and believe that that is not true which Sense and Reason represents unto us: For, however we judge of things, we have, both in this and all other cases, a more certain knowledge, which proceeds from Divine Faith; as S. *Peter* hath most excellently expresst it: Who though with his Senses he saw, and perceived the Glory of our Lord in his Transfiguration, and heard his words manifesting his great Power; yet nevertheless all these things compared with the Light of Faith, he adds: **We have also a more sure word of* Prophecy, &c. Wherefore since this Opinion of *Pythagoras* and *Copernicus* hath entred upon the Stage of the World in so strange a Dress, and at the first appearance (besides the rest) doth seem to oppose sundry Authorities of Sacred Scripture, it hath (this being granted) been justly rejected of all men as a meer absurdity.

Faith is more certain, than either Sense or Reason.

* 2 Pet. 1. 19.

But yet becauſe the common Syſteme of the World deviſed by *Ptolemy* hath hitherto ſatisfied none of the Learned, hereupon a ſuſpicion is riſen up amongſt all, even *Ptolemy's* followers themſelves, that there muſt be ſome other Syſteme, which is more true than this of *Ptolemy*; For although the *Phænomena* of Celeſtial Bodys may ſeem to be generally reſolved by this Hypotheſis, yet they are found to be involved with many difficulties, and referred to many devices; as namely, of Orbes of ſundry Forms and Figures, Epicicles, Equations, Differences, Excentricks, and innumerable ſuch like fancies and Chymæra's which ſavour of the *Ens Rationis* of Logicians, rather than of any *Realem Eſſentiam*. Of which kinde is that of the *Rapid Motion*, than which I finde not any thing that can be more weakly grounded, and more eaſily controverted and diſproved: And ſuch is that conceit of the * Heaven void of Stars, moving the inferior Heavens or Orbes: All which are introduced upon occaſion of the variety of the Motions of Celeſtial Bodyes, which ſeemed impoſſible, by any other way, to be reduced to any certain and determinate Rule. So that the Aſſertors of that common Opinion, freely confeſs, that in deſcribing the Worlds Syſteme, they cannot as yet diſcover, or teach the true Hypotheſis thereof: But that their endeavours are onely to finde out, amongſt many things, what is moſt agreeable with truth, and may, upon better and more accomodate Reaſons, anſwer the Celeſtial *Phænomena*.

* Or *Primum Mobile.*

Since that, the Teleſcope (an Optick Invention) hath been found out, by help of which, many remarkable things in the Heavens, moſt worthy to be known, and till then unthought of, were diſcovered by manifeſt ſenſation; as for inſtance, That the Moon is Mountainous; *Venus* and *Saturn* Tricorporeal; and *Jupiter* Quadricorporeal: Likewiſe that in the *Via Lactea*, in the *Pleiades*, and in the Stars called *Nebuloſæ* there are many Stars, and thoſe of the greateſt Magnitude which are by turns adjacent to one another; and in the end it hath diſcovered to us, new fixed Stars, new planets, and new Worlds. And by this ſame Inſtrument it appears very probable, that *Venus* and *Mercury* do not move properly about the Earth, but rather about the Sun; and that the Moon alone moveth about the Earth. What therefore can be inferred from hence, but that the Sun doth ſtand immovable in the Centre, and that the Earth, with the other Celeſtial Orbes, is circumvolved about it? Wherefore by this and many other Reaſons it appears, That the Opinion of *Pythagoras* and *Copernicus* doth not diſagree with Aſtronomical and Coſmographical Principles; yea, that it carryeth with it a great likelihood and probability of Truth: Whereas amongſt the ſo many ſeveral Opinions, that deviate from the common Syſteme, and deviſe others,

others, such as were those of *Plato*, *Calippus*, *Endoxus*; and since them of *Averroe*, * *Cardanus*, *Fracastorius*, and others both Antient and Modern, there is not one found that is more facile, more regularly and determinately, accommodated to the *Phænomena* and Motions of the Heavens, without *Epicycles*, *Excentrix*, *Homocentricks* Deferents, and the supputation of the Rapid Motion. And this Hypothesis hath been asserted for true, not onely by *Pythagoras*, and, after him, by *Copernicus*, but by many famous men, as namely, *Heraclitus*, and *Ecphantus*, *Pythagoreans*, all the Disciples of that Sect, *Miceta* of *Syracuse*, *Martianus Capella*, and many more. Amongst whom, those (as we have said) that have attempted the finding out of New Systemes (for they refused both this of *Pythagoras*, and that of *Ptolemy*) are numberless: who yet notwithstanding allowed this Opinion of *Pythagoras* to carry with it much probability, and indirectly confirmed it; inasmuch as that they rejected the common one as imperfect, defective, and attended with many contradictions and difficulties. Amongst these may be numbered Father * *Clavius*, a most learned Jesuite; who, although he refutes the Systeme of *Pythagoras*, yet acknowledgeth the Levity of the common Systeme, and he ingeniously confesseth, that for the removal of difficulties, in which the common Systeme will not serve the turn, Astronomers are forced to enquire after another Systeme, to the discovery of which, he doth very earnestly exhort them.

* Cardan. de rerum var. ist. Lib. 1. Cap. 1.

* P. Clavius in ultima suor. Operum editione.

Now can there a better or more commodious Hypothesis be devised, than this of *Copernicus*, ? For this Cause many Modern Authors are induced to approve of, and follow it: but with much hæsitancy, and fear, in regard that it seemeth in their Opinion so to contradict the Holy Scriptures, as that it cannot possibly be reconciled to them. Which is the Reason that this Opinion hath been long suppresst, and is now entertained by men in a modest manner, ad as it were with a veiled Face; according to that advice of the Poet:

Judicium populi nunquam contempseris unus,
Ne nullis placeas, dum vis contemnere multos.

Upon consideration of which, (out of my very great love towards the Sciences, and my ardent desire to see the encrease and perfection of them, and the Light of Truth freed from all Errours and Obscurities) I began to argue with my self touching this Point after this manner: This Opinion of the *Pythagoreans* is either true, or false; If false, it ought not to be mentioned, and deserves not to be divulged: If true, it matters not, though it contradict all, as well Philosophers as Astronomers: And though for its establishment and reducement to use a new Philosophy and

and Aſtronomy, (founded upon new Principles and Hypotheſe) ſhould be conſtituted: For the Authority of Sacred Scripture will not oppoſe it; neither doth one Truth contradict another. If therefore the Opinion of *Pythagoras* be true, without doubt God hath diſpoſed and dictated the words of of Holy Writ in ſuch a manner, that they may admit an apt ſenſe and reconciliation with that Hypotheſis. Being moved by theſe Reaſons, and the probability of the ſaid Opinion, I thought good to try whether Texts of Sacred Scripture might be expounded according to Theological and Phyſical Principles, and might be reconciled to it, ſo that (in regard that hitherto it hath been held probable) it may in after times, coming without ſcruple to be acknowledged for true, advance it ſelf, and appear in publick with an uncovered Face, without any mans prohibition, and may lawfully and freely hold a Sacred intelligence with Holy Truth, ſo earneſtly coveted and commended by good Men. Which deſigne, having hitherto been undertaken by none that I know, will, I am perſwaded, be very acceptable to the Studious of theſe Learnings, eſpecially to the moſt Learned *Galilæo Galilæi*, chief Mathematician to the moſt Serene Grand Duke of *Tuſcany*, and *John Kepler*, chief Mathematician to his Sacred and invincible Majeſty, the Emperour, and to all that Illuſtrious, and much to be commended Academy of the *Lynceans*; whom, if I miſtake not, are all of this Opinion. Although I doubt not but they, and many other Learned Men might eaſily have found out theſe or the like Reconciliations of Scriptural expreſſions; to whom nevertheleſs I have thought fit (in reſpect of that profeſſion which I have undertaken, upon the faith of my ſoul, and the propenſity that I have towards Truth) to offer that of the Poet,

The Author firſt Theologically defends the Earths Mobility, approved by many of the Moderns.

Nullius addictus jurare in verba Magiſtri.

And in teſtimony of my eſteem to them and all the Learned, to communicate theſe my thoughts; confidently aſſuring my ſelf that they will accept them, with a Candor equal to that wherewith I have written them.

Therefore to come to the buſineſs: All Authorities of Divine Writ which ſeem to oppoſe this Opinion, are reducible to ſix Claſſes: The firſt is of thoſe that affirm the Earth to ſtand ſtill, and not to move: as *Pſal.* 92. *He framed the round World ſo ſure, that it cannot be moved*: Alſo *Pſal.* 104. *Who laid the Foundations of the Earth, that it ſhould not be removed for ever*: And *Eccleſiaſtes* 1. *But the Earth abideth for ever*: And others of the like ſenſe.

The ſecond is of thoſe which atteſt the Sun to move, and Revolve

Revolve about the Earth; as *Pſal.*19. (*b*) *In them hath he ſet a Tabernacle for the Sun, which cometh forth as a Bridegroom out of his chamber, and rejoyceth as a Gyant to run his Courſe. It cometh forth from the uttermoſt part of the Heaven, and runneth about unto the end of it again; and there is nothing hid from the heat thereof.* And *Eccleſiaſt.*1. *The Sun riſeth, and the Sun goeth down, and haſteth to the place where he aroſe: it goeth towards the South, and turneth about unto the North.* Whereupon the Suns Retrogradation is mentioned as a Miracle, *Iſaiah* 38. *The Sun returned ten degrees.* And *Eccleſiaſticus* 48. *In his time the Sun went backward, and lengthened the life of the King.* And for this reaſon it is related for a Miracle, in the Book of *Joſhuah*, that at the Prayers of that great Captain the Sun ſtood ſtill, its motion being forbidden it, by him: *Joſh.*10. *Sun ſtand thou ſtill upon Gibeon.* Now if the Sun ſhould ſtand ſtill, and the Earth move about it, its ſtation at that time was no Miracle; and if *Joſhuah* had intended, that the light of the day ſhould have been prolonged by the Suns ſplendour, he would not have ſaid, *Sun ſtand thou ſtill*, but rather *Earth ſtand thou ſtill.*

(*b*) *Or* In Sole poſuit tabernaculum ſuum, *according to the Tranſlation our Author followeth.*

The third Claſſis is of thoſe Authorities which ſay, that Heaven is *above*, and the Earth *beneath*; of which ſort is that place of *Joel*, *chap.*2. cited by S. *Peter*, in *Acts.*2. *I will ſhew wonders in Heaven above, and ſignes in the Earth beneath*, with others of the like purport. Hereupon Chriſt at his Incarnation is ſaid to *come down from Heaven*; and after his Reſurrection to have *aſcended up into heaven.* But if the Earth ſhould move about the Sun, it would be, as one may ſay, in Heaven, and conſequently would rather be *above* Heaven than *beneath* it. And this is confirmed; For that the Opinion which placeth the Sun in the Centre, doth likewiſe place *Mercury* above the Sun, and *Venus* above *Mercury*; and the Earth above *Venus*, together with the Moon, which revolves about the Earth, and therefore the Earth, together with the Moon, is placed in the third Heaven. If therefore in Spherical Bodies, as in the World, *beneath* ſignifies no more than to be neer to the centre, and *above*, than to approach the Circumference, it muſt needs follow, that for making good of Theological Poſitions concerning the Aſcenſion and Deſcenſion of Chriſt, the Earth is to be placed in the centre, and the Sun, with the other Heavens in the Circumference; and not according to *Copernicus*, whoſe Hypotheſis inverts this Order: with which one cannot ſee how the true Aſcenſion and Deſcenſion can be conſiſtent.

In Spherical Bodies, Deorſum *is the Centre, and* Surſum *the Circumference.*

The fourth Claſſis is of thoſe Authorities which make Hell to be in the Centre of the World, which is the Common Opinion of Divines, and confirmed by this Reaſon, That ſince Hell (taken

ken in its ſtrict denomination) ought to be in the loweſt part of the World, and ſince that in a Sphere there is no part lower then the Centre, Hell ſhall be, as it were, in the Centre of the World, which being of a Spherical Figure, it muſt follow, that Hell is either in the Sun (foraſmuch as it is ſuppoſed by this Hypotheſis to be in the Centre of the World) or elſe ſuppoſing that Hell is in the Centre of the Earth, if the Earth ſhould move about the Sun, it would neceſſarily enſue, that Hell, together with the Earth, is in Heaven, and with it revolveth about the third Heaven; than which nothing more abſurd can be ſaid or imagined.

Hell is in the centre of the Earth, not of the World.

The fifth Claſſis, is of thoſe Authorities which alwayes oppoſe Heaven to the Earth, and ſo again the Earth to Heaven; as if there were the ſame relation betwixt them, with that of the Centre to the Circumference, and of the Circumference to the Centre. But if the Earth were in Heaven, it ſhould be on one ſide thereof, and would not ſtand in the Middle, and conſequently there would be no ſuch relation betwixt them; which nevertheleſs do not only in Sacred Writ, but even in Common Speech, ever and every where anſwer to each other with a mutual Oppoſition. Whence that of *Geneſ.* 1. *In the beginning God created the Heaven and the Earth*: and *Pſal.* 115. *The Heaven, even the Heavens are the Lords; but the Earth hath he given to the Children of men*: and our Saviour in that Prayer which he preſcribeth to us, *Matth.* 6. *Thy will be done in Earth, as it is in Heaven*: and S. *Paul*, 1 *Corinth.* 15. *The firſt man is of the* Earth, *earthy; the ſecond man is of Heaven, heavenly*: and *Coloſſ.* 1. *By him were all things created that are in Heaven, and that are in* Earth: and again, *Having made peace through the Blood of his Croſſe for all things, whether they be things in* Earth *or things in Heaven*: and *Chap.* 3. *Set your affections on things above, not on things on the* Earth; with innumerable other ſuch like places. Since therefore theſe two Bodies are alwayes mutually oppoſed to each other, and Heaven, without all doubt, referreth to the Circumference, it muſt of neceſſity follow, that the Earth is to be adjudged the place of the Centre.

Heaven and Earth are always mutually oppoſed to each other.

The ſixth and laſt Claſſis is of thoſe Authorities, which (being rather of Fathers and Divines, than of the Sacred Scripture) ſay, That the Sun, after the day of Judgment ſhall ſtand immoveable in the Eaſt, and the Moon in the Weſt. Which Station, if the *Pythagorick* Opinion hold true, ought rather to be aſcribed to the Earth, than to the Sun; for if it be true, that the Earth doth now move about the Sun, it is neceſſary that after the day of Judgment it ſhould ſtand immoveable. And truth is, if it muſt ſubſiſt without motion in one conſtant place, there is no reaſon why

After the day of Judgment the Earth ſhall ſtand immoveable.

why it ſhould rather ſtand in one ſite of that Place than in another, or why it ſhould rather turn one part of it than another to the Sun, if ſo be that every of its parts without diſtinction, which is deſtitute of the Suns light, cannot chooſe but be diſmal, and much worſe affected than that part which is illuminated. Hence alſo would ariſe many other abſurdities beſides theſe.

Theſe are the Claſſes, &c. from which great aſſaults are made againſt the ſtructure of the Pythagorick Syſteme; yet by that time I ſhall have firſt laid down ſix Maximes or Principles, as impregnable Bulwarks erected againſt them, it will be eaſie to batter them, and to defend the Hypotheſis of *Pythagoras* from being attaqued by them. Which before I propound, I do profeſs (with that Humility and Modeſty which becometh a Chriſtian, and a perſon in Religious Orders) that I do with reverence ſubmit what I am about to ſpeak to the Judgment of Holy Church. Nor have I undertaken to write theſe things out of any inducements of Temerity, or Ambition, but out of Charity and a Deſire to be auxiliary to my neighbour in his inquiſition after Truth. And there is nothing in all this Controverſie maintained by me (that expect to be better inſtructed by thoſe who profeſs theſe Studies) which I ſhall not retract, if any perſons ſhall by ſolid Reaſons & reiterated Experiments, prove ſome other Hypotheſis to be more probable; but yet, until ſuch time as they ſhall decide the Point, I ſhall labour all I can for its ſupport.

My firſt and chiefeſt Maxime is this; When any thing is attributed in Holy Writ, to God, or to a Creature, thats not beſeeming to, or incommenſurate with them, it muſt of neceſſity be received and expounded one, or more of the four following wayes; Firſt, it may be ſaid to agree with them *Metaphorically, and Proportionally, or by Similitude.* Secondly, *According to our manner of Conſidering, Apprehending, Conceiving, Underſtanding, Knowing, &c.* Thirdly, *according to the Opinion of the Vulgar, and the Common way of Speaking:* to which Vulgar Speech the Holy Ghoſt doth very often with much ſtudy accomodate it ſelf. Fourthly, *In reſpect of our ſelves, and for that he makes himſelf like unto us.* Of each of theſe wayes there are theſe examples: God doth not walk, ſince he is Infinite and Immoveable; He hath no Bodily Members, ſince he is a Pure Act; and conſequently is void of all Paſſion of Minde; and yet in Sacred Scripture, *Gen. 3. verſ. 8.* it is ſaid, *He walked in the cool of the day*: and *Job 22. verſ. 14.* it is ſaid, *He walketh in the* * *Circuit of Heaven*: and in many other places coming, departing, making haſt is aſcribed to God; and likewiſe Bodily parts, as Eyes, Ears, Lips, Face, Voice, Countenance, Hands, Feet, Bowels, Garments, Arms; as alſo many Paſſions, ſuch as Anger,

* Circa Cardines Cœli.

Sorrow, Repentance, and the like. What ſhall we ſay therefore? Without doubt ſuch like Attributes agree with God (to uſe the Schoolmens words *Metaphorically*, *Proportionally*, *and by Similitude*: And touching Paſſions, it may be ſaid, that God condeſcendeth to repreſent himſelf after that manner: as for inſtance, *The Lord is angry*; i.e. *He revealeth himſelf as one that is angry: He grieved*; i.e. *He revealeth himſelf, as one that is ſorrowful*: *It repented him that he had made man*; i.e. *He ſeemed as one that repented.* And indeed all theſe things are *Comparativè ad nos*, and in reſpect of us. So God is ſaid to be in Heaven, to move in time, to ſhew himſelf, to hide himſelf, to obſerve and mark our ſteps; to ſeek us, to ſtand at the door, to knock at the door; not that he can be contained in a bodily place, nor that he is really moved, nor in time; nor that humane manners or cuſtomes can agree with him, ſave only according to our manner of Apprehenſion: This Conception of ours orderly diſtinguiſheth theſe Attributes in him one from another, when, notwithſtanding, they are one and the ſame with him: This Apprehenſion of ours divideth alſo his actions into ſeveral times, which, nevertheleſſe, for the moſt part, are produced in one and the ſame inſtant: And this, to conclude, alwayes apprehendeth thoſe things with ſome defect, which, notwithſtanding are in God moſt perfect. For this reaſon doth the Sacred Scripture expreſs it ſelf *according to the Vulgar Opinion*, whilſt it aſcribes to the Earth Ends and Foundations, which yet it hath not; to the Sea a Depth not to be fathomed; to Death (which is a Privation, and conſequently a Non-entity) it appropriates Actions, Motion, Paſſions, and other ſuch like Accidents, of all which it is deprived, as alſo Epithites and Adjuncts, which really cannot ſuit with it: *Is not the bitterneſſe of Death paſt?* 1 Sam. 15. 32. *Let death come upon them*, Pſal 6. *He hath prepared the Inſtruments of Death*, Pſal. 7. 14. *Thou raiſeſt me from the gates of Death*, Pſal. 84. *In the midſt of the ſhadow of Death*, Pſal. 23. *Love is ſtrong as Death*, Cant. 8. 9. *The Firſt-Born of Death*, Job 18. 13. *Deſtruction and Death ſay, &c.* Job 28. 22. And who knows not that the whole Hiſtory of the rich Glutton doth conſiſt of the like phraſes of *Vulgar Speech*? So *Eccleſiaſticus*, Chap. 27. verſ. 11. *The godly man abideth in wiſdome, as the Sun*; *but a fool changeth as the Moon*; and yet the Moon according to the real truth of the matter no wayes changeth, but abides the ſame for ever, as *Aſtronomers* demonſtrate; one half thereof remaining alwayes lucid, and the other alwayes opacous. Nor at any time doth this ſtate vary in it, unleſſe *in reſpect of us*, and *according to the opinion of the Vulgar.* Hence it is cleer, that the holy Scripture ſpeaks according to the common form of ſpeech uſed

Luke 16.

ſed amongſt the unlearned, and according to the appearance of things, and not according to their true Exiſtence. In like manner *Geneſ.* 1. in the deſcription of the Creation of all things, the Light is ſaid to be made firſt of all, and yet it followeth in the Text, *And the Evening and the Morning made the firſt day*: and a little after the ſeveral Acts of the Creation are diſtinguiſhed and aſſigned to ſeveral days, and concerning each of them it is ſaid in the Text, *And the Evening and the Morning made the ſecond day*; and then *the third day, the fourth day, &c.* Hence many doubts ariſe, all which I ſhall propound according to the common Syſteme, that it may appear even from the *Hypotheſis* of that Syſteme, that the ſacred Scripture ſometimes, for the avoyding of emergent difficulties, is to be underſtood in a vulgar ſenſe and meaning, and in reſpect of us, and not according to the nature of things. Which diſtinction even *Ariſtotle* himſelf ſeemeth to have hinted, when he ſaith, * *Some things are more intelligible to us*; *others by nature*, or *ſecundum ſe*.

Alia ſunt notiora nobis, alia, notiora natura, vel ſecundum ſe, *Ariſt. lib.* 1. *Phyſ.*

Firſt therefore; If the light were made before heaven, then it rolled about without heaven to the making of the diſtinction of Day and Night. Now this is contrary to the very doctrine of theſe men, who affirm that no Cœleſtial Body can be moved unleſſe *per accidens*, and by the motion of Heaven, *and as a knot in a board at the motion of the board.* Again, if it be ſaid, that the Light was created at the ſame time with Heaven, and began to be moved with Heaven, another doubt ariſeth, that likewiſe oppoſeth the foreſaid common *Hypotheſis*: For it being ſaid, that Day and Night, Morning and Evening were made, that ſame is either in reſpect of the Univerſe, or onely in reſpect of the Earth and us. If ſo be that the Sun turning round (according to the *Hypotheſis* of the Common Syſteme) doth not cauſe the Night and Day, but only to opacous Bodies which are deſtitute of all other light, but that of the Sun, whilſt in their half part (which is their *Hemiſphære*) and no more, (for that the Suns light paſſeth over but one half of an opacous Body, unleſs a very ſmall matter more in thoſe of leſſer bulk) they are illuminated by the Suns aſpect, the other half remaining dark and tenebroſe, by reaſon of a ſhadow proceeding from its own Body. Therefore the diſtinction of dayes by the light of heaven, according to the deſcription of them in the ſacred Scriptures, muſt not be underſtood *abſolutely*, and *ſecundum ſe*, and *Nature her ſelf*; but in reſpect of the Earth, and of us its inhabitants, and conſequently *ſecundum nos*. 'Tis not therefore new, nor unuſual in ſacred Scripture to ſpeak of things *ſecundum nos*, and only *in reſpect of us*, and *ſecundum apparentiam*; but not *ſecundum ſe*, and *rei naturam*, or *Abſolutely* and *Simply*.

And if any one would underſtand theſe Days of ſacred Scipture, not only *ſecundum nos*, but alſo *ſecundum naturam*, as circulations of Cœleſtial Light returning to the ſelf ſame point from whence it did at firſt proceed; ſo as that there needs no reſpect to be had to Night or to * Darkneſſe, for which ſole reaſon we are fain to imbrace the Interpretation of ſacred Scripture *ſecundum nos*; In oppoſition to this we may thus argue: If the ſacred Scripture be underſtood to ſpeak *abſolutely*, of iterated and ſucceſſive circulations of light, and not *reſpectu noſtri*, as if theſe words *Evening and Morning* had never been inſerted, which in their natural acceptation denote the Suns habitude to us and to the Earth: For that the *Morning* is that time when the Sun begins to wax light, and to riſe above the *Horizon* in the Eaſt, and become viſible in our *Hemiſphære*, and *Evening* is the time in which the Sun declines in the Weſt, and approacheth with its light neerer to the other oppoſite *Horizon* and *Hemiſphære*, which is contiguous to this of ours. But the word *Day* is a Corelative to the word *Night*. From hence therefore it evidently appeareth, that theſe three words *Evening*, *Morning*, and *Day*, cannot be underſtood of a Circulation of Light *ſecundum ſe*, and *abſolutè*, but only *ſecundum nos*, and *reſpectu noſtri*; and in that ſenſe indeed the *Morning* and *Evening* do make the *Night* and *Day*,

* Aut ad Umbram

In like manner, *Gen.* 1. 16. it is ſaid, *God made two great Lights; the greater Light to rule the Day, and the leſſer Light to rule the Night, and the Stars.* Where both in the Propoſition and in the ſpecification of it, things are ſpoken which are very diſagreeing with Cœleſtial Bodies. Therefore thoſe words are in that place to be interpreted according to the foreſaid Rules; namely, according to the third and fourth; ſo that they may be ſaid to be underſtood *according to the ſenſe of the vulgar, and the common way of ſpeaking*, which is all one, as if we ſhould ſay, *ſecundum apparentiam*, and *ſecundum nos*, *vel reſpectu noſtri*. For firſt, it is ſaid in the Propoſition, *And God made two great Lights*; meaning by them the Sun and Moon, whereas according to the truth of the matter theſe are not the Greater Lights; For although the Sun may be reckoned amongſt the Greater, the Moon may not be ſo, unleſs *in reſpect of us*. Becauſe amongſt thoſe that are abſolutely the Greater, and a little leſſer than the Sun (nay in a manner equal to it) and far bigger than the Moon, we may with great reaſon enumerate *Saturn*, or ſome of the Fixed Stars of the firſt Magnitude, ſuch as *Canopus*, (otherwiſe called *Arcanar*) in the end of a River; or the *Little Dog* in the mouth of the *Great Dog*; or the Foot of *Orion*, called *Rigel*; or his *Right ſhoulder*, or any other of that Magnitude. There-

Which are really the great Lights in Heaven.

Therefore the *two great Lights* are to be underſtood in reſpect of us, and according to vulgar eſtimation, and not according to the true and reall exiſtence of ſuch Bodies. Secondly, in the ſpecification of the Propoſition it is ſaid, *The greater Light to rule the Day*; hereby denoting the Sun; in which the verbal ſenſe of Scripture agreeth with the Truth of the Thing; For that the Sun is the Greateſt of all Luminaries, and Globes. But that which followeth immediately after, *And the leſſer Light to rule the Night*, meaning the Moon, cannot be taken in the true and real ſenſe of the words: For the Moon is not the leſſer Light, but *Mercury*; which is not only much leſſer than the Moon, but alſo than any other Star. And if, again, it be ſaid, That the Holy Text doth not ſpeak of the Stars, but onely of the Luminaries, for that preſently after they are mentioned apart, *And the Stars*; and that what we ſay is true touching the compariſon of the Stars amongſt themſelves, but not in reſpect of the Luminaries, namely, the Sun and Moon: This reply doth diſcover a man to be utterly ignorant in theſe Studies, and ſuch who having not the leaſt ſmattering in them, doth conceive an abſurd and erroneous Opinion of the Cœleſtial Bodies. For the Moon and Sun, conſidered in themſelves, and as they appear to us, if they ſhould be a far greater diſtance from us, than indeed they are, would be no other, nor would appear to us otherwiſe than Stars, as the reſt do in the Firmament. But Great Luminaries they neither are, nor ſeem to be, ſave only *in reſpect of us*: And ſo, on the other ſide, the Stars, as to themſelves, are no other than ſo many Suns and ſo many Moons; yet are ſo far remote from us, that by reaſon of their diſtance they appear thus ſmall, and dim of light, as we behold them. For the greater and leſſer diſtance of heavenly Bodies (*cæteris paribus*) doth augment and diminiſh their appearance both as to Magnitude and Light. And therefore the words which follow in that place of *Geneſis*, *And the Stars* (as diſtinguiſhing the Stars from the Sun and Moon) are to be taken in no other acceptation than that which we have ſpoken of, namely, *according to the ſenſe of the Vulgar, and the common manner of ſpeech.* For indeed, according to the truth of the matter, all Cœleſtial Bodies, being ſhining Globes, are of a vaſt bigneſs, to which if we ſhould be ſo neer as we are to the Moon, they would ſeem to us of as great, yea a greater magnitude than the Moon: As likewiſe on the contrary, if we were as far diſtant from the Sun and Moon, as we are from them, both Moon and Sun would ſhew but as ſtars to us. And yet the ſplendor of the Sun would doubtleſs be greater *intenſivè* than that of any other ſtar. For, although it ſhould be granted that ſome ſtars (as thoſe of the Fixed that twinkle) do ſhine of themſelves

The Sun, Moon, and Stars are one & the ſame thing.

ſelves, and by their own nature, as the Sun, that derives not its light from others (which yet remains undecided and doubtful) and borrow not their light from the Sun; Nevertheleſs ſince the brightneſs of none of the ſtars may be compared with the Suns ſplendour, which was created by God firſt, and before all other Luminaries, in the higheſt kind of Light, it would therefore notwithſtanding follow, that none of thoſe ſtars, although placed in the ſame proximity to us with the Sun, and therefore appearing to us of the ſame Magnitude as the Sun, can beſtow upon us ſo much Light as we receive from the Sun: As on the contrary, the Sun, at the ſame remoteneſſe from us as they are, would indeed, as to its Magnitude, appear to us as one of thoſe ſtars, but of a ſplendour much more *intenſe* than that of theirs. So that, now, the Earth is nothing elſe but another Moon or ſtar, and ſo would it appear to us, if we ſhould behold it from a convenient diſtance *on high*. And in it might be obſerved (in that variety of Light and Darkneſs which the Sun produceth in it by making Day and Night) the ſame difference of Aſpects that are ſeen in the Moon, and ſuch as are obſerved in tricorporate *Venus*; in like manner alſo 'tis very probable that the ſame might be diſcerned in other Planets, which ſhine by no light of their own, but by one borrowed from the Sun. What ever therefore may touching theſe matters be delivered in the ſacred Leaves or the common ſpeech of men, diſſenting from the real truth, it ought (as we have ſaid before) abſolutely to be received and underſtood *ſecundum vulgi ſententiam, & communem loquendi & concipiendi ſtylum.*

The Earth is another Moon or Star.

And ſo, to return to our purpoſe, if, all this conſidered, the *Pythagorian* opinion be true, it will be eaſie, according to the ſame Rule, to reconcile the authority of ſacred Scriptures with it, however they ſeem to oppoſe it, and in particular thoſe of the firſt and ſecond Claſſis, *ſcilicet* by my firſt *Maxime*: For that in thoſe places the holy Records ſpeak according to our manner of underſtanding, and according to that which appeareth in reſpect of us; *For thus it is with thoſe Bodies, in compariſon of us, and as they are deſcribed by the vulgar and commune way of humane Diſcourſe; So that the Earth appears as if it were ſtanding ſtill and immoveable, and the Sun, as if it were circumambient about her.* And ſo the Holy Scripture is uſed in the Commune and Vulgar way of ſpeaking; becauſe in reſpect of our ſight, the Earth ſeems rather to ſtand fixed in the Centre, and the Sun to circumvolve about it, than otherwiſe: as it happens to thoſe that are putting off from the Banks of a River to whom the ſhore ſeems to move backwards, and go from them: but they do not perceive (which yet is the truth) that they themſelves go forwards.

Why the Sunne ſeemeth to us to move, & not the Earth.

Which

Which fallacy of our ſight is noted, and the Reaſon thereof aſſigned by the Opticks; upon wich, as being ſtrange to, and beſides my purpoſe, I will not ſtay) and on this account is *Æneas* brought in by *Virgil*, ſaying;

Æneid. 3. *Provehimur portu, terræque urbeſque recedunt.*

But it will not be amiſs to conſider why the ſacred Scripture doth ſo ſtudiouſly comply with the opinions of the Vulgar, and why it doth not rather accurately inſtruct men in the truth of the matters, and the ſecrets of Nature. The Reaſon is, firſt, the benignity of Divine Wiſdome, whereby it ſweetly accomodates it ſelf to all things, in proportion to their Capacity and Nature. Whence in Natural Sciences, it uſeth natural and neceſſary cauſes, but in Liberal Arts it worketh liberally, upon Generous Perſons after a ſublime and lofty manner; upon the Common People, familiarly and humbly; upon the Skilful, learnedly; upon the Simple, vulgarly; and ſo on every one, according to his condition and quality. Secondly, becauſe it is not its Intention to fill our mindes in this life with vain and various curioſities, which might occaſion our doubt and ſuſpenſe. For the truth is, (*a*) *He that increaſeth knowledge, increaſeth ſorrow.* Moreover it did not only permit, but even decree, thatth e World ſhould be very much buſied in Controverſies and Diſputations, and that it ſhould be imployed about the uncertainty of things; according to that ſaying of *Eccleſiaſtes* (*b*) *He hath ſet the World in their heart; ſo that no man can find out the work that God maketh from the beginning unto the end.* And touching thoſe doubts, God will not permit that they ſhall be diſcovered to us before the end of the World: (*c*) *At which time he will bring to light the hidden things of darkneſſe:* But Gods onely ſcope in the ſacred Scripture is to teach men thoſe things which conduce to the attainment of Eternal Life; which having obtained, (*d*) *We ſhall ſee him face to face:* (*e*) *and ſhall be like him, for we ſhall ſee him as he is.* Then ſhall he clearly *à Priori* make known unto us all thoſe Curioſities, and Dogmatical Queſtions, which in this life, (*f*) *in which we ſee through a Glaſſe darkly*, could be known by us but imperfectly and *à poſteriori*, and that not without much pains and ſtudy. For this cauſe the Wiſdome of God, revealed to us in the ſacred Leaves, is not ſtiled Wiſdome abſolutely, but (*g*) *Saving Wiſdome*; Its onely end being to lead us to ſalvation. And S. *Paul* preaching to the *Corinthians*, ſaith; (*h*) *I determined to know nothing among you, ſave Jeſus Chriſt, and him crucified:* whereas notwithſtanding he was thorowly inſtructed, and profoundly learned in

(*a*) Eccleſ. *c.* 1. *v. ult.*

(*b*) *Chap.* 3. *v.* 11.

(*c*) 1 Cor. *c.* 4. *v.* 5

(*d*) 1 Cor. *c.* 13. *v.* 12.

(*e*) 1 John *c.* 3. *v.* 2.

(*f*) 1 Cor. *c.* 13. *v.* 12.

(*g*) Eccleſiaſt. 15. 3

(*h*) 1 Cor. *c.* 2. *v.* 2

in all humane Sciences; but making no account of theſe things he profeſſeth that it was his deſire to teach them no more but the way to Heaven. Hence is that which God ſpeaketh to us by (i) Is. c. 48. v. 17. *Iſaiah*, (*i*) *Ego Dominus Deus, docens te utilia* [*I am the Lord thy God which teacheth thee profitable things:*] Where the *Gloſſary* addeth, *non ſubtilia* [not ſubtilties.] For God neither taught us, Whether the *Materia Prima* of Heaven, and the Elements be the ſame; nor Whether *Continual* be compoſed of Indiviſibles, or whether it be diviſible *in infinitum*; nor, whether the Elements are formally *mixt*; nor how many the Cœleſtial Spheres, and their Orbs are; Whether there be Epicycles or Eccentricks; nor the Vertues of Plants and Stones; nor the Nature of Animals; nor the Motion and Influence of the Planets; nor the Order of the Univerſe; nor the Wonders of Minerals, and univerſal Nature: but only [*utilia:*] things profitable, to wit, his Holy Law ordained to the end, that we being put into poſſeſſion of Bleſſedneſs, might at length be made capable of all perfect knowledge, and the viſion of the whole Order and admirable Harmony, as alſo the Sympathy and Antipathy of the Univerſe and its parts, *in his Word*, wherein all thoſe things ſhall moſt clearly and diſtinctly, then, appear to us, which mean while, in this life, he hath remitted (as far as its ability reacheth) to humane ſearch and enquiry: But it was not his purpoſe to determine any thing, directly or indirectly, touching the truth of them. Becauſe as the knowledge thereof would little or nothing profit Us, but might in ſome caſes prove prejudicial; ſo the ignorance thereof can doubtleſs be no detriment, but may in ſome caſes be very beneficial to us. And therefore by his moſt admirable Wiſdome it comes to paſs, that though all things in this World are dubious, uncertain, wavering, and perplexed; yet his Holy Faith alone is moſt certain; and although the opinions about Philoſophical and Doctrinal points be divers, there is in the Church but one Truth of Faith and Salvation. Which Faith, as neceſſary to Salvation, is ſo ordered by Divine Providence, that it might not only be indubitable, but alſo unſhaken, ſure, immutable, and manifeſt to all men: the infallible Rule of which he hath appointed the Holy Church, that is waſhed with his precious Blood, and governed by his Holy Spirit, to whom belongs our Sanctification, as being his work. This therefore is the Reaſon why God would have Speculative Queſtions, which nothing conduce to our Salvation and Edification, and why the Holy Ghoſt hath very often condeſcended to Vulgar Opinions and Capacities, and hath diſcovered nothing that is ſingular or hidden to us, beſides thoſe things that pertain to Salvation. So that conſequently it is clear by what hath been ſaid, how and

1 Theſſ. 4.

why

why nothing of certainty can be evinced from the foreſaid Authorities to the determining of Controverſies of this Nature; as alſo with what Reaſon from this firſt *Axiome* the Objections of the firſt and ſecond Claſſe are eaſily anſwered, as alſo any other Authority of ſacred Scripture produced againſt the *Pythagorian* and *Copernican* Syſteme ſo long as by other proofs it is true.

And the Authorities of the ſecond Claſſe in particular by this ſame Maxime, *Of the ordinary manner of apprehending things as they appear to us, and after the common way of ſpeaking*, may be thus reconciled and expounded; namely, Oftentimes an Agent is commonly, and not improperly ſaid to move, (though it have no motion) not becauſe it doth indeed move, but *by extrinſick denomination*, becauſe receiving its influence and action at the motion of the Subject; the Form and Quality infuſed to the Subject by the ſaid Agent doth likewiſe move. As for example, a Fire burning in a Chimney is an immoveable Agent, before which a man oppreſt with cold ſits to warm himſelf who being warmed on one ſide, turns the other to the Fire, that he may be warmed on that ſide alſo, and ſo in like manner he holds every part to the Fire ſucceſſively, till his whole body be warmed. 'Tis clear, that although the Fire do not move, yet at the Motion of the Subject, to wit the Man, who receiveth the heat and action of the Fire, the Form and Quality of its Heat doth move *ſingulatim, & per partes*, round about the mans body, and alwayes ſeeketh out a new place: and ſo, though the Fire do not move, yet by reaſon of its effect, it is ſaid to go round all the parts of the Mans body, and to warm it, not indeed by a true and real motion of the Fire it ſelf, ſince it is ſuppoſed (and that not untruly) not to move, but by the motion to which the Body is excited, out of a deſire of receiving the heat of the Fire in each of its parts. The ſame may be applied to the Illumination impreſſed ſucceſſively on the parts of any Globe, which moves Orbicularly at the aſpect of a ſhining immoveable Light. And in the ſame manner may the Sun be ſaid to riſe and ſet, and to move above the Earth, although in reality he doth not move, nor ſuffer any mutation; that is to ſay, Inaſmuch as his Light (which effect is the Form and Quality proceeding from him, as the Agent, to the Earth as the Subject) doth ſenſibly glide forwards, by reaſon of the Orbicular motion of the Earth; and doth alwayes betake it ſelf to ſome new place of her ſurface; upon which ground he is truly ſaid (*ſecundum vulgarem ſermonem*) to move above, and revolve about the Earth: Not that the Sun doth move, (for by this Opinion we affirm the Earth to move, that it may receive the Sun one while in one, another while in another part of it) but that at the motion of the Earth

her ſelf a contrary way, the Quality diffuſed into her, and impreſſed upon her by the Sun, namely the Light of the Day is moved, which riſeth in one part of her, and ſets in another contrary to that, according to the nature and condition of her motion; And for this reaſon the Sun it ſelf by conſequence is ſaid to riſe and ſet, (which notwithſtanding *ex Hypotheſi* ſtands immoveable) and that no otherwiſe then *per denominationem extrinſecam*, as hath been ſaid.

Joſhua c. 10. ver. 12. After this manner the command of *Joſhuah*, *Sun ſtand thou ſtill*, and the Miracle of the Suns ceſſation of Motion wrought by him, may be ſo underſtood, as that not the Solar Body properly, but the Suns ſplendour upon the Earth ſtood ſtill; ſo that not the Sun it ſelf, (being of it ſelf before that time immoveable) but the Earth that receiveth its ſplendour, ſtayed her Motion; which, as ſhe inceſſantly purſuing her ordinary Motion towards the Eaſt, * called up the Light of the Sun in the Weſt, ſo ſtanding ſtill, the Suns light impreſt upon it likewiſe ſtood ſtill.

* *expelled.*

Iſa. c. 38. v. 8. After the ſame manuer proportionally is that Text of *Iſaiah* explained, touching the Suns going ten degrees backward upon the Dial of *Ahaz*. So (which may ſerve for another Example) the Hand being moved about the flame of a burning Candle that ſtands ſtill, the Light moveth on the Hand, that is to ſay, the ſaid Hand is illuſtrated now in one part, anon in another, when as the Candle it ſelf all the while removes not out of its place: whereupon *per denominationem extrinſecam*, the ſaid Light may be affirmed to riſe and ſet upon the Hand, namely, by the ſole motion of the ſaid Hand, the Candle it ſelf never moving all the while. And let this ſuffice for the explanation of my firſt Principle or *Maxime*; which by reaſon of its difficulty and extraordinary weight required ſome prolixity in the handling of it.

My ſecond Maxime is this, Things both Spiritual and Corporeal, Durable and Corruptible, Moveable and Immoveable, have received from God a perpetual, unchangeable, and inviolable Law, conſtituting the Eſſence and Nature of every one of them: according to which Law all of them in their own Nature perſiſting in a certain Order and Conſtancy, and obſerving the ſame perpetual Courſe, may deſervedly be ſtiled moſt Stable and Determinate. Thus Fortune (than which there is nothing in the World more inconſtant or fickle) is ſaid to be conſtant and unalterable in her continual volubility, viciſſitude, and inconſtancy, which was the occaſion of that Verſe,

Et ſemper conſtans in levitate ſua eſt.

And thus the motion of Heaven (which by the conſtan Law of

of Nature ought to be perpetual) may be ſaid to be immutable and immoveable, and the Heavens themſelves to be immoveably moved, and Terrene things to be immutably changed, becauſe thoſe never ceaſe moving, nor theſe changing. By this Principle or Maxime all difficulties belonging to the firſt Claſſis are cleared, by which the Earth is ſaid to be ſtable and immoveable, that is, by underſtanding this one thing, That the Earth, as to its own Nature, though it include in it ſelf a local Motion, and that threefold, according to the opinion of *Copernicus* (*ſcilicet* Diurnal, with which it revolveth about its own Centre; Annual, by which it moveth through the twelve Signes of the Zodiack, and the motion of Inclination, by which its Axis is alwayes oppoſed to the ſame part of the World) as alſo other Species of Mutation, ſuch as Generation and Corruption, Accretion and Diminution, and Alteration of divers kinds; yet in all theſe ſhe is ſtable & conſtant, never deviating from that Order which God hath appointed her, but moveth continually, conſtantly and immutably, according to the ſix before named Species of Motion.

Several Motions of the Earth according to Copernicus.

My third Maxime ſhall be this; When a thing is moved according to ſome part of it, and not according to its whole, it cannot be ſaid to be *ſimply* & *abſolutely* moved, but only *per accidens*, for that ſtability taken ſimply & abſolutly do rather accord with the ſame. As for example, if a Barrel or other meaſure of Water be taken out of the Sea, and transferred to another place, the Sea may not therefore *abſolutely* & *ſimply* be ſaid to be removed from place to place, but only *per accidens*, and *ſecundum quid*, that is, according to a part of it, but rather (to ſpeak ſimply) we ſhould ſay that the Sea cannot be carried or moved out of its proper place, though as to its parts it be moved, and transferred to & again. This Maxime is manifeſt of it ſelf, and by it may the Authorities be explained which ſeem to make for the immobility of the Earth in this manner; namely, The Earth *per ſe & abſolutè* conſidered as to its *Whole*, is not mutable, ſeeing it is neither generated nor corrupted neither increaſed nor diminiſhed; neither is it altered *ſecundum totum*, but only *ſecundum partes*. Now it plainly appears, that this is the genuine and true Senſe of what is aſcribed to it out of *Eccleſiaſtes*, *cap.* 1. *v.* 4. *One Generation paſſeth away, and another Generation cometh, but the Earth abideth for ever*: as if he ſhould ſay; although the Earth, according to its parts, doth generate and corrupt, and is liable to the viciſſitudes of Generation and corruption, yet in reference to its Whole it never generateth nor Corrupteth, but abideth immutable for ever: Like as a Ship, which though it be mended one while in the Sail-yard, another while in the Stern, and afterwards in other parts it yet remains the ſame Ship as it was at firſt. But tis to be ad-

The Earth Secundum Totum *is Immutable, though not Immoveable.*

vertized, that that Scripture doth not ſpeak of a Local Motion, but of Mutations of another nature; as in the very ſubſtance, quantity or quality of the Earth it ſelf. But if it be ſaid, that it is to be underſtood of a Local Motion, then it may be explained by the inſuing Maxime, that is to ſay, a reſpect being had to the natural Place aſſigned it in the Univerſe, as ſhall be ſhewed by and by.

The fourth Axiome is this; That every Corporeal thing, moveable or immoveable from its very firſt Creation, is alotted its proper and natural place; and being drawn or removed from thence, its motion is violent, and it hath a natural tendency to move back thither again: alſo that nothing can be moved from its natural place, *ſecundum Totum*; For moſt great and dreadful miſchiefs would follow from that perturbation of things in the Univerſe. Therefore neither the whole Earth, nor the whole Water, nor the whole Air can *ſecundum totum* be driuen or forced out of their proper place, ſite, or Syſteme in the Univerſe, in reſpect of the order and diſpoſition of other mundane Bodies. And thus there is no Star (though Erratick) Orb or Sphere that can deſert its natural place, although it may otherwiſe have ſome kind of motion. Therefore all things, how moveable ſoever, are notwithſtanding ſaid to be ſtable and immoveable in their proper place, according to the foreſaid ſenſe, *i.e. ſecundum totum*; For nothing hinders, but that *ſecundum partes* they may ſome way move; which motion ſhall not be natural, but violent. Therefore the Earth, although it ſhould be moveable, yet it might be ſaid to be immoveable, according to the precedent Maxime, for that it's neither moved in a right Motion nor out of the Courſe aſſigned it in its Creation for the ſtanding Rule of its motion; but keep within its own ſite, being placed in that which is called the Grand Orb, above *Venus*, and beneath *Mars*, and being in the middle betwixt theſe (which according to the common opinion is the Suns place) it equally and continually moveth about the Sun, and the two other intermediate Planets, namely *Venus* and *Mercury*, and hath the Moon (which is another Earth, but Ætherial, as *Macrobius* after ſome of the ancient Philoſophers, will have it) about it ſelf. From whence, inaſmuch as ſhe perſiſteth uniformly in her Courſe, and never at any time departeth from it, ſhe may be ſaid to be ſtable and immoveable: and in the ſame ſenſe Heaven likewiſe, with all the Elements, may be ſaid to be immoveable.

The Earth cannot Secundum Totum, *remove out of its Natural Place.*

The Natural Place of the Earth.

The Moon is an Ætherial Body.

The fifth Maxime followeth, being little different from the former. Amongſt the things created by God, ſome are of ſuch a nature, that their parts may be *ab invicem*, or by turns, ſeparated from themſelves, and diſ-joyned from their Whole; others

others may not, at leaſt, taken *collectively*: now thoſe are periſhable, but theſe perpetual. The Earth therefore ſince it is reckoned amongſt thoſe things that are permanent, as hath been ſaid already, hath its parts, not diſſipable, nor *ab invicem*, ſeparable from its Centre (whereby its true and proper place is aſſigned it) and from its whole, taken collectively: becauſe according to its whole it is always preſerved, compact, united, and cohærent in it ſelf, nor can its parts be ſeperated from the Centre, or from one another, unleſs it may ſo fall out *per accidens*, and violently in ſome of its parts; which afterwards, the obſtacle being removed, return to their Natural Station ſpontaneouſly, and without any impulſe. In this Senſe therefore the Earth is ſaid to be Immoveable, and Immutable: yea even the Sea, Aire, Heaven, and any other thing (although otherwiſe moveable) ſo long as its parts are not diſſipable and ſeperable, may be ſaid to be Immoveable, at leaſt taken *collectively*. This Principle or Maxim differeth from the precedent only in that this referrs to the parts in order to *Place*, and this, in order to the Whole.

The Earths Centre keepeth it in its Natural Place.

From this Speculation another Secret is diſcovered. For hence it is manifeſt wherein the proper and genuine formality of the Gravity aad Levity of Bodyes conſiſteth; a point which is not ſo clearly held forth, nor ſo undeniably explained by the Peripatetick Phyloſophy. *Gravity* therefore is nothing elſe according to the Principles of this new Opinion, than a certain power and appetite of the Parts to rejoyn with their Whole, and there to reſt as in their proper place. Which Faculty or Diſpoſition is by Divine Providence beſtowed not only on the Earth, and Terrene Bodies, but, as is believed, on Cœleſtial Bodies alſo, namely the Sun, Moon, and Starrs; all whoſe parts are by this Impulſion connected, and conſerved together, cleaving cloſely to each other, and on all ſides preſſing towards their Centre, until they come to reſt there. From which Concourſe and Compreſſion a Sphærical and Orbicular Figure of the Cæleſtial Orbes is produced, wherein by this occult Quality naturally incident to each of them they of themſelves ſubſiſt, and are alwayes preſerved. But *Levity* is the Extruſion and Excluſion of a more tenuoſe and thin Body from the Commerce of one more Solid and denſe, that is Heterogeneal to it, by vertue of Heat. Whereupon, as the Motion of Grave Bodies is *Compreſſive*, ſo the Motion of Light Bodies is *Extenſive*: For its the propperty of Heat to dilate and rarify thoſe things to which it doth apply, conjoine and communicate it ſelf. And for this reaſon we find Levity and Gravity not only in reſpect of this our Tereſtrial Globe, and the Bodies adjacent to it, but alſo in reſpect of thoſe Bodies which are ſaid to be in the Heavens, in which thoſe parts which

Gravity and Levity of Bodies, what it is.

All Cœleſtial Bodies have Gravity and Levety.

Compreſſive Motion, proper to Gravity; the Extenſive, to Levity.

by

by reaſon of their proclivity make towards their Centre are Grave, and thoſe that incline to the Circumference Light. And ſo in the Sun, Moon, and Starrs, there are parts as well Grave as Light. And conſequently Heaven it ſelf that ſo Noble Body, and of a fifth Eſſence, ſhall not be conſtituted of a Matter different from that of the Elements, being free from all Mutation in it's Subſtance, Quantity, and Quality: Nor ſo admirable and excellent as *Ariſtotle* would make us to believe; nor yet a ſolid Body, and impermeable; and much leſſe (as the generality of men verily believe) of an impenetrable and moſt obdurate Denſity: but in it (as this Opinion will have it) Comets may be generated; and the Sun it ſelf, as tis probable, exhaling or attracting ſundry vapours to the ſurface of its Body, may perhaps produce thoſe Spots which were obſerved to be ſo various, and irregular in its *Diſcus*: of which *Galilæus* in a perticular * Treatiſe hath moſt excellently and moſt accurately ſpoken; inſomuch, that though it were not beſides my preſent purpoſe, yet it is convenient that I forbear to ſpeak any thing touching thoſe matters, leaſt I ſhould ſeem to do that which he hath done before me: But now if there be found in the Sacred Scriptures any Authority contrary to theſe things, it may be ſalved by the foreſaid Arguments Analogically applyed. And furthermore it may be ſaid, that that Solidity is to be ſo underſtood, *as that it admits of no vacuum, cleft, or penetration from whence the leaſt vacuity might proceed.* For the truth is, as that cannot be admitted in bodily Creatures, ſo it is likewiſe repugnant to Heaven it ſelf, being indeed a Body of its own Nature the moſt Rare of all others, and tenuoſe beyond all Humane Conception, and happly hath the ſame proportion to the Aire, as the Aire to the Water.

Heaven is not compoſed of a fift Eſſence differing from the matter of inferior Bodies.

Nor yet a Solid or denſe Body but Rare.

* Delle Macchie ſolarj.

* *Unius Corporis ſimplicis, unus eſt motus ſimplex, et huic duæ ſpecies, Rectus & Circularis: Rectus duplex à medio, & ad medium; primus levium, ut Aeris & Ignis: ſecundus gravium, ut Aquæ & Terræ: Circularis, qui eſt circa medium competit Cœlo, quod neque eſt grave, neque leve.* Ariſt. *de Cœlo.* Lib. 1.

* *Vide Copernicum de Revolutionibus Cœleſt.*

Simple Motion peculiar to only Simple Bodies.

It is clear alſo from theſe Principles how falſe theſe words of *Ariſtotle* are, that: *Of one ſimple Body, there is one ſimple Motion; and this is of two kindes, Right and Circular: the Right is twofold, from the medium, and to the medium; the firſt of Light Bodyes, as the Aire and Fire: the ſecond of Grave Bodyes, as the Water and Earth: the Circular, which is about the medium, belongeth to Heaven, which is neither Grave nor Light*: For all this Philoſophy is now forſaken, and of it ſelf grown into diſ-eſteem; for though it be received for an unqueſtionable truth in this new Opinion, that to a ſimple body appertains one only ſimple Motion, yet it granteth no Motion but what is Circular, by which alone a ſimple body is conſerved in its naturall Place, and ſubſiſts in its Unity, and is properly ſaid to move *in loco* [*in a place*:] whereby it comes to paſs that a Body for this reaſon doth continue to move in it ſelf, [*or about its own axis*;] and although it have a Motion,

yet

yet it abideth ſtill in the ſame place, as if it were perpetually immoveable. But right Motion, which is properly *ad locum*, [*to a place*] can be aſcribed only to thoſe things which are out of their naturall place, being far from union with one another, and from unity with their whole, yea that are ſeperated and divided from it: Which being that it is contrary to the Nature and forme of the Univerſe, it neceſſarily followeth, that right Motion doth in ſhort ſute with thoſe things which are deſtitute of that perfection, that according to their proper Nature belongeth to them, and which by this ſame right Motion they labour to obtaine, untill they are redintigrated with their Whole, and with one another, and reſtored to their Naturall place; in which at the length, having obtained their perfection, they ſettle and remaine immoveable. Therefore in right Motions there can be no Uniformity, nor ſimplicity; for that they vary by reaſon of the uncertaine Levity or Gravity of their reſpective Bodyes: for which cauſe they do not perſevere in the ſame Velocity or Tardity to the end which they had in the beginning. Hence we ſee that thoſe things whoſe weight maketh them tend downwards, do deſcend at firſt with a ſlow Motion; but afterwards, as they approach neerer and neerer to the Centre, they precipitate more and more ſwiftly. And on the otherſide, thoſe things which by reaſon of their lightneſs are carryed upwards (as this our Terreſtriall fire, which is nothing elſe but a ſmoak that burneth, and is inkindled into a flame) are no ſooner aſcended on high, but, in almoſt the ſelf-ſame moment, they fly and vaniſh out of ſight; by reaſon of the rarefaction and extenſion, that they as ſoon as they acquire, are freed from thoſe bonds which violently and againſt their own Nature kept them under, and deteined them here below. For which reaſon, it is very apparent, that no Right Motion can be called Simple, not only in regard that (as hath been ſaid) it is not * even and uniforme, but alſo becauſe it is mixt with the Circular, which lurketh in the Right by an occult conſent, *ſcilicet* by reaſon of the Natural affection of the Parts to conforme unto their Whole. For when the Whole moveth Circularly, it is requiſite likewiſe that the Parts, to the end that they may be united to their Whole, (howbeit *per accidens* they are ſometimes moved with a Right Motion) do move (though not ſo apparently) with a Circular Motion, as doth their Whole. And thus at length we have evinced that Circular Motion only is Simple, Uniform and * Æquable, and of the ſame tenor [*or rate*] for that it is never deſtitute of its interne Cauſe: whereas on the contrary, Right Motion, (which pertains to things both Heavy and Light) hath a Cauſe that is imperfect and deficient, yea that ariſeth from Defect it ſelf, and that tendeth to, and ſeeketh after no

Right Motion belongeth to Imperfect Bodies, and that are out of their natural Places.

Right Motion cannot be Simple.

Right Motion is ever mixt with the Circular.

* *aquabilis.*

* *Even.*

Circular Motion is truly Simple and Perpetual.

nothing elſe but the end and termination of it ſelf: in regard that Grave and Light Bodies, when once they have attained their proper and Natural Place, do deſiſt from that Motion to which they were incited by Levity and Gravity. Therefore: ſince Circular Motion is proper *to the Whole*, and Right Motion *to the Parts*, theſe differences are not rightly referred to Motion, ſo as to call one Motion Right, another Circular, as if they were not conſiſtent with one another: For they may be both together, and that Naturally, in the ſame Body; no leſſe than it is equally Natural for a Man to participate of Senſe and Reaſon, ſeeing that theſe differences are not directly oppoſite to one another. Hereupon Reſt and Immobility only are oppoſed to Motion; and not one Species of Motion to another. And for the other differences *à medio*, *ad medium*, and *circa medium*, they are diſtinguiſhed not *really*, but only *formally*, as the Point, Line and Superficies, none of which can be without the other two, or without a Body. Hence it appears, that in as much as this Philoſophy differs from that of *Ariſtotle*, ſo in like manner doth this New Coſmographical Syſtem vary from the Common one, that hath been hitherto received. But this by the way, upon occaſion of explaining the Fifth Maxim: For as to the truth or falſhood of theſe foregoing Poſitions (although I conceive them very probable) I am reſolved to determine nothing at preſent, neither ſhall I make any farther enquiry into them.

Circular Motion belongeth to the Whole Body, and the Right to its parts.

Circular and Right Motion conſecedent, and may conſiſt together in the ſame Body.

The Sixth and Laſt Maxim is this. Every thing is Simply denominated ſuch as it is in compariſon of all things, or of many things which make the greater number of that kinde, but not in reſpect of a few which make but the leſſer part of them. As, for inſtance, a Veſſel ſhall not be called abſolutely Great becauſe it is ſo whilſt it is compared with two or three others: but it ſhall be ſaid to be great abſolutely, and will be ſo, if it exceed in magnitude all indivials, or the greater part of them. Nor again ſhall a Man be ſaid to be abſolutely Big, becauſe he is bigger than a Pigmey; nor yet abſolutely Little, becauſe leſſe than a Gyant: but he ſhall be termed abſolutely Big or Little in compariſon of the ordinary Stature of the greater part of Men. Thus the Earth cannot abſolutely be ſaid to be High or Low for that it is found to be ſo in reſpect of ſome ſmall part of the Univerſe; nor again ſhall it be abſolutely affirmed to be High, being compared to the Centre of the World, or ſome few parts of the Univerſe, more near to the ſaid Centre, as is the *Sun*, *Mercury* or *Venus*: but it ſhall receive its abſolute denomination according as it ſhall be found to be in compariſon of the greater number of the Spheres and Bodies of the Univerſe. The Earth therefore, in compariſon of the whole Circuit of the Eighth Sphære which includeth

The Earth in what ſenſe it may abſolutely be ſaid to be in the loweſt part of the World.

cludeth all Corporeal Creatures, and in compariſon of *Jupiter*, *Mars*, and *Saturn* together with the *Moon*, and much more in compariſon of other Bodies, (if any ſuch there be) above the Eighth Sphere and eſpecially the Empyrial Heaven, may be truly ſaid to be in the loweſt place of the World, and almoſt in the Centre of it; nor can it he ſaid to be above any of them, except the *Sun*, *Mercury* and *Venus*: So that one may apply unto it the name of an Infime and Low, but not a Supreme or Middle Body. And ſo to come down from Heaven, eſpecially the Empyrian, to it (as it is accepted in the Deſcent of Chriſt from Heaven to his Holy Incarnation) and from it to go up to Heaven (as in Chriſts return to Heaven in his Glorious Aſcention) is truly and properly to *Deſcend* from the Circumference to the Centre, and to *aſcend* from the parts which are neareſt to the Centre of the World to its utmoſt Circumference. This Maxim therefore may eaſily and according to truth explain Theologicall Propoſitions: and this is ſo much the more confirmed, in that (as I have obſerved) almoſt all Texts of Sacred Scripture which oppoſe the Earth to Heaven, are moſt conveniently and aptly underſtood of the Empyrial Heaven (being the Higheſt of all the Heavens, and Spiritual in reſpect of its end) but not of the inferiour or intermediate Heavens, which are a Corporeal, and were framed for the benefit of Corporeal Creatures: and thus when in the Plural Number Heavens are mentioned, then all the Heavens promiſcuouſly and without diſtinction are to be underſtood, as well the Empyrian it ſelf as the Inferiour Heavens. And this Expoſition indeed any man (that doth but take notice of it) may find to be moſt true. And ſo for this Reaſon the Third Heaven into which St. *Paul* was wrapt up, by this Maxim may be taken for the Empyrean: if for the the Firſt Heaven we underſtand that immenſe Space of Erratick and Moveable Bodies illuminated by the Sun, in which are comprehended the Planets, as alſo the Earth moveable, and the Sun immoveable, Who like a King upon his Auguſt Tribunal, ſits with venerable Majeſty immoveable and conſtant in Centre of all the Sphæres, and, with his Divine Beames, doth bountifully exhilerate all Cœleſtial Bodies that ſtand in need of his vital Light, for which they cravingly wander about him; and doth liberally and on every ſide comfort and illuſtrate the Theatre of the whole World, and all its parts, even the very leaſt, like an immortal and perpetual Lamp of high and unſpeakable value. The Second Heaven ſhall be the Starry Heaven, commonly called the Eighth Sphære, or the Firmament, wherein are all the Fixed Starrs, which according to this Opinion of *Pythagoras*, is (like as the Sun and Centre) void of all Motion, the Centre and utmoſt Circumference mutually agreeing with each other in

Chriſt in his Incarnation truly deſcended from Heaven, and in his Aſcenſion truly aſcended into Heaven.

2 Cor. c. 12. v. 3. *Whether in the body or out of the body, I cannot tell,*

The Sun is King, Heart and Lamp of the World himſelf being abſolutely independant.)

Immobility. And the Third shall be the Empyrean Heaven, that is the Seat of the Blessed. And in this manner we may come to explain and understand that admirable Secret, and profound Mystery ænigmatically revealed by *Plato* to *Dionysius* of *Syracuse*: (a) *All things are about the King of all things, Second things about the second, and Third things about the Third*: For that God being the Centre of Spiritual things, the Sun, of Corporeal, Christ, of those that are Mixt, or made up of both, things do doubtlesse depend of that of these three Centres that is most correspondent and proportionable to them, and the Centre is ever adjudged to be the nobler and worthier place: and therefore in Animals the Heart, in Vegitables the Pith or Kernell wherein the Seed lyeth that conserveth their perpetuity, and virtually includes the whole Plant, are in the Midst, and in the Centre: and thus much shall suffice to have hinted at, since there may another occasion offer it self for a larger Explication of these things. By this Maxim the Authorities and Arguments of the Third Fourth and Fifth Classes are resolved.

The Ænigma of Plato.

(a) *Circa omnium Regem sunt omnia, & Secunda circa Secundum, et Tertia circa Tertium*: *Vide* Theodo. de Græc. affect. curat. lib. 2. Steuch. lib. de Perennj. Philoso.

It may be added withall, that even the *Sun*, *Mercury* and *Venus* (that is to say in respect of the Earth) are to be thought *above*, and not *beneath* the Earth it self, although in respect of the Universe, yea and also absolutely, they are *below*. The reason is, because in respect of the Earth they alwayes appear above its Surface: and although they do not environe it, yet by the Motion of the said Earth they behold one while one part, another while another part of its Circumference. Since therefore those things which in a Sphærical Body are nearer to the Circumference and more remote from the Centre are said to be *above*, but those that are next adjoyning to the Centre are said to be *below*; it clearly followeth that whilst the *Sun*, *Mercury* and *Venus* are not only turned towards the Surface and Circumference of the said Earth, but are at a very great distance without it, successively turned about it, and every way have a view of it, and are very far remote from its Centre, they may, in respect of the said Earth, be said to be *above* it; as also on the other side, the Earth in respect of them may be said to be *beneath*: howbeit on the contrary, in respect of the Universe, the Earth in reality is much higher than they. And thus is salved the Authority of *Ecclesiastes* in many places, expressing those things that are, or are done on the Earth in these words, *Which are done, or which are under the Sun*, And in the same manner those words are reduced to their true Sense wherein it is said, That we are *under the Sun*, and *under the Moon*, whereupon Terrene things are expressed by the name of *Sublunary*.

Eccles. c. 1. 2. 3. *and almost thorout.*

* *Quod fiunt, vel sunt sub sole.*

The Sixth Classis threatneth a difficulty which is common as well

well to this of *Copernicus*, as to the Vulgar Opinion; ſo that they are both alike concerned in the ſolution of it: But ſo far as it oppoſeth that of *Copernicus*, its anſwer is eaſy from the Firſt Maxim.

But that which is added in the Fourth Claſſe, That it followeth from this Opinion, that Hell (for that it is included by the Earth, as is commonly held) doth move circularly about the Sun, and in Heaven, and that ſo Hell it ſelf will be found to be in Heaven; diſcovers, in my judgment, nothing but Ignorance and Calumny, that inſinuate the belief of their Arguments rather by a corrupt ſenſe of the Words, than by ſolid Reaſons taken from the boſome of the Nature of things. For in this place Heaven is no wiſe to be taken for Paradice, nor according to the Senſe of Common Opinion, but (as hath been ſaid above) according to the *Copernican* Hypotheſis, for the ſubtileſt and Pureſt Aire, far more tenuous and rare than this of ours; whereupon the Solid Bodies of the Stars, Moon, and Earth, in their Circular and Ordinary Motions, do paſſe thorow it, (the Sphære of Fire being by this Opinion taken away.) And as according to the Common Opinion it was no abſurdity to ſay, That Hell being demerged in the Centre of the Earth and of the World it ſelf, hath Heaven and Paradice above and below it, yea and on all ſides of it, and that it is in the middle of all the Cœleſtial Bodies (as if it were poſited in a more unworthy place) ſo, neither in this will it be deemed an Error, if from the other Syſtem, which differeth not much from the Vulgar one, thoſe or the like things follow as do in that. For both in that of *Copernicus*, and the Vulgar Hypotheſis, Hell is ſuppoſed to be placed amongſt the very dreggs of the Elements, and in the Centre of the Earth it ſelf, for the confinement and puniſhment of the damned. Therefore we ought not for want of Reaſons to trifle away time in vain and impertinent ſtrife about words, ſince their true Senſe is clouded then with no obſcurity, and in regard that it is very clear to any man indued with a refined Intellect, and that hath but an indifferent judgment in the Liberal Arts, and eſpecially in the Mathematicks, that the ſame, or not very different Conſequences do flow from both theſe Opinions.

Heaven according to Copernicus is the ſame with the moſt tenuous Æther; but different from Paradice, which ſurpaſſeth all the Heavens.

By theſe Maxims and their Interpretations it appears, that the *Pythagorick* and *Copernican* Opinion is ſo probable, that its poſſible it may exceed even the *Ptolemaick* in probability; and ſince there may be deduced from it a moſt ordinate Syſteme, and a mroe admirable and myſterious Hypotheſis of the World than from that of *Ptolomy*: the Authorities of Sacred Scripture and Theological Tenents in the mean while not oppoſing it, being opportunely and appoſitely (as I have ſhown how they may be)

be) reconciled with it: And ſince that by it not only the Phœnomena of all the Cœleſtial Bodies are moſt readily ſalved, but alſo many Natural Reaſons are diſcovered, which could not otherwiſe, (but with extream difficulty) have been found out: And ſince it, laſt of all, doth open a more eaſy way into Aſtronomy and Phyloſophy, and rejecteth all thoſe ſuperfluous and imaginary inventions produced by Aſtronomers to the end only, that they might be able by them to render a reaſon of the ſo many and ſo various Motions of the Cœleſtial Orbs.

And who knows, but that in that admirable compoſure of the Candleſtick which was to be placed in the Tabernacle of God, he might out of his extraordinary love to us have been pleaſed to ſhaddow forth unto us the Syſteme of the Univerſe, and more eſpecially of the Planets? (*a*) *Thou ſhalt make a Candleſtick of pure Gold*, (ſaith the Text;) *of beaten work ſhall it be made: his Shaft, and his Branches, his Bowls, his Knops, and his Flowers* (*b*) *ſhall be of the ſame.* Here are five things deſcribed, the Shaft of the Candleſtick in the midle, the Branches on the ſides, the Bowls, the Knops and the Flowers. And ſince there can be no more Shafts but one, the Branches are immediatly deſcribed in theſe (*c*) words: *Six Branches ſhall come out of the ſides of it: three Branches out of the one ſide, and three Branches out of the other ſide:* Happly theſe ſix Branches may point out to us ſix (*d*) Heavens, which are moved about the Sun in this order; *Saturn*, the ſloweſt and moſt remote of all, finiſheth his courſe about the Sun thorrow all the twelve Signes of the Zodiack in thirty Years: *Jupiter*, being nearer than he, in twelve Years: *Mars*, being yet nearer than him, in two Years: The *Earth*, which is ſtill nearer than he, doth perform the ſame Revolution, together with the Orbe of the *Moon*, in the ſpace of a Year, that is in Twelve Months: *Venus*, which is yet nearer than all theſe, in (*e*) 9 Months: And laſt of all *Mercury*, whoſe vicinity to the Sun is the greateſt of all, accompliſheth its whole converſion about the Sun in eighty Dayes. After the deſcription of the ſix Branches, the ſacred Text proceeds to the deſcription of the Bowls, the Knops, and the Flowers, ſaying, (*f*) *Three Bowls made like unto Almonds, with a Knop and a Flower in one Branch; and three Bowls made like Almonds in the other Branch, with a Knop and a Flower: this ſhall be the work of the ſix Branches that come out of the Shaft. And in the Candleſtick ſhall be four Bowls made like unto Almonds, with their Knops and their Flowers: there ſhall be a knop under two branches of the ſame, and a Knop under two Branches of the ſame, and a Knop under two Branches of the ſame; which together are ſix Branches, proceeding from one Shaft.* The truth is, the ſhallowneſſe of my underſtanding cannot fathome the depth

(a) Exod. 25. 31.

(b) *My Authour following the vulgar Tranſlation, which hath an Eligance in ſome things beyond ours, cites the words thus,* Facies Candelabrum ductile de auro mundiſſimo, Haſtile ejus, & Calamos, & Sphærulas, ac Lilia, ex ipſo procedentia.

(c) *verſe* 32.

(d) *or Spheres.*

(e) *Though our Authour ſpeaketh here poſitively of nine Months, &c. Fathers are not agreed about the period of this planet, nor that of* Mercury, *as you may ſee at large in* Riccioli, Almageſt. nov. *Tom.* 1. *part* 1. *l.* 7. *ſect.* 3. *cha.* 11. *num.* 11. *page* 627. *where he maketh* Venus *to conſummate her Revolution in neer* 225 *dayes, or* 7½ *Mon. and* Mercury *in about* 88 *dayes, or* 3 *Months: in which he followeth* Kepl. *in Epitome Aſtronom. p.* 760.

(f) *verſ.* 33, 34.

depth of all the Myſteries that are couched in this moſt wiſe diſpoſure of things: nevertheleſſe being amazed, and tranſported with admiration, I will ſay; Who knows but that thoſe three Bowls *like* unto Almonds to be repreſented on each of the Branches of the Candleſtick may ſignifie thoſe Globes which are apter (as is this our Earth) for the receiving than emitting of Influences? Perhaps alſo they denote thoſe Globes of late diſcovered by the help of the Optick Teleſcope, which participate with *Saturn*, *Jupiter*, *Venus*, and poſſibly alſo with the other Planets? Who knows likewiſe, but that there may be ſome occult proportion between theſe Globes and thoſe Myſterious Knops and Lilies inſinuated unto us in the ſacred Scriptures? But this ſhall here ſuffice to bound humane Preſumption, and to teach us to exſpect with an Harpocratick ſilence from Time, the Indice of Truth, a diſcovery of theſe Myſteries: (*g*) *Solomon* made ten Candleſticks by the ſame Patern of *Moſes*, which he placed, five on one hand and five on another, in the Temple erected by him in honour of the moſt High God; which very thing doth alſo, without all queſtion, contain moſt abſtruſe ſignifications. Moreover, that Apple of the Knowledg of Good and Evil prohibited our firſt Parents by God is not without a Myſtery; which ſome ſay was an Indian Figg. In which theſe things are to be obſerved: Firſt, That it is replete with many Kernels, every one of which hath a particular Centre. Secondly, Though of it ſelf it be hard and ſolid, yet about its Circumference it is of a more rare and tenuouſe ſubſtance; herein reſembling the Earth, which though in its Centre, and thoſe parts which are neareſt to it, it be ſtony, Metallick, and compact, yet the nearer one approacheth to the Circumference, its parts are ſeen to be the more rare and tenuouſe: and withall it hath another body, more rare than its own, namely the Water, above which there is yet another, more ſubtil than all the reſt of inferiour Bodyes, that is to ſay, the Aire,

(g) 1 Kings *c.*7. *v.*49. 2 Chron. *c.* 4. *verſ.*7.

The ſame Repreſentation with that of the Indian Figg is held forth to us by the *Malum Punicum*, or Pomegranate, with its innumerable polycentrick Stones or Kernels, all which in the parts more remote from their Centre, and nearer approaching towards the Circumference, are of a ſubſtance ſo ſubtil and rare, that being but lightly compreſſed, they in a manner wholly convert into a moſt tenuoſe Liquor or juice: Of which fruit it pleaſed Divine Wiſdom to make mention, and ordained that its Figure ſhould be imbroidered and wrought with a needle in the *ſacerdotal* Garment of *Aaron*: (*h*) *Beneath* (ſaith God) *upon the hem of it thou ſhalt make Pomegranates of blew, and of purple, and of ſcarlet, round about the border thereof; and Bells of gold between them round*

(h) Exod. 28. 33, 34, & 39. v. 24, 25, 26.

round about : a golden bell and a pomegranate, a golden bell and a pomegranate, upon the hem of the Robe round about. And that this was a Myſtical Repreſentation of the Worlds Effigies, is averred by *Solomon*, ſaying; (*i*) *For in the long* (*k*) *Garment that he had on was the*(*l*)*whole World; and in the foure rows of the ſtones was the Glory of the Fathers graven, and thy Majeſty in the Diadem of his Head.*

(*i*) Sap. c. 18. v. 24.

(*k*) Exod.c.28. v. 6, 9, 17, 36.

(*l*) Or, *totus Orbis Terrarum*, as the vulgar Tranſlation hath it.

The ſame likewiſe is ſignified to us by the Grape, and in like manner by all other Fruits ; but eſpecially the Figg, Grape, and Pomegranate : whence theſe three are almoſt alwayes placed together in the Sacred Scriptures. So *Numb.* 20. the People of Iſrael complain againſt *Moſes* and *Aaron* : (*m*) *Wherefore have you made us to come up out of Egypt, to bring us into this evil place, where there can grow no Seed, neither is there either Figgs, or Vines, or Pomegranates ?*. Intimating that theſe kinds of Fruits were preferred by them for their excellency before all others. And in *Joel* (*n*) *The Vine is dryed up, and the Figg-tree languiſheth, the Pomegranate-tree, the Palm-tree alſo, and the Apple-tree, even all the Trees of the field are withered; becauſe joy is withered away from the Sons of Men.* Likewiſe in *Haggai* : (*o*) *Is the ſeed yet in the Bud ? and hath as yet the Vine and the Fig-tree, and the Pomegranate, and the Olive-tree brought forth ?* In like manner in *Deuteronomie* the Land of Promiſe is commended to be (*p*) *A Land of Wheat, and Barly, and Vines in which grow, Figg-trees, and Pomegranates, and Olive-trees,* &c. And in the Structure of the Temple undertaken by *Solomon* upon Divine Inſpiration the (*q*) Chapiters of the Pillars were adorned with ſeveral rowes of Pomegranates : which particular is mentioned, not in one but many places of Holy Writ. Yea and ſometimes accidentally and occationally the Holy hath Ghoſt ænigmatically repreſented this moſt admirable and Moſt Wiſe Structure of the World, the Order of the Heavens, and the diſpoſure of Creatures Spiritual and Corporeal by Emblems, Parables, and Figures, leaſt they ſhould be as it were dazled and blinded, by the refulgent ſplendor of ſo excellent an Object. Hence we ſee, that in theſe Doctrinal & Dubious Points we may diſcourſe in ſuch manner by help of the Holy Scripture as is meet for the underſtanding of the Prophets; which ſeeing they are very obſcure, they ſhall be fully underſtood, and may be aptly applyed only then when they ſhall be fulfilled, and not before : So alſo when once the true Syſteme of the Univerſe is found out, then, and not till then, the meaning of theſe Figures, and Ænigma's ſhall be made known unto us : Thus before the coming of the Son of God had diſcovered unto us the Myſtery of the Holy Trinity, none were able to comprehend or imagine what was concealed under thoſe words

(*m*) Numb.c.20. v. 5.

(*n*) Joel c. 1. v. 12.

(*o*) Hagg. c. 2. v. 19.

(*p*) Deut.c.8.v.8.

(*q*) 1 Kings c. 7. v. 20. & 2 Kings c. 25. v. 17. & 2 Chro. c. 3. v. 15, 16. & c. 4. v. 12, 13. & Jerem. c. 52. v. 21, 22.

words; (r) *In Principio creavit Elohim Cœlum & Terram:* for that they did not see how the Noun Plural *Elohim* (which is as much as to say *Dij*, [Gods] should be joyned with the Verb Singular, *Creavit*: But the Mystery of the Unity of Essence and Trinity of Persons in God being revealed, it was presently known, that the Singular Number, *Creavit*, had reference to the Unity of Essence, (in regard that the Works of the Trinity *ad extra* are indivisible) and the Plural, *Elohim*, to the Persons. Who, I pray, in elder times could have found out this Mystery? And thus the Name of God is thrice repeated in *Psal.* 67. (s) *God, even our God shall blesse us, God shall blesse us, &c.* Which at first might seem a Pleonasme, and superfluous repetition; but afterwards it was evident that *David* did there set out the Benedictions of several Persons implyed, to wit, the Father, Son, and Holy Ghost. Innumerable Examples of the like kind may be found in the Sacred Leaves. Therefore, to conclude, I will say with **David*, *Psal.* 92. *Oh Lord how glorious are thy Works! thy thoughts are very deep: an unwise man knoweth not, and a fool doth not understand these things.*

(r) Gen. c. 1. v. 1.

(s) Psal. 67. v. 6. 7.

* Psal. 92. v. 5, 6.

These are the particulars that I have thought fit to offer, as a Divine, concerning the not-improbable Opinion of the Mobility of the Earth and Stability of the Sun: which I hope will be acceptable to you, Reverend Sir, out of the love and diligence wherewith you persue Virtue and Learning. But (to the end that you may also receive an account of my other Studies) I hope very shortly to publish in Print my Second Tome **Of the Institutions of all Learnings*, which shall containe all the Liberall Arts, as I have already signified in that *Syntax*, and *Spicimen* by me heretofore put forth, and published under your Name. The other five following Tomes by me promised (which shall treat of Phylosophy and Theology) are not altogether so forward, nevertheless they will be speedily finished. In the mean time there will come forth my Book *Concerning* Oracles*, now finished, together with a Treatise * *Of Artificial Divination.* And for a Pledge thereof, I send you at this time annexed to this Epistle a Tract * *Concerning Natural Cosmological Divination*, or of Natural Prognosticks, and Presages of the Changes of Weather, and other things which fall within the compasse of Natue. God grant you all Happinesse.

* *Institutionum omnium Doctrinarum.*

* *De Oraculis.*

* *De Divinatione artificiosa.*

* *De Divinatione Naturali Cosmologica.*

Most Reverend Sir

NAPLES, from the Covent of the *Carmelites*, Jan. 6. 1615.

Your Most Humble Servant

PAOLO ANTONIO FOSCARINI.

FINIS.

Imprimatur, P. ANT. GHIBERT, *Vic. Gen.*

JOANNES LONGUS *Can. & Cur. Archiep. Neap.* THEOL. *Vidit.*

A

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TRANSLATIONS:

THE SECOND

TOME.

THE SECOND PART;

Containing,

I. D. Benedictus Castellus, *his* DISCOURSE *of the* MENSURATION *of* RUNNING WATERS.

II. *His Geometrical* DEMONSTRATIONS *of the Measure of* RUNNING WATERS.

III. *His* LETTERS *and* CONSIDERATIONS *touching the Draining of* FENNS, *Diversions of* RIVERS, *&c.*

IV. D. Corsinus, *His* RELATION *of the state of the Inundations, &c. in the Territories of* BOLOGNA, *and* FERRARA.

By THOMAS SALUSBURY, *Esq.*

LONDON,
Printed by William Leybourne, MDCLXI.

OF THE

MENSURATION

OF

RUNNING WATERS.

An Excellent Piece

Written in ITALIAN

BY

DON BENEDETTO CASTELLI,
Abbot of St. *BENEDETTO ALOYSIO*,
and Profeſſour of the Mathematicks to
Pope *URBAN VIII.* in *ROME*.

Engliſhed from the Third and beſt Edition, with the addition of a Second Book not before extant:

By *THOMAS SALUSBURY*.

LONDON,
Printed by WILLIAM LEYBOURN, 1661.

THE

AUTHOURS EPISTLE

TO

Pope VRBAN VIII.

I Lay at the Feet of your Holineſſe theſe my Conſiderations concerning the MENSURATION OF RUNNING WATERS: Wherein if I ſhall have ſucceeded, being a matter ſo difficult and unhandled by Writers both Ancient Modern, the diſcovery of any thing of truth hath been the Effect of Your Holineſſes Command; and if through inability I have miſſed the Mark, the ſame

Command will ſerve me for an Excuſe with Men of better Judgment, and more eſpecially with Your Holineſſe, to whom I humbly proſtrate my ſelf, and kiſſe Your Sacred Feet.

From ROME.

Your Holineſſes

Moſt humble Servant

BENEDETTO.

A Monk of *Caſſino*.

AN ACCOUNT OF THE Authour and Work.

DON BENEDETTO CASTELLI, *the famous Authour of these ensuing Discourses of the* Mensuration of Running Waters, *is descended from the Worshipful FAMILY of the* CASTELLII, *and took his first breath near to the lake THRASIMENUS, (where* Hanibal *gave a fatal overthrow to the* Roman *Legions) in that sweet and fertile part of happy* ITALY, *called the* Territory *of* PERUGIA, *a branch of the Dukedome of* TUSCANY, *which at present submitteth to the Jurisdiction of the Church, as being a part of* St. PETER'S Patrimony. *His Parents, who were more zealous of the good of his Soul than observant of the Propension of his Genius, dedicated him (according to the Devotion of that Country) to the Service of the Church; and entered him into the Flourishing Order of Black-Friers, called from the place Moncks of* Monte Cassino, *and from the Founder* Benedictines. *Nature, that She might consummate the Profusion of her Favours upon him, sent him into the World in an Age that was so ennobled and illuminated with Eminent Scholars in all Kinds of Literature, that hardly any Century since the Creation can boast the like.*

6. *In*

§. *In particular, the* SCIENCES MATHEMATICAL *had then got that Fame and Eſteem in the Learned World, that all men of Spirit or Quality became either Students in, or Patrons of thoſe Sublime Knowledges. On this occaſion the Curioſity of our* AUTHOUR *being awakened, his Active Wit could not endure to be any longer confined to the Slaviſh Tuition of Hermetical Pedagogues; but in concurrence with the Genius of the Age, he alſo betook himſelf to thoſe moſt Generous and Liberal Studies. His helps in this his deſign were ſo many, and ſo extraordinary, that had his Inclination been weaker, or his Apprehenſion leſſer, he could hardly have failed attaining more than a Common Eminency in theſe Sciences. For beſides the Deluge of Learned and Uſeful Books, which the Preſſe at that time ſent forth from all parts of* EUROPE, *he had the good Fortune to fall into the Acquaintance, and under the Inſtruction of the moſt Demonſtrative and moſt Familiar Man in the World, the Famous* GALILEO: *whoſe ſucceſſe being no leſſe upon this his* Pupil *than upon the reſt of thoſe Illuſtrious and Ingenious Perſons that reſorted from all parts to ſit under his Admirable Lectures, he in a ſhort time attained to that Name in the Mathematicks, that he was invited to* ROME, *Complemented, and Preferred by his then Holineſſe the Eighth* URBAN, *upon his very firſt Acceſſion to the* Papacy, *which was in the Year* 1623.

§. *This Pope being moved with a Paternal Providence for the Concerns of his Subjects in that part of* ITALY *about* BOLOGNA, FERRARA, *and* COMMACHIO, *lying between the Rivers of* PO *and* RENO, *which is part of* Lo Stato della Chieſa, *or the Church Patrimony, appoints this our* CASTELLI *in the Year* 1625, *to accompany the Right Honourable* Monſignore GORSINI (*a moſt obſervant and intelligent perſon in theſe affaires, and at that time Superintendent of the General Draines, and Preſident of* ROMAGNA) *in the Grand Viſitation which he was then ordered to make concerning the diſorders occaſioned by the Waters of thoſe parts.*

§. CASTELLI, *having now an Opportunity to employ, yea more, to improve ſuch Notions as he had imbued from the Lectures of his Excellent* MASTER, *falls to his work with all induſtry: and in the time that his Occaſions detained him in* ROMAGNA *he perfected the Firſt Book of this his Diſcourſe concerning the* Menſuration of Running Waters. *He confeſſeth that he had ſome years before applyed himſelf to this part of Practical Geometry, and from ſeveral Obſervations collected part of that Doctrine which at this time he put into Method, and which had procured him the Repute of ſo much Skill that he began*

to

to be Courted by ſundry Princes, and great Prelates. In particular about the beginning of the Year 1623. and before his Invitation to ROME *he was employed by Prince* Ferdinando I, *Grand Duke of* TUSCANY, *to remedy the Diſorders which at that time happened in the Valley of* PISA *in the Meadows that lye upon the Banks of* Serchio *and* Fiume Morto: *and in the preſence of the Grand Duke, Grand Dutcheſſe Mother, the Commiſſioners of Sewers, and ſundry other Perſons in a few hours he made ſo great a progreſſe in that affair, as gave his Moſt Serene Highneſſe high ſatisfaction, and gained himſelf much Honour.*

§. *No ſooner had he in his fore-mentioned Voiage to* ROMAGNA *(which was but few Moneths after, in the ſame Year) committed his Conceptions to paper, but he communicated them to certain of his Friends. In which number we finde* Signore Ciampoli *Secretary of the Popes Private Affaires; whom in the beginning of the Firſt Book he gratefully acknowledgeth to have been contributary, in his Purſe, towards defraying the charge of Experiments, and in his Perſon, towards the debating and compleating of Arguments upon this Subject. Some few years after the Importunity of Friends, and the Zeal he had for the Publique Good prevailed with him to preſent the World with his Firſt Diſcourſe, accompanied with a Treatiſe of the Geometrical Demonſtrations of his whole* Doctrine. *What Reception it found with the Judicious muſt needs be imagined by any one that hath obſerved how* Novelty *and* Facility *in conjunction with* Verity *make a Charm of irreſiſtable Operation.*

§. New *it was, for that no man before him had ever attempted to* Demonſtrate *all the three* Dimenſions, *to wit, the Length, Breadth and Profundity, of this Fluid and Current Element. And he detecteth ſuch groſſe Errours in thoſe few that had undertook to write upon the Subject (of which he inſanceth in* Frontinus *and* Fontana, *as thoſe that include the reſt) and delivereth ſuch ſingular and unheard-of Paradoxes (for ſo they ſound in Vulgar Eares) as cannot but procure unſpeakable delight to his Reader.*

§. Eaſie *it is likewiſe and* True; *and that upon ſo Familiar Experiments and Manifeſt* Demonſtrations, *that I have oft queſtioned with my ſelf which merited the greater wonder, he, for diſcovering, or all men that handled the Argument before him for not diſcovering a* Doctrine *of ſuch ſtrange* Facility *and Infallibility. But yet as if our Authour deſigned to oblige the whole World to him by ſo excellent a* Preſent, *he ſelects a Subject that he knew would be carreſſed by all perſons of Nobler Souls, upon the accounts afore-named, and by all Mankind in General, as gratifying them in their much adored Idol* Utility. *And to ren-*

der

der his Art the more profitable, he reduceth the lofty, and eaſie-to-be-miſtaken Speculations of the Theory, into certain and facile Directions for Practice; teaching us how to prevent and repaire the Breaches of Seas, and Inundations of Rivers; to draine and recover Fenns and Marches; to divert, conveigh and diſtribute Waters for the Flowing and Stercoration of Grounds, ſtrengthening of Fortifications, ſerving of Aquaducts, preſerving of Health (by cleanſing Streets, and ſcowring Sewers) and maintaining of Commerſe (by defending Bridges, cleering Rivers, and opening Ports and Channels) with innumerable other Benefits of the like nature. And, that I may omit no circumſtance that may recommend my Authour, the Fortune of this his Treatiſe hath been ſuch, that as if he intended a Plus ultra *by it, or as if all men deſpaired to out-do it, or laſtly, as if* CASTELLI *hath been ſo great a* Maſter *that none have preſumed to take Pencil in hand for the finiſhing of what he* Pourfoild, *this ſmall Tract like the Arabian Phœnix (of which it is ſaid* Unica ſemper Avis) *did for ſeveral years together continue ſingle in the World, till that to verifie it to be truly* Phœnician, *it renewed its Age by undergoing a ſecond Impreſſion. And as if this did not make out the Immortal vertue of it, it hath had* Anno 1660 *a third Circulation, and riſen in this laſt Edition as it were from the Urne of its Authour; and that ſo improved by the Addition of a ſecond part, that it promiſeth to perpetuate his Merits to all Poſterity. To be brief, the meer Fame of this Work reſounded the Honourable Name of* CASTELLI *into all the Corners of* Italy, *I may ſay of* Europe; *inſomuch, that, in hopes to reap great benefit by his Art, the reſpective Grandees of the adjacent Countries courted his Judgment and Advice about their* Draining of Fenns, Diverſion of Rivers, *Evacuation of Ports, Preventing of Inundations, &c. So that every Summer he made one or more of theſe Journies or Viſitations. Particularly, the Senate of* Venice *conſulted him about their Lake; to whom he delivered his Opinion in* May 1641. *and upon farther thoughts he preſented them with another Paper of Conſiderations the* 20 December *following. Prince* LEOPOLDO *of* TUSCANY *likewiſe requeſted his Advice in the beginning of the enſuing year* 1642, *which occaſioned his Letter to Father* Franceſco di San Giuſeppe, *bearing date* February 1, *To which* Signore Bartolotti *oppoſing, he writes a ſecond Letter, directed to one of the Commiſſioners of* Sewers, *vindicating his former, and refuting* Bartolotti, *both which I here give you.*

§. *The Preferments which his Merits recommended him unto, were firſt to be Abbot of* Caſſino, *from which he was removed*

Anno

Anno 1640, *or thereabouts, unto the Abbey of* Santo Benedetto Aloysio; *and much about the same time preferred to the Dignity of Chief Mathematician to his grand Patron Pope* URBAN VIII. *and Publique Professour of Mathematicks in the University of* ROME.

§. *Here a Stop was put to the Carier of his Fortunes, and being fuller of Honour than of Years, was by Death, the Importunate Intrerupter of Generous Designs, prevented in doing that farther Good which the World had good reason to promise it self from so Profound and Industrious a Personage, leaving many Friends and Disciples of all Degrees and Qualities to lament his losse, and honour his Memory.*

§. *His singular Virtues and Abilities had gained him the Friendship of very many; as to instance in some, he had contracted strict Amity with* Monsignore Maffei Barberino *a Florentine, Præfect of the Publique Wayes, and afterwards Pope with the Name of* URBAN VIII. *as was said before; with the above-named* Monsignore Corsini *Superintendant of the General Draines: with* Monsignore Piccolomini *Arch-Bishop of* Siena; *with Cardinal* Serra: *with Cardinal* Caponi, *who hath studied much and writ well upon this Subject; and with Cardinal* Gaetano *who frequently consulted with him in his design of Draining the Fenns of* ROMAGNA. *Moreover Prince* LEOPOLDO, *and his Brother the Grand Duke had very great kindnesse for him; which speaks no small attractioni in him, considering him as a favourite of the Family of* Barberini, *between whom and the House of* Medeci *there is an inveterate Fewd. Amongst persons of a lower Quality he acknowledgeth* Signore Ciampoli *the Popes Secretary*, Sig. Ferrante Cesarini, Sig. Giovanni Basadonna *Senator of* Venice; *and I find mentioned* Sig. Lana, Sig. Albano, Padre Serafino, Pad. Francesco de San. Giuseppe, *and many others.*

§. *The Works in which he will survive to all succeeding Ages are first His solid and sober Confutation of the Arguments of* Signore Lodovico dell Columbo, *and* Signore Vincentio di Gratia *against the Tract of* Galileo Delle cose che stanno sopra Aqua, *wherein he vindicates his said* Master *with a Gratitude that Tutors very rarely reap from the pains they take in Cultivating their Pupils. This Apology was first Printed* Anno 1615. *and was a second time published, as also those of his Antagonists, amongst the Works of* GALILEO, *set forth by the Learned* Viviani 1656. *He hath likewise writ several other curious Pieces, as I am informed by the most Courteous* Carolo Manolessi *of* Bologna; *amongst others an excellent Treatise concerning* Colours, *which he putteth me in hopes to see printed very*

very speedily. And last of all these Discourses and Reflections upon the Mensuration of Running Waters, *with the addition of a Second Book, three Epistles, and four Considerations upon the same Argument, which conduce much to Illustrate his Doctrine and Facilitate the Practice of it; and which with a Relation of* Monsignore Corsini, *make the second part of my First Tome.*

§. *I might here sally forth into the Citation of sundry Authours of Good Account, that have transmitted his Character to Posterity, but shall confine my self to onely two; the one is of his* Master, *the other of his* Scholar; *than whom there cannot be two more competent Judges of his Accomplishments. To begin with his* Master, *the Quick-sighted, and truly Lyncean* GALILEO, *who speaking of his Abilities in Astronomy saith* (a) Che la felicità del suo ingegno non la fà bisognosa dell' opera suo. *And again, submitting a certain Demonstration, which he intended to divulge, to the Judgment of this our Abbot, he writes to him in this manner:* (b) Questo lo comunico a V. S. per lettera prima che ad alcun altro, con attenderne principalmente il parer suo, e doppo quello de nostri Amici discosti, conpensiero d' inviarne poi altre Copie ad altri Amici d' Italia, e di Francia, quando io ne venga da lei consigliato: e qui pregandola a farci parte d' alcuna delle sue peregrine speculationi; con sincerissimo affetto, &c. *And the most acute Mathematician* Signore Evangelista Terricelli, *late Professour to the Grand Duke in immediate Succession after* GALILEO, *maketh this Honourable and Grateful Mention of him, and his Book:* (c) Omitto magnum illum nutantis Maris motum; Prætereo etiam omnem Fluminum, Aquarumque Currentium tum mensurum, tum usum, quarum omnis doctrina reperta primum fuit ab Abbate BENEDICTO CASTELLIO Preceptore meo. Scripsit ille Scientiam suam, & illam non solum demonstratione, verum etiam opere confirmavit, maxima cum Principum & populorum utilitate, majore cum admiratione Philosophorum. Extat illius Liber, vere aureus.

(a) Nella continuatione dell Nuntio sidereo.

(b) Lettera al P. Abbate D. B. Castelli D'Arcetro; li. 3. Decemb. 1639.

(c) De Motu Aquarum. Lib. 2. Prop. 37. p. 191.

§. *I have onely two particulars more to offer the English Reader: The one concerns the Book, and it is this, That after the general Aprobation it hath had in* Italy, *I cannot but think it deserveth the same Civil Entertainment with us, in regard that it cometh with no lesse* Novelty, Facility, Verity, and Utility *to us than to those whom the Authour favoured with the Original. Our Rivers and Sewers through Publique Distractions and Private Incroachments are in great disorder, as those Channels for instance which formerly were Navigable unto the very Walls of* York

York *and* Salisbury, *&c: Our Ports are choaked and obſtructed by Shelfes and Setlements: Our Fennsdo in a great part lie waſte and unimproved: Now all theſe may be (and, as I find by the Confeſſion of ſome whoſe Practiſes upon the Copy of the Firſt Book onely of our Authour hath got them both Money and Reputation, in part have been) remedied by the Ways and Means he here ſets down. The truth is the Argument hath been paſt over with an Univerſal Silence; ſo that to this day I have not ſeen any thing that hath been written Demonſtratively and with Mathematical Certainty concerning the ſame, ſave onely what this Learned Prelate hath delivered of his Own Invention in theſe Treatiſes: who yet hath ſo fully and plainly handled the Whole Doctrine, that I may affirm his Work to be every way abſolute. It muſt be confeſt the Demonſtration of the Second Propoſition of the Second Book did not well pleaſe the Authour, and had he lived he would have ſupplyed that defect, but being prevented by Death, the Reader muſt content himſelf with the Mechanical Proof that he giveth you of the truth of ſo Excellent a Concluſion.*

§. *The other particular that I am to offer is, that out of my deſire to contribute what lyeth in me to the compleating of this Piece for Engliſh Practice, I have exeeded my promiſe not onely in giving you the Second and following Books which were not extant at the time of tendring my Overtures, but alſo in that I have added a Map or Plat of all the Rivers, Lakes, Fenns, &c. mentioned thorowout the Work. And if I have not kept touch in point of Time, let it be conſidered that I am the Tranſlator and not the Printer. To conclude, according to your acceptance of theſe my endeavours, you may expect ſome other Tracts of no leſſe Profit and Delight.* Farewell.

T. S.

ERRATA of the *ſecond* PART of the *firſt* TOME.

In PREFACE, read *Ferdinando II.* ibid. *l'Aqua.*

PAGE 2. LINE 26, *for* muſt *read* much. P. 3. l. 22, *r.* and let. l. 25. *r.* water, from l. 41. *r.* Tappe, *(as every where elſe)*. Page 4. l. 18. *r* cords. Page 6. l. 9. *r.* acquire, or. Page 9. l. 1. *r.* irreperable. P. 10. l. 13. *r.* diſſimboguement. *For* Page 17. *r.* P. 15. P. 15. l. 27, *r.* in. l. 36, *r.* is as. l. 38, *r. Panaro.* P. 17. l. 12, *Giulio.* l. 17. *r.* Meaſurers. l. 25, *r.* meaſured it, *r.* neceſſarily. P. 23. l. 19. *r.* for help. *for* Page 31. *r.* P. 32. P. 24. l. 14, *r.* to. l. 17, *r.* namly, of the. l. 23, *r.* eaſie. P. 25. l. 38. *r.* Cock. p. 29. l. 7. *r.* laſted, . p. 31. l. 32. *r.* Soe. p. 41. l. 20. *r.* to the line. p. 48. l. 19. *r.* us the *. id. *Figure falſe* p. 52. l. 30, and 31. *for* Theorem *r.* Propoſition. p. 53. l. 29. *r.* again. p. 57. l. 19, *r.* ſame if. l. 44. *r.* bodily. p. 58. l. 9. *r.* gathering. l. 40. *omit*, p. 60. l. 2. *omit*, if. p. 65. l. 1. *r.* tide *dele*; p. 66. l. 35. *r.* Stoppage of. p. 68. l. 12, *for* Lords the *r.* Lords. l. *ult. for* they *r.* it. p. 69. l. 14. *r.* to one. *id.* carried *dele* to. p. 71. l. 20, *r.* and that. l. 25, *r.* Braces; it. l. 29. *r.* Braces. l. 44, *r.* the *Brent.* p. 72. l. 23. *r. Serene Highneſſe.* p. 73. l. 24, *r.* deliberation:. l. 26 *for* ſummer *r.* Moddel. l. 40. *r.* Months. p. 79. l. 18. *r.* that into. p. 82. l. 22. *dele*; p. 85. l. 9, 10. *dele* a free drame. p. 88. l. 5. *r.* Palmes. p. 89. l. 8. *r.* Princes. p. 92. l. 3. *r.* Diſcourſes. p. 93. l. 31. *r.* Tautologie. p. 94. l. 9. *r.* miracle; p. 97. l. 13. *r.* weighty. p. 101. l. 21. *r.* Marrara. p. 107. l. 28, *r.* Patrimony. l. 40, *r.* above. p. 111. l. 16. *r.* ſaid. *For* p. 432. *r.* p. 114. p. 114. l. 35. *r.* of 200. l. 41. *r.* cloſed. p. 115. l. 29. *r.* conſtant;.

OF THE MENSURATION OF Running Waters.

LIB. I.

WHat, and of how great moment the conſideration of *Motion* is in natural things, is ſo manifeſt, that the Prince of *Peripateticks* pronounced that in his Schools now much uſed Sentence: *Ignorato motu, ignoratur natura.* Thence it is that true Philoſophers have ſo travailed in the contemplation of the Celeſtial motions, and in the ſpeculation of the motions of Animals; that they have arrived to a wonderful height and ſublimity of underſtanding. Under the ſame Science of *Motion* is comprehended all that which is written by Mechanitians concerning Engines moving of themſelves, *Machins* moving by the force of Air, and thoſe which ſerve to move weights and immenſe magnitudes with ſmall force. There appertaineth to the Science of *Motion* all that which hath been written of the alteration not onely of Bodies, but of our Minds alſo; and in ſum, this ample matter of *Motion* is ſo extended and dilated, that there are few things which fall under mans notice, which are not conjoyned with *Motion*, or at leaſt depending thereupon, or to the knowledge thereof directed; and of almoſt every of them, there hath been written and compoſed by ſublime wits, learned Treatiſes and Inſtructions.

And becauſe that in the years paſt I had occaſion by Order of our Lord Pope *Urban* 8. to apply my thoughts to the motion of the Waters of Rivers, (a matter difficult, moſt important, and little handled by others) having concerning the ſame obſerved ſome particulars not well obſerved, or conſidered till now, but of great moment both in publick and private affairs; I have thought good to publiſh them, to the end that ingenious ſpirits might have occaſion to diſcuſſe more exactly then hitherto hath been done, ſo neceſſary and profitable a matter, and to ſupply alſo my defects in this ſhort and difficult Tractate. Difficult I ſay, for the truth is, theſe knowledges, though of things next our ſenſes, are ſometimes more abſtruce and hidden, then the knowledge of things more remote; and much better, and with greater exquiſitneſs are known the motions of the Planets, and Periods of the Stars, than thoſe of Rivers and Seas: As that ſingular light of Philoſophie of our times, and my Maſter *Signore Galileo Galilei* wiſely obſerveth in his Book concerning the Solar ſpots. And to proceed with a due order in Sciences, I will take ſome ſuppoſitions and cognitions ſufficiently clear; from which I will afterwards proceed to the deducing of the principal concluſions. But to the end that what I have written at the end of this diſcourſe in a demonſtrative and Geometrical method, may alſo be underſtood of thoſe which never have applyed their thoughts to the ſtudy of Geometry; I have endeavoured to explain my conceit by an example, and with the conſideration of the natural things themſelves, muſt after the ſame order in which I began to doubt in this matter; and have placed this particular Treatiſe here in the beginning, adverting nevertheleſs, that he who deſires more full and abſolute ſolidity of Reaſons, may overpaſs this prefatory diſcourſe, and onely conſider what is treated of in the demonſtrations placed towards the end, and return afterwards to the conſideration of the things collected in the *Corollaries* and Appendices; which demonſtrations notwithſtanding, may be pretermitted by him that hath not ſeen at leaſt the firſt ſix Books of the Elements of Euclid; ſo that he diligently obſerveth that which followeth.

I ſay therefore, that having in times paſt, on divers occaſions heard ſpeak of the meaſures of the waters of Rivers, and Fountains, ſaying, ſuch a River is two or three thouſand feet of water; ſuch a ſpring-water is twenty, thirty, or forty inches, *&c.* Although in ſuch manner I have found all to treat thereof in word and writing, without variety, and as we are wont to ſay, *conſtanti ſermone*, yea even Artiſts and Ingeneers, as if it were a thing that admitted not of any doubt, yet howſoever I remained ſtill infolded in ſuch an obſcurity, that I well knew I underſtood

derstood nothing at all, of that which others pretended full and clearly to understand. And my doubt arose from my frequent observation of many Trenches and Channels, which carry water to turn Mills, in which Trenches, and Channels, the water being measured, was found pretty deep; but if afterwards the same water was measured in the fall it made to turn the Wheel of the Mill, it was much lesse, not amounting often to the tenth part, nor sometimes to the twentieth, insomuch, that the same running water came to be one while more, another while less in measure, in divers parts of its Channel; and for that reason this vulgar manner of measuring running Waters, as indeterminate and uncertain, was by me justly suspected, the measure being to be determinate, and the same. And here I freely confesse that I had singular help to resolve this difficulty from the excellent & accurate way of discoursing, as in allother matters, so also in this, of the Right Honourable and Truly Noble Signior *Ciampoli*, Secretary of the Popes secret affairs. Who moreover, not sparing for the costs of the same, generously gave me occasion a few years past to try by exact experiments that which past concerning this particular. And to explain all more clearly with an example; we suppose a Vessel filled with Water, as for instance a Butt, which is kept full, though still water runneth out, and the Water run out by two Taps equal of bigneſſe, one put in the bottom of the Vessel, and the other in the upper part; it is manifest that in the time wherein from the upper part shall issue a determinate measure of water from the inferiour part there shall issue four, five, and many more of the same measures, according to the difference of the height of the Taps, and the distance of the upper Tap from the Superficies and level of the water of the Vessel: and all this will alwayes follow, though, as hath been said, the Taps be equal, and the water in discharging keep the said Taps alwayes full. Where first we note, that, although the measure of the Taps be equal, nevertheless there issueth from them in equal times unequal quantities of water, And if we should more attentively consider this busineſſe, we should find, that the water by the lower Tap, runneth and passeth with much greater velocity, then it doth by the upper; whatever is the reason. If therefore we would have such a quantity of Water discharge from the upper tap, as would discharge from the neather in the same time, it is plain, that either the upper Taps must be multiplyed in such sort, that so many more Taps in number be placed above than below, as the neather tap shall be more swift than the upper, or the upper Tap made so much bigger than the nether, by how much that beneath shall be more swift than that above; and so then in equal times, the same quantity of Water shall discharge from the upper, as doth from the neather part.

I will declare my ſelf by another example. If we ſhould imagine, that two cords or lines of equal thickneſs, be drawn through two holes of equal bore; but ſo that the firſt paſs with quadruple velocity to the ſecond: It is manifeſt, that if in a determinate time, we ſhall by the firſt bore have drawn four Ells of the line, in the ſame time, by the ſecond hole we ſhall have drawn but one Ell of cord onely; and if by the firſt there paſſe twelve Ells, then through the ſecond there ſhall paſſe onely three Ells; and in ſhort the quantity of cord ſhall have the ſame proportion to the cord, that the volocity hath to the velocity. And therefore we deſiring to compenſate the tardity of the ſecond cord, and maintaining the ſame tardity to draw through the ſecond hole as much cord as through the firſt, it will be neceſſary to draw through the ſecond bore four ends of cord; ſo that the thickneſs of all the cords by the ſecond hole, have the ſame proportion to the thickneſs of the cord which paſſeth onely by the firſt, as the velocity of the cord by the firſt hole hath reciprocally to the velocity of the codrs by the ſecond hole. And thus its clear, that when there is drawn through two holes equal quantity of cords in equal time, but with unequal velocity, it will be neceſſary, that the thickneſs of all the four cords ſhall have the ſame reciprocal proportion to the thickneſs of the ſwifter-cord, that the velocity of the ſwifter cord hath to the velocity of the ſlower. The which is verified likewiſe in the fluid Element of Water.

And to the end that this principal fundamental be well underſtood, I will alſo note a certain obſervation made my me in the Art of Wyer-drawing, or ſpinning Gold, Silver, Braſs, and Iron, and it is this; That ſuch Artificers deſiring more and more to diſgroſſe and ſubtillize the ſaid Metals, having wound about a Rocket or Barrel, the thread of the Metal, they place the Rocket in a frame upon a ſtedfaſt Axis, in ſuch ſort that the Rocket may turn about in it ſelf; then making one end of the thread to paſſe by force through a Plate of Steel pierced with divers holes, greater and leſſer, as need requireth, faſtning the ſame end of the thread to another Rocket, they wind up the thread, which paſſing through a bore leſs than the thickneſſe of the thread, is of force conſtrained to diſgroſſe and ſubtillize. Now that which is intenſly to be obſerved in this buſineſs, is this, That the parts of the thread before the hole, are of ſuch a thickneſſe, but the parts of the ſame thread after it is paſſed the hole, are of a leſſer thickneſſe: and yet nevertheleſſe the maſſe and weight of the thread which is drawn forth, is ever equal to the maſſe and weight of the thread which is winded up. But if we ſhould well conſider the matter, we ſhould finde, that the thicker the thread before the hole is, than the thread paſſed the hole, the greater reciprocally is the velocity

velocity of the parts of the thread paſſed the hole, than the velocity of the parts before the hole: Inſomuch that if *verbi gratia* the thickneſſe of the thread before the hole, were double to the thickneſſe after the hole, in ſuch caſe the velocity of the parts of the thread paſſed the hole, ſhould be double to the velocity of the parts of the thread before the hole; and thus the thickneſſe compenſates the velocity, and the velocity compenſates the thickneſſe. So that the ſame occurreth in the ſolid Metals of Gold, Silver, Braſs, Iron, &c. that eveneth alſo in the fluid Element of Water, and other liquids, namely, That the velocity beareth the ſame proportion to the velocity, that the thickneſſe of the Metal, or Water, hath to the thickneſſe.

And therefore granting this diſcourſe, we may ſay, that as often as two Taps with different velocity diſcharge equal quantities of Water in equal times, it will be neceſſary that the Tap leſſe ſwift be ſo much greater, and larger, than the Tap more ſwift, by how much the ſwifter ſuperates in velocity the ſlower; and to pronounce the Propoſition in more proper terms, we ſay; That if two Taps of unequal velocity, diſcharge in equal times equal quantities of Water, the greatneſſe of the firſt ſhall be to the greatneſſe of the ſecond, in reciprocal proportion, as the velocity of the ſecond to the velocity of the firſt. As for example, if the firſt Tap ſhall be ten times ſwifter than the ſecond Tap, it will be neceſſary, that the ſecond be ten times bigger and larger than the firſt; and in ſuch caſe the Taps ſhall diſcharge equall quantities of water in equal times; and this is the principal and moſt important point, which ought to be kept alwayes in minde, for that on it well underſtood depend many things profitable, and worthy of our knowledge.

Now applying all that hath been ſaid neerer to our purpoſe, I conſider, that it being moſt true, that in divers parts of the ſame River or Current of running water, there doth always paſſe equal quantity of Water in equal time (which thing is alſo demonſtrated in our firſt Propoſition) and it being alſo true, that in divers parts the ſame River may have various and different velocity; it follows of neceſſary conſequence, that where the River hath leſſe velocity, it ſhall be of greater meaſure, and in thoſe parts, in which it hath greater velocity, it ſhall be of leſſe meaſure; and in ſum, the velocity of ſeveral parts of the ſaid River, ſhall have eternally reciprocall and like proportion with their meaſures. This principle and fundamental well eſtabliſhed, that the ſame Current of Water changeth meaſure, according to its varying of velocity; that is, leſſening the meaſure, when the velocity encreaſeth, and encreaſing the meaſure, when the velocity decreaſeth; I paſſe to the conſideration of many par-

particular accidents in this admirable matter, and all depending on this ſole Propoſition, the ſenſe of which I have oft repeated, that it might be well underſtood.

COROLLARIE I.

AND firſt, we hence conclude, that the ſame Streams of a Torrent, namely, thoſe ſtreams which carry equal quantity of Water in equal times, make not the ſame depths or meaſures in the River, in which they enter, unleſſe when in the entrance into the River they acquire; or to ſay better, keep the ſame velocity; becauſe if the velocicities acquired in the River ſhall be different, alſo the meaſures ſhall be diverſe; and conſequently the depths, as is demonſtrated.

COROLLARIE II.

AND becauſe ſucceſſively, as the River is more and more full, it is conſtituted ordinarily in greater & greater velocity: hence it is that the ſame ſtreams of the Torrent, that enter into the River, make leſſe and leſſe depths, as the River grows more and more full; ſince that alſo the Waters of the Torrent being entered into the River, go acquiring greater and greater velocities, and therefore diminiſh in meaſure and height.

COROLLARIE III.

WE obſerve alſo, that while the main River is ſhallow, if there fall but a gentle rain, it ſuddenly much increaſeth and riſeth; but when the River is already ſwelled, though there fall again another new violent ſhower, yet it increaſeth not at the ſame rate as before, proportionably to the rain which fell: which thing we may affirm particularly to depend on this, that in the firſt caſe, while the River is low, it is found alſo very ſlow, and therefore the little water which entereth into it, paſſeth and runs with little velocity, and conſequently occupieth a great meaſure: But when the River is once augmented, by new water being alſo made more ſwift, it cauſeth the great Flood of water which falleth, to bear a leſſe meaſure, and not to make ſuch a depth.

COROLLARIE IV.

FRom the things demonſtrated is manifeſt alſo, that whilſt a Torrent entereth into a River, at the time of Ebbe, then the Torrent moveth with ſuch a certain velocity, what ever it be, paſſing

passing by its extreamest parts, wherewith it communicateth with the River; in which parts, the Torrent being measured, shall have such a certain measure: but the River, swelling and rising, also those parts of the Torrent augment in greatnesse and measure, though the Torrent, in that instant, dis-imbogue no more water than it did before: so that the River being swelled, we are to consider two mouths of the same Torrent, one lesse before the rising, the other greater after the rising, which mouths discharge equal quantities of water in equal times; therefore the velocity by the lesser mouth shall be greater than the velocity by the greater mouth; and thus the Torrent shall be retarded from its ordinary course.

COROLLARIE V.

FRom which operation of Nature proceedeth another effect worthy of consideration; and it is, that the course of the water retarding, as hath been said in those ultimate parts of the Torrent, if it shall happen that the Torrent grow torbid and muddy, and its streame be retarded in such a degree, that it is not able to carry away those minute grains of Earth, which compose the muddinesse; in this case the Torrent shall clear away the mud, and carry away the Sand at the bottome of its own Chanel, in the extream parts of its mouth, which raised and voided Sand, shall again afterwards be carried away, when the River abating, the Torrent shall return to move with its primitive velocity.

COROLLARIE VI.

WHilst it is demonstrated, that the same water hath different measures in its Chanel or course, according as it varieth in velocity; so that the measure of the water is alwayes greater, where the velocity is lesser; and on the contrary, the measure lesser, where the velocity is greater: from hence we may most elegantly render the reason of the usual Proverb, *Take heed of the still waters*: For that if we consider the self same water of a River in those parts, wherein it is less swift, and thence called *still* or *smooth* water, it shall be, of necessity, of greater measure than in those parts, in which it is more swift, and therefore ordinarily shall be also more deep and dangerous for passengers; whence it is well said, *Take heed of the still Waters*; and this saying hath been since applied to things moral.

COROLLARIE VII.

LIkewiſe, from the things demonſtrated may be concluded, that the windes, which ſtop a River, and blowing againſt the Current, retard its courſe and ordinary velocity ſhall neceſſarily amplifie the meaſure of the ſame River, and conſequently ſhall be, in great part, cauſes; or we may ſay, potent con-cauſes of making the extraordinary inundations which Rivers uſe to make. And its moſt certain, that as often as a ſtrong and continual wind ſhall blow againſt the Current of a River, and ſhall reduce the water of the River to ſuch tardity of motion, that in the time wherein before it run five miles, it now moveth but one, ſuch a River will increaſe to five times the meaſure, though there ſhould not be added any other quantity of water; which thing indeed hath in it ſomething of ſtrange, but it is moſt certain, for that look what proportion the waters velocity before the winde, hath to the velocity after the winde, and ſuch reciprocally is the meaſure of the ſame water after the winde, to the meaſure before the winde; and becauſe it hath been ſuppoſed in our caſe that the velocity is diminiſhed to a fifth part, therefore the meaſure ſhall be increaſed five times more than that, which it was before.

COROLLARIE VIII.

WE have alſo probable the cauſe of the inundations of *Tyber*, which befel at *Rome*, in the time of *Alexander* the Sixth, & of *Clement* the Seventh; which innundations came in a ſerene time, and without great thaws of the Snows; which therefore much puzzled the wits of thoſe times. But we may with much probability affirm, That the River roſe to ſuch a height and excreſcence, by the retardation of the Waters dependant on the boiſtrous and conſtant Winds, that blew in thoſe times, as is noted in the memorials.

COROLLARIE. IX.

IT being moſt manifeſt, that by the great abundance of Water the Torrents may increaſe, and of themſelves alone exorbitantly ſwell the River; and having demonſtrated that alſo without new Water, but onely by the notable retardment the River riſeth and increaſeth in meaſure, in proportion as the velocity decreaſeth: hence it is apparent, that each of theſe cauſes being able of it ſelf, and ſeparate from the other to ſwell the River; when it ſhall happen that both theſe two cauſes conſpire the augmentation of the

the River, in ſuch a caſe there muſt follow very great and irrepable innundations.

COROLLARIE X.

FRom what hath been demonſtrated, we may with facility reſolve the doubt which hath troubled, and ſtill poſeth the moſt diligent, but incautelous obſervers of Rivers, who meaſuring the Streams and Torrents which fall into another River; as thoſe for inſtance, which enter into the *Po*, or thoſe which fall into *Tiber*; and having ſummed the total of theſe meaſures, and conferring the meaſures of the Rivers and Brooks, which fall into *Tiber*, with the meaſure of *Tiber*, and the meaſures of thoſe which diſimbogue into *Po*, with the meaſure of *Po*, they find them not equal, as, it ſeems to them, they ought to be, and this is becauſe they have not well noted the moſt important point of the variation of velocity, and how that it is the moſt potent cauſe of wonderfully altering the meaſures of running Waters; but we moſt facilly reſolving the doubt, may ſay that theſe Waters diminiſh the meaſure, being once entered the principal Channel, becauſe they increaſe in velocity.

COROLLARIE XI.

THrough the ignorance of the force of the velocity of the Water, in altering its meaſure, & augmenting it when the velocity diminiſheth; and diminiſhing it when the velocity augmenteth: The Architect *Giovanni Fontana*, endeavoured to meaſure, and and to cauſe to be meaſured by his Nephew, all the Brooks and Rivers which diſcharged their Waters into *Tiber*, at the time of the Innundation; which happened at *Rome* in the year 1598, and publiſhed a ſmall Treatiſe thereof, wherein he ſummeth up the meaſures of the extraordinary Water which fell into *Tiber*, and made account that it was about five hundred Ells more than ordinary; and in the end of that Treatiſe concludeth, that to remove the Innundation wholly from *Rome*, it would be neceſſary to make two other Channels, equal to that at preſent, and that leſſe would not ſuffice; and finding afterwards that the whole Stream paſſed under the Bridge *Quattro-Capi*, (the Arch whereof is of a far leſs meaſure then five hundred Ells) concludeth, that under the ſaid Bridge paſt a hundred fifty one Ells of Water compreſſed, (I have ſet down the preciſe term of compreſt Water, written by *Fontana*) wherein I finde many errors.

The firſt of which is to think that the meaſures of theſe Waters compreſſed in the Channels of thoſe Brooks and Rivers,

ſhould maintain themſelves the ſame in *Tiber*, which by his leave, is moſt falſe, when ever thoſe waters reduced into *Tiber*, retain not the ſame velocity which they had in the place in which *Fontana* and his Nephew meaſured them: And all this is manifeſt from the things which we have above explained; for, if the Waters reduced into *Tiber* increaſe in velocity, they decreaſe in meaſure; and if they decreaſe in velocity, they increaſe in meaſure.

Secondly, I conſider that the meaſures of thoſe Brooks and Rivers, which enter into *Tiber* at the time of Innundation, are not between themſelves really the ſame, when their velocities are not equal, though they have the ſame names of Ells and Feet; for that its poſſible that a diſinboguement of ten Ells requadrated (to ſpeak in the phraſe of *Fontana*) of one of thoſe Brooks, might diſcharge into *Tiber* at the time of Innundation, four, ten, and twenty times leſs Water, than another mouth equal to the firſt in greatneſs, as would occur when the firſt mouth were four, ten, or twenty times leſs ſwift than the ſecond. Whereupon, whilſt *Fontana* ſummes up the Ells and Feet of the meaſures of thoſe Brooks and Rivers into a total aggregate, he commits the ſame error with him, which would add into one ſumme diverſe moneys of diverſe values, and diverſe places, but that had the ſame name; as if one ſhould ſay ten Crowns of *Roman* money, four Crowns of Gold, thirteen Crowns of *Florence*, five Crowns of *Venice*, and eight Crowns of *Mantua*, ſhould make the ſame ſumme with forty Crowns of Gold, or forty Crowns of *Mantua*.

Thirdly, It might happen that ſome River or Current in the parts nearer *Rome*, in the time of its flowing, did not ſend forth more Water than ordinary; and however, its a thing very clear, that whilſt the ſtream came from the ſuperior parts, that ſame Brook or River would be augmented in meaſure, as hath been noted in the fourth *Corollary*; in ſuch ſort, that *Fontana* might have inculcated, and noted that ſame River or Current as concurring to the Innundation, although it were therein altogether unconcerned.

Moreover, in the fourth place we muſt note, That it might ſo fall out, that ſuch a River not onely was unintereſſed in the Innundation, though augmented in meaſure, but it might I ſay happen, that it was inſtrumental to the aſſwaging the Innundation, by augmenting in the meaſure of its own Channel; which matter is ſufficiently evident; for if it be ſuppoſed that the River in the time of flood, had not had of it ſelf, and from its proper ſprings more Water than ordinary, its a thing certain, that the Water of *Tiber* riſing and increaſing; alſo that River, to level it ſelf with the Water of *Tiber*, would have retained ſome of its

its Waters in its own Chanel, without discharging them into *Tyber*, or else would have ingorged and swallowed (if I may so say) some of the water of *Tyber*; and in this case, at the time of Inundation, lesse abundance of water would have come to *Rome*, and yet nevertheless the measure of that River would have been increased.

Fifthly, *Fontana* deceiveth himself, when he concludeth, that to remove the Inundation from *Rome*, it would be necessary to make two other Chanels of Rivers, that were as large as that, which is the present one, and that less would not suffice, which, I say, is a fallacy: and to convince him easily of his errour, it sufficeth to say, that all the Streams being passed under the Bridge *Quattro-Capi*, as he himself attests, a Channel would suffice only of the capacity of the said Bridge, provided that the water there might run with the same velocity, as it did under the Bridge at the time of Inundation; and on the contrary, twenty Currents of capacity equal to the present one, would not suffice, if the water should run with twenty times less velocity, than it made at the time of the Inundation.

Sixthly, to me it seemeth a great weakness to say, that there should passe under the Bridge *Quattro-Capi*, an hundred fifty one ells of water compressed; for that I do not understand that water is like Cotton or Wool, which matters may be prest and trod, as it happeneth also to the air, which receiveth compression in such sort, that after that in some certain place a quantity of air shall be reduced to its natural constitution; and having taken up all the said place, yet nevertheless compressing the first Air with force and violence, it is reduced into far less room, and will admit four or six times as much air, as before, as is experimentally * seen in the Wind-Gun, invented in our dayes by *M. Vincenzo Vincenti* of *Urbin*, which property of the Air of admitting condensation, is also seen in the portable Fountains of the same *M. Vincenzo*: which Fountains spirt the Water on high, by force of the Air compressed, which whilst it seeks to reduce its self to its natural constitution, in the dilation causeth that violence. But the water can never, for any thing I know, crowd, or press so, as that if before the compression it held or possest a place, being in its natural constitution, I believe not, I say, that it is possible, by pressing and crowding to make it possess less room, for if it were possible to compress the Water, and make it to occupy a less place, it would thence follow, that two Vessels of equal measure, but of unequal height, should be of unequal capacity, and that should hold more water which was higher; also a Cylinder, or other Vessel more high than broad, would containe more water erected, than being laid along; for that being erected,

* And as is at large demonstrated by that most excellent and Honourable personage *Mr. Boile* in the industrious experiment of his Pneumatic Engine.

ed, the water put therein would be more preſſed and crowded.

And therefore, in our caſe, according to our principles we will ſay, that the water of that Stream paſseth all under the ſaid Bridge *Quattro-Capi*, for that being there moſt ſwift, it ought of conſequeuce to be leſs in meaſure.

And here one may ſee, into how many errours a man may run through ignorance of a true and real Principle, which once known and well underſtood, takes away all miſts of doubting, and eaſily reſolveth all difficulties.

COROLLARIE. XII.

THrough the ſame inadvertency of not regarding the variation of velocity in the ſame Current, there are committed by Ingineers and Learned men, errours of very great moment (and I could thereof produce examples, but for good reaſons I paſs them over in ſilence) when they think, and propoſe, by deriving new Channels from great Rivers, to diminiſh the meaſure of the water in the River, and to diminiſh it proportionally, according to the meaſure of the Water which they make to paſs through the Channel, as making *v.g.* a Channel fifty foot broad, in which the derived water is to run waſt, ten foot deep, they think they have diminiſhed the meaſure of the Water in the River five hundred feet, which thing doth not indeed ſo fall out; and the reaſon is plain; for that the Chanel being derived, the reſt of the main River, diminiſheth in velocity, and therefore retains a greater meaſure than it had at firſt before the derivation of the Chanel; and moreover, if the Chanel being derived, it ſhall not conſerve the ſame velocity which it had at firſt in the main River, but ſhall diminiſh it, it will be neceſſary, that it hath a greater meaſure than it had before in the River; and therefore to accompt aright, there ſhall not be ſo much water derived into the Channel, as ſhall diminiſh the River, according to the quantity of the water in the Channel, as is pretended.

COROLLARIE XIII.

THis ſame conſideration giveth me occaſion to diſcover a moſt ordinary errour, obſerved by me in the buſineſſe of the water of *Ferara*, when I was in thoſe parts, in ſervice of the moſt Reverend and Illuſtrious Monſignor *Corſini*; the ſublime wit of whom hath been a very great help to me in theſe contemplations; its very true, I have been much perplexed, whether I ſhould commit this particular to paper, or paſſe it over in ſilence, for that I have ever doubted; that the opinion ſo common and more-

moreover confirmed with a moſt manifeſt experiment, may not onely make this my conjecture to be eſteemed far from true, but alſo to diſcredit with the World the reſt of this my Treatiſe: Nevertheleſſe I have at laſt reſolved not to be wanting to my ſelf, and to truth in a matter of it ſelf, and for other conſequences moſt important; nor doth it ſeem to me requiſite in difficult matters, ſuch as theſe we have in hand, to reſigne our ſelves to the common opinion, ſince it would be very ſtrange if the multitude in ſuch matters ſhould hit on the truth; nor ought that to be held difficult, in which even the vulgar do know the truth and right; beſides that I hope moreover to prove all in ſuch ſort, that perſons of ſolid judgment, ſhall reſt fully perſwaded, ſo that they but keep in mind the principal ground and foundation of all this Treatiſe; and though that which I will propoſe, be a particular; as I have ſaid, pertaining onely to the intereſts of *Ferara*; yet nevertheleſſe from this particular Doctrine well underſtood, good judgement may be made of other the like caſes in general: I ſay then, for greater perſpecuity, and better underſtanding of the whole, That about thirteen miles above *Ferara*, near to *Stellata*, the main of *Po*, branching it ſelf into two parts, with one of its Arms it cometh cloſe to *Ferara*, retaining the name of the Po of *Ferara*; and here again it divideth it ſelf into two other branches, and that which continueth on the right hand, is called the Po of *Argenta*, and of *Primaro*; and that on the left the Po of *Volana*. But for that the bed of the Po of *Ferara* being heretofore augmented and raiſed, it followeth that it reſteth wholly deprived of the Water of the great Po, except in the time of its greater ſwelling; for in that caſe, this Po of *Ferara* being reſtrained with a Bank near to *Bondeno*, would come alſo in the overflowings of the main Po, to be free from its Waters: But the Lords of *Ferara* are wont at ſuch time as the Po threateneth to break out, to cut the bank; by which cutting, there diſgorgeth ſuch a Torrent of Water, that it is obſerved, that the main Po in the ſpace of ſome few hours abateth near a foot, and all perſons that I have ſpoken with hitherto, moved by this experiment, think that it is of great profit and benefit to keep ready this Vent, and to make uſe of it in the time of its fullneſſe. And indeed, the thing conſidered ſimply, and at the firſt appearance, it ſeemeth that none can think otherwiſe; the rather, for that many examining the matter narrowly, meaſure that body of Water which runneth by the Channel, or Bed of the Po of *Ferara*, and make account, that the body of the Water of the great Po, is diminiſhed the quantity of the body of the Water which runneth by the Po of *Ferara*. But if we well remember what hath been ſaid in the beginning of the Treatiſe, and how much

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the variety of the velocities of the ſaid Water importeth, and the knowledge of them is neceſſary to conclude the true quantity of the running Water, we ſhall finde it manifeſt, that the benefit of this Vent is far leſſe than it is generally thought: And moreover, we ſhall finde, if I deceive not my ſelf, that there follow from thence ſo many miſchiefs, that I could greatly incline to believe, that it were more to the purpoſe wholly to ſtop it up, than to maintain it open: yet I am not ſo wedded to my opinion, but that I am ready to change my judgement upon ſtrength of better reaſons; eſpecially of one that ſhall have firſt well underſtood the beginning of this my diſcourſe, which I frequently inculcate, becauſe its abſolutely impoſſible without this advertiſement to treat of theſe matters, and not commit very great errours.

I propoſe therefore to conſideration, that although it be true, that whilſt the water of the main *Po* is at its greateſt height, the Bank and Dam then cut of the *Po* of *Ferara*, and the ſuperior waters having a very great fall into the Channel of *Ferara*, they precipitate into the ſame with great violence and velocity, and with the ſame in the beginning, or little leſſe, they run towards the *Po* of *Volana*, and of *Argenta* on the ſea coaſts; yet after the ſpace of ſome few hours, the *Po* of *Ferara* being full, and the ſuperior Waters not finding ſo great a diclivity there, as they had at the beginning of the cutting, they fall not into the ſame with the former velocity, but with far leſſe, and thereby a great deal leſſe Water begins to iſſue from the great *Po*; and if we diligently compare the velocity at the firſt cutting, with the velocity of the Water after the cutting made, and when the *Po* of *Ferara* ſhall be full of Water, we ſhall finde perhaps that to be fifteen or twenty times greater than this, and conſequently the Water which iſſues from the great *Po*, that firſt impetuoſity being paſt, ſhall be onely the fifteenth or twentieth part of that which iſſued at the beginning; and therefore the Waters of the main *Po* will return in a ſmall time almoſt to the firſt height. And here I will pray thoſe who reſt not wholly ſatisfied with what hath been ſaid, that for the love of truth, and the common good, they would pleaſe to make diligent obſervation whether in the time of great Floods, the ſaid Bank or Dam at *Bondeno* is cut, and that in few hours the main *Po* diminiſheth, as hath been ſaid about a foot in its height; that they would obſerve I ſay, whether, a day or two being paſt, the Waters of the main *Po* return almoſt to their firſt height; for if this ſhould follow, it would be very clear, that the benefit which reſulteth from this diverſion or Vent, is not ſo great as is univerſally preſumed; I ſay, it is not ſo great as is preſumed; becauſe, though it be granted for true, that the Waters of the main *Po*, abate at the beginning of the

the Vent, yet this benefit happens to be but temporary and for a few hours: If the riſing of *Po*, and the dangers of breaking forth were of ſhort duration, as it ordinarily befalleth in the overflowings of Torrents, in ſuch a caſe the profit of the Vent would be of ſome eſteem: But becauſe the ſwellings of *Po* continue for thirty, or ſometimes for forty dayes, therefore the gain which reſults from the Vent proveth to be inconſiderable. It remaineth now to conſider the notable harms which follow the ſaid Sluice or Vent; that ſo reflection being made, and the profit and the detriment compared, one may rightly judge, and chooſe that which ſhall be moſt convenient. The firſt prejudice therefore which ariſeth from this Vent or Sluice, is; That the Channels of *Ferara*, *Primaro*, and *Volana* filling with Water, all thoſe parts from *Bondeno* to the Sea ſide are allarmed and endangered thereby. Secondly, The Waters of the *Po* of *Primaro* having free ingreſſe into the upper Valleys, they fill them to the great damage of the Fields adjacent, and obſtruct the courſe of the ordinary Trenches in the ſame Valleys; inſomuch that all the care, coſt, and labour about the draining and freeing the upper Valleys from Water, would alſo become vain and ineffectual. Thirdly, I conſider that theſe Waters of the *Po* of *Ferara* being paſſed downwards towards the Sea, at the time that the main *Po* was in its greater excreſcences and heights, it is manifeſt by experience, that when the great *Po* diminiſheth, then theſe Waters paſſed by the *Po* of *Ferara* begin to retard in their courſe, and finally come to turn the current upwards towards *Stellata*, reſting firſt in the intermediate time, almoſt fixed and ſtanding, and therefore depoſing the muddineſſe, they fill up the Channel of the River or Current of *Ferara*. Fourthly and laſtly, There followeth from this ſame diverſion another notable damage, and it is like to that which followeth the breaches made by Rivers; near to which breaches in the lower parts, namely below the breach, there is begot in the Channel of the River, a certain ridge or ſhelf, that is, the bottom of the River is raiſed, as is ſufficiently manifeſt by experience; and thus juſt in the ſame manner cutting the Bank at *Bondeno*, there is at it were a breach made, from which followeth the riſing in the lower parts of the main *Po*, being paſt the mouth of *Pamaro*, which thing, how pernitious it is, let any one judge that underſtandeth theſe matters. And therefore both for the ſmall benefit, and ſo many harms that enſue from maintaining this diverſion, I ſhould think it were more ſound advice to keep that Bank alwaies whole at *Bondeno*, or in any other convenient place, and not to permit that the Water of the Grand *Po* ſhould ever come near to *Ferara*.

COROLLARIE XIV.

IN the Grand Rivers, which fall into the Sea, as here in *Italy* *Po*, *Adige*,* and *Arno*, which are armed with Banks againſt their excreſcencies, its obſerved that far from the Sea, they need Banks of a notable height; which height goeth afterwards by degrees diminiſhing, the more it approacheth to the Sea-coaſts: in ſuch ſort, that the *Po*, diſtant from the Sea about fifty or ſixty miles at *Ferara*, ſhall have Banks that be above twenty feet higher than the ordinary Water-marks; but ten or twelve miles from the Sea, the Banks are not twelve feet higher than the ſaid ordinary Water-marks, though the breadth of the River be the ſame, ſo that the excreſcence of the ſame Innundation happens to be far greater in meaſure remote from the Sea, then near; and yet it ſhould ſeem, that the ſame quantity of Water paſſing by every place, the River ſhould need to have the ſame altitude of Banks in all places: But we by our Principles and fundamentals may be able to render the reaſon of that effect, and ſay; That that exceſſe of quantity of Water, above the ordinary Water, goeth alwaies acquiring greater velocity; the nearer it approacheth the Sea, and therefore decreaſeth in meaſure, and conſequenly in height. And this perhaps might have been the cauſe in great part, why the *Tyber* in the Innundation *Anno* 1578. iſſued not forth of its Channel below *Rome* towards the Sea.

* *Artefia.*

COROLLARIE XV.

FRom the ſame Doctrine may be rendred a moſt manifeſt reaſon why the falling Waters go leſſening in their deſcent, ſo that the ſame falling Water, meaſured at the beginning of its fall, is greater, and bigger, and afterwards by degrees leſſeneth in meaſure the more it is remote from the beginning of the fall. Which dependeth on no other, than on the acquiſition, which it ſucceſſively makes of greater velocity; it being a moſt familiar concluſion among Philoſophers, that grave bodies falling, the more they remove from the beginning of their motion, the more they acquire of ſwiftneſſe; and therefore the Water, as a grave body, falling, gradually velocitates, and therefore decreaſeth in meaſure, and leſſeneth.

COROLLARIE XVI.

AND on the contrary, the ſpirtings of a Fountain of Water, which ſpring on high, work a contrary effect; namely in

in the beginning they are ſmall, and afterwards become greater and bigge; and the reaſon is moſt manifeſt, becauſe in the beginning they are very ſwift, and afterwards gradually relent their impetuoſity, and motion; ſo that in the beginning of the excurſion that they make, they ought to be ſmall, and afterwards to grow bigger, as in the effect is ſeen.

APPENDIX. I.

INto the errour of not conſidering how much the different velocities of the ſame running water in ſeveral places of its current, are able to change the meaſure of the ſame water, and to make it greater, or leſſe, I think, if I be not deceived, that *Ginlio Frontino* a noble antient Writer, may have faln in the Second Book which he writ, of the Aqueducts of the City of *Rome*: Whilſt finding the meaſure of the Water **Commentariis* leſſe than it was *in erogatione* 1263. *Quinaries*, he thought that ſo much difference might proceed from the negligence of the Meaſures; and when afterwards with his own induſtry he meaſured the ſame water at the beginnings of the Aqueducts, finding it neer 10000. *Quinaries* bigger than it was *in Commentariis* he judged, that the overplus was imbeziled by Miniſters and Partakers; which in part might be ſo, for it is but too true, that the publique is almoſt alwayes defrauded; yet nevertheleſſe, I verily believe withal; that beſides the frauds of theſe Officers, the velocities of the water in the place wherein *Frontino* meaſured, it might be different from thoſe velocities, which are found in other places before meaſured by others; and therefore the meaſures of the waters might, yea ought neceſſarily to be different, it having been by us demonſtrated, that the meaſures of the ſame running water have reciprocal proportion to their velocities. Which *Frontino* not well conſidering, and finding the water *in Commentariis* 12755. *Quinaries in erogatione* 14018, and in his own meaſure *ad capita ductuum*, at the head of the fountain 12755. *Quinaries*, or thereabouts, he thought, that in all theſe places there paſt different quantities of water; namely, greater at the fountain head then that which was *in Erogatione*, and this he judged greater than that which was *in Commentariis*.

* *Commentarius* beareth many ſenſes, but in this place ſignifieth a certain Regiſter of the quantities of the Waters in the ſeveral publique Aquiducts of *Rome*; which word I find frequently uſed in the Law-books of antient Civilians: And by errogation we are to underſtand the diſtribution or delivering out of thoſe ſtores of Water.

APPENDIX II.

A Like miſtake chanced lately in the Aqueduct of *Acqua-Paola*, which Water ſhould be 2000 Inches, and ſo many effectively ought to be allowed; and it hath been given in

ſo to be by the Signors of *Bracciano* to the *Apoſtolick-Chamber*; and there was a meaſure thereof made at the beginning of the Aqueduct; which meaſure proved afterwards much leſſe and ſhort, conſidered and taken in *Rome*, and thence followed diſcontents and great diſorders, and all becauſe this property of Running-Waters, of increaſing in meaſure, where the velocity decreaſed; and of diminiſhing in meaſure, where the velocity augmented, was not lookt into.

APPENDIX III.

ALike errour, in my judgement, hath been committed by all thoſe learned men, which to prevent the diverſion of the *Reno* of *Bologna* into *Po* by the Channels, through which it at preſent runneth, judged, that the *Reno* being in its greater excreſcence about 2000. feet, and the *Po* being near 1000. feet broad, they judged, I ſay, that letting the *Reno* into *Po*, it would have raiſed the Water of *Po* two feet; from which riſe, they concluded afterwards moſt exorbitant diſorders, either of extraordinary Inundations, or elſe of immenſe and intolerable expences to the people in raiſing the Banks of *Po* and *Reno*, and with ſuch like weakneſſes, often vainly diſturbed the minds of the perſons concerned: But now from the things demonſtrated, it is manifeſt, That the meaſure of the *Reno* in *Reno*, would be different from the meaſure of *Reno* in *Po*; in caſe that the velocity of the *Reno* in *Po*, ſhould differ from the velocity of *Reno* in *Reno*, as is more exactly determined in the fourth Propoſition.

APPENDIX IV.

NO leſs likewiſe are thoſe Ingeneers and Artiſts deceived, that have affirmed, That letting the *Reno* into *Po*, there would be no riſe at all in the Water of *Po*: For the truth is, That letting *Reno* into *Po*, there would alwaies be a riſing; but ſometimes greater, ſometimes leſſe, as the *Po* ſhall have a ſwifter or ſlower Current; ſo that if the *Po* ſhall be conſtituted in a great velocity, the riſe will be very ſmall; and if the ſaid *Po* ſhall be ſlow in its courſe, then the riſe will be notable.

APPENDIX V.

AND here it will not be beſides the purpoſe to advertiſe, That the meaſures, partments, and diſtributions of the Waters of Fountains, cannot be made exactly, unleſs there be conſidered

ſidered, beſides the meaſure, the velocity alſo of the Water; which particular not being thorowly obſerved, is the cauſe of continual miſcariages in ſuch like affairs.

APPENDIX VI.

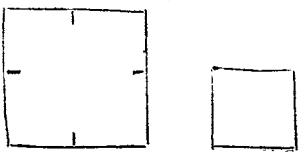
LIke conſideration ought to be had with the greater diligence, for that an errour therein is more prejudicial; I ſay, ought to be had by thoſe which part and divide VVaters; for the watering of fields, as is done in the Territories of *Breſcia*, *Bergama*, *Crema*, *Pavia*, *Lodigiano*, *Cremona*, and other places: For if they have not regard to the moſt important point of the variation of the velocity of the VVater, but onely to the bare Vulgar meaſure, there will alwaies very great diſorders and prejudices enſue to the perſons concerned.

APPENDIX VII.

IT ſeemeth that one may obſerve, that whilſt the Water runneth along a Channel, Current, or Conduit, its velocity is retarded, withheld, and impeded by its touching the Bank or ſide of the ſaid Channel or Current; which, as immoveable, not following the motion of the VVater, interrupteth its velocity: From which particular, being true, as I believe it to be moſt true, and from our conſiderations, we have an occaſion of diſcovering a very nice miſtake, into which thoſe commonly fall who divide the VVaters of Fountains. VVhich diviſion is wont to be, by what I have ſeen here in *Rome*, performed two wayes; The firſt of which is with the meaſures of like figures, as Circles, or Squares, having cut through a Plate of metal ſeveral Circles or Squares, one of half an inch, another of one inch, another of two, of three, of four, *&c.* with which they afterwards adjuſt the Cocks to diſpence the VVaters. The other manner of dividing the VVaters of Fountains, is with rectangle paralellograms, of the ſame height, but of different Baſes, in ſuch ſort likewiſe, that one paralellogram be of half an inch, another of one, two, three, *&c.* In which manner of meaſuring and dividing the Water, it ſhould ſeem that the Cocks being placed in one and the ſame plain, equidiſtant from the level, or ſuperior ſuperficies of the water of the Well; and the ſaid meaſures being moſt exactly made, the VVater ought conſequently alſo to be equally divided, and parted according to the proportion of the meaſures. But if we well conſider every particular, we ſhall finde, that the Cocks, as they ſucceſſively are greater, diſcharge alwaies more VVater than the juſt quantity, in compariſon of

the leſſer; that is, to ſpeak more properly, The VVater which paſſeth through the greater Cock, hath alwaies a greater proportion to that which paſſeth through the leſſer, than the greater Cock hath to the leſſer. All which I will declare by an example.

Let there be ſuppoſed for more plainneſs two Squares; (the ſame may be underſtood of Circles, and other like Figures) The firſt Square is, as we will ſuppoſe, quadruple to the other, and theſe Squares are the mouths of two Cocks; one of four inches, the other of one: Now its manifeſt by what hath been ſaid, that the VVater which paſſeth by the leſs Cock, findeth its velocity impeded in the circumference of the Cock; which impediment is meaſured by the ſaid circumference. Now it is to be conſidered, that if we would have the Water which paſſeth through the greater Cock, to be onely quadruple to that which paſſeth through the leſſe, in equal ſpaces of time, it would be neceſſary, that not onely the capacity and the meaſure of the greater Cock be quadruple to the leſſer Cock, but that alſo the impediment be quadrupled. Now in our caſe it is true, That the belly and mouth of the Cock is quadrupled, and yet the impediment is not quadrupled, but is onely doubled; ſeeing that the circumference of the greater Square, is onely double to the circumference of the leſſer Square; for the greater circumference containeth eight of thoſe parts, of which the leſſer containeth but four, as is manifeſt by the deſcribed Figure; and for that cauſe there ſhall paſs by the greater Cock, above four times as much VVater, as ſhall paſs by the leſſer Cock.



The like errour occurreth alſo in the other manner of meaſuring the VVater of a Fountain, as may eaſily be collected from what hath been ſaid and obſerved above.

APPENDIX VIII.

THe ſame contemplation diſcovereth the errour of thoſe Architects, who being to erect a Bridge of ſundry Arches over a River, conſider the ordinary breadth of the River; which being *v. g.* fourty fathom, and the Bridge being to conſiſt of four Arches, it ſufficeth them, that the breadth of all the four Arches taken together, be fourty fathom; not conſidering that in the ordinary Channel of the River, the Water hath onely two impediments which retard its velocity; namely, the touching and gliding along the two ſides or ſhores of the River: but the

the ſame water in paſſing under the Bridge, in our caſe meeteth with eight of the ſame impediments, bearing, and thruſting upon two ſides of each Arch (to omit the impediment of the bottom, for that it is the ſame in the River, and under the Bridge) from which inadvertency ſometimes follow very great diſorders, as quotidian practice ſhews us.

APPENDIX IX.

IT is alſo worthy to conſider the great and admirable benefit that thoſe fields receive, which are wont to drink up the Rain-water with difficulty, through the height of the water in the principal Ditches; in which caſe the careful Husbandman cutteth away the reeds and ruſhes in the Ditches, through which the waters paſs; whereupon may be preſently ſeen, ſo ſoon as the reeds and ruſhes are cut, a notable Ebb in the level of the water in the Ditches; inſomuch that ſometimes it is obſerved, that the water is abated after the ſaid cutting a third and more, of what it was before the cutting. The which effect ſeemingly might depend on this, That, before thoſe weeds took up room in the Ditch, and for that cauſe the water kept a higher level, and the ſaid Plants being afterwards cut and removed, the water came to abate, poſſeſſing the place that before was occupied by the weeds: Which opinion, though probable, and at firſt ſight ſatisfactory, is nevertheleſs inſufficient to give the total reaſon of that notable abatement which hath been ſpoken of: But it is neceſſary to have recourſe to our conſideration of the velocity in the courſe of the water, the chiefeſt and true cauſe of the variation of the meaſure of the ſame Running-Water; for, that multitudes of reeds, weeds, and plants diſperſed through the current of the Ditch, do chance notably to retard the courſe of the water, and therefore the meaſure of the water increaſeth; and thoſe impediments removed, the ſame water gaineth velocity, and therefore decreaſeth in meaſure, and conſequently in height.

And perhaps this point well underſtood, may be of great profit to the fields adjacent to the *Pontine* Fens, and I doubt not but if the River *Ninfa*, and the other principal Brooks of thoſe Territories were kept well cleanſed from weeds, their waters would be at a lower level, and conſequently the drains of the fields would run into them more readily; it being alwayes to be held for undoubted, that the meaſure of the water before the cleanſing, hath the ſame proportion to the meaſure after cleanſing, that the velocity after the cleanſing hath to the velocity before the cleanſing: And becauſe thoſe weeds being cleanſed away,

away, the courſe of the water notably increaſeth, it is therefore neceſſary that the ſaid water abate in meaſure, and become lower.

APPENDIX. X.

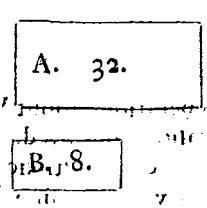
WE having above obſerved ſome errors that are committed in diſtributing the waters of Fountains, and thoſe that ſerve to water fields; it ſeemeth now fit, by way of a cloſe to this diſcourſe, to advertiſe by what means theſe diviſions may be made juſtly and without error. I therefore think that one might two ſeveral wayes exquiſitly divide the water of Fountains; The firſt would be by diligently examining, Firſt, how much water the whole Fountain diſchargeth in a determinate time, as for inſtance: How many Barrels, or Tuns it carrieth in a ſet time; and in caſe you are afterwards to diſtribute the water, diſtribute it at the rate of ſo many Barrels or Tuns, in that ſame time; and in this caſe the participants would have their punctual ſhares: Nor could it ever happen to ſend out more water, than is reckoned to be in the principal Fountain; as befel *Giulio Frontino*, and as alſo it frequently happeneth in the Modern Aqueducts, to the publick and private detriment.

The other way of dividing the ſame waters of a Fountain, is alſo ſufficiently exact and eaſie, and may be, by having one onely ſize for the Cock or Pipe, as ſuppoſe of an inch, or of half an inch; and when the caſe requireth to diſpence two, three, and more inches, take ſo many Cocks of the ſaid meaſure as do evacuate the water, which is to be emitted; and if we are to make uſe onely of one greater Cock, we being to place one to diſcharge for example four inches; and having the former ſole meaſure of an inch, we muſt make a Cock that is bigger, its true, than the Cock of one inch; but not ſimply in a quadruple proportion, for that it would diſcharge more than juſt ſo much water, as hath been ſaid above; but we ought to examine diligently how much water the little Cock emitteth in an hour; and then enlarge, and contract the greater Cock, ſo, that it may diſcharge four times as much water as the leſſer in the ſame time; and by this means we ſhall avoid the diſorder hinted in the ſeventh Appendix. It would be neceſſary nevertheleſs, to accommodate the Cocks of the Ciſtern ſo, that the level of the water in the Ciſtern may alwayes reſt at one determinate mark above the Cock, otherwiſe the Cocks will emit ſometimes greater, and ſometimes leſſe abundance of water: And becauſe it may be that the ſame water of the Fountain may be ſometimes more abundant, ſometimes leſs; in ſuch caſe it will be neceſſary to

to adjuſt the Ciſtern ſo, that the exceſs above the ordinary water, diſcharge into the publick Fountains, that ſo the particular participants may have alwayes the ſame abundance of water.

APPENDIX XI.

MUch more difficult is the diviſion of the waters which ſerve to water the fields, it not being poſſible to obſerve ſo commodiouſly, what quantity of water the whole Ditch ſends forth in one determinate time, as may be done in Fountains: Yet nevertheleſs, if the ſecond propoſition by us a little below demonſtrated, be well underſtood, there may be thence taken a very ſafe and juſt way to diſtribute ſuch waters. The Propoſition therefore by us demonſtrated is this: If there be two Sections, (namely two mouths of Rivers) the quantity of the water which paſſeth by the firſt, hath a proportion to that which paſſeth by the ſecond, compounded of the proportions of the firſt Section to the ſecond, and of the velocity through the firſt, to the velocity through the ſecond. As I will declare for example by help of practice, that I may be underſtood by all, in a matter ſo important. Let the two mouths of the Rivers be A, and B, and let the mouth A be in meaſure and content thirty two feet, and the mouth B, eight feet. Here you muſt take notice, that it is not alwayes true, that the Water which paſſeth by A, hath the ſame proportion to that which paſſeth by B, that the mouth A hath to the mouth B; but onely when the velocityes by each of thoſe paſſages are equal: But if the velocityes ſhall be unequal, it may be that the ſaid mouths may emit equal quantity of Water in equal times, though their meaſure be unequal; and it may be alſo, that the bigger doth diſcharge a greater quantity of Water: And laſtly, it may be, that the leſs mouth diſchargeth more Water than the greater; and all this is manifeſt by the things noted in the beginning of this diſcourſe, and by the ſaid ſecond Propoſition. Now to examine the proportion of the Water that paſſeth by one Ditch, to that which paſſeth by another, that this being known, the ſame Waters and mouths of Ditches may be then adjuſted; we are to keep account not onely of the greatneſs of the mouths or paſſages of the Water, but of the velocity alſo; which we will do, by firſt finding two numbers that have the ſame proportion between themſelves,



31. 8. 4.

ſelves, as have the mouths, which are the numbers 32 and 8 in our example: Then this being done, let the velocity of the Water by the paſſages A and B, be examined (which may be done keeping account what ſpace a piece of Wood, or other body that ſwimmeth, is carried by the ſtream in one determinate time; as for inſtance in 50 pulſes) and then work by the golden Rule, as the velocity by A, is to the velocity by B, ſo is the number 8, to another number, which is 4. It is clear by what is demonſtrated in the ſaid ſecond Propoſition, that the quantity of water, which paſſeth by the mouth A, ſhall have the ſame proportion of that which paſſeth by the mouth B, that 8 hath to 1. Such proportion being compoſed of the proportions of 32 to 8, and of 8 to 4; namely, to the greatneſs of the mouth A, to the greatneſs of the mouth B, and of the velocity in A, to the velocity in B. This being done, we muſt then contract the mouth which diſchargeth more then its juſt quantity of water, or enlarge the other which diſchargeth leſs, as ſhal be moſt commodious in practice, which to him that hath underſtood this little that hath been delivered, will be very aſie.

A. 32.
B. 8.

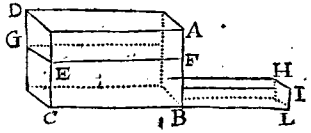
32. 8. 4.

APPENDIX XII.

THeſe opperations about Water, as I have hitherto on ſundry occaſions obſerved, are involved in ſo many difficulties, and ſuch a multiplicity of moſt extravagant accidents, that it is no marvel if continually many, and very important errours be therein committed by many, and even by Ingeneers themſelves, and Learned-men; and becauſe many times they concern not onely the publique, but private intereſts: Hence it is, that it not onely belongeth to Artiſts to treat thereof, but very oft even the vulgar themſelves pretend to give their judgement therein: And I have been troubled many times with a neceſſity of treating, not onely with thoſe, which either by practice, or particular ſtudy, underſtood ſomewhat in theſe matters; but alſo with people wholly void of thoſe notions, which are neceſſary for one that would on good grounds diſcourſe about this particular; and thus many times have met with more difficulty in the thick skulls of men, than in precipitous Torrents, and vaſt Fennes. And in particular, I had occaſion ſome years paſt to go ſee the Cave or Emiſſary of the Lake of *Perugia*, made many years agon by *Braccio Fortobraccio*, but for that it was with great ruines by Time decayed, and rendred unuſeful, it was repaired with induſtry

duſtry truly heroicall and admirable, by Monſignor *Maffei Barberino*, then Prefect for the Wayes, and now Pope. And being neceſſitated, that I might be able to walk in the Cave, and for other cauſes, I let down the Sluices of the ſaid Cave, at the mouth of the Lake: No ſooner were they ſtopt, but a great many of the people of the Towns and Villages coaſting upon the *Lake* flocking thither, began to make grievous complaints, that if thoſe Sluices were kept ſhut, not onely the Lake would want its due Vent, but alſo the parts adjacent to the Lake would be over flown to their very great detriment. And becauſe at firſt appearance their motion ſeemed very reaſonable, I found my ſelf hard put to it, ſeeing no way to perſwade ſuch a multitude, that the prejudice which they pretended I ſhould do them by keeping the Sluices ſhut for two dayes, was abſolutely inſenſible; and that by keeping them open, the Lake did not ebb in the ſame time ſo much as the thickneſs of a ſheet of Paper: And therefore I was neceſſitated to make uſe of the authority I had, and ſo followed my buſineſs as cauſe required, without any regard to that Rable tumultuouſly aſſembled. Now when I am not working with Mattock or Spade, but with the Pen and Diſcourſe, I intend to demonſtrate clearly to thoſe that are capable of reaſon, and that have well underſtood the ground of this my Treatiſe, that the fear was altogether vain which thoſe people conceited. And therefore I ſay, that the Emiſſary or Sluice of the Lake of *Perugia*, ſtanding in the ſame mannner as at preſent, and the water paſſing thorow it with the ſame velocity as now; to examine how much the Lake may abate in two days ſpace, we ought to conſider, what proportion the ſuperficies of the whole Lake hath to the meaſure of the Section of the Emiſſary, and afterwards to infer, that the velocity of the water by the Emiſſary or Sluice, ſhall have the ſame proportion to the abatement of the Lake, and to prove thorowly and clearly this diſcourſe, I intend to demonſtrate the following Propoſition.

Suppoſe a Veſſel of any bigneſſe, and that it hath an Emiſſary or Cock, by which it diſchargeth its water. And look what proportion the ſuperficies of the veſſel hath to the meaſure of the ſection of the cock, ſuch proportion ſhall the velocity of the Water in the Cock have to the abatement of the Lake. Let the Veſſel be A B C D, H I L B, through which the Water runneth, the ſuperficies of the Water in the Veſſel A D, and the ſection of the Cock H L: and let the Water in the Veſſel be ſuppoſed to have falne in one determinate time from A to F.



I ſay that the proportion of the ſuperficies of the Veſſel A D is in proportion to the meaſure of the ſection of the Emiſſary H L, as the velocity of the Emiſſary or Cock to the line A F; which is manifeſt, for that the Water in the Veſsel moving by the line A F; as far as F, and the whole maſs of Water A G diſcharging it ſelf, and in the ſame time the ſame quantity of Water being diſcharged by the ſection of the Emiſſary H L; it is neceſſary by what I have demonſtrated in the third Propoſition, and alſo explained in the beginning of this Treatiſe, that the velocity by the Emiſſary or Cock be in proportion to the velocity of the abatement, as the ſuperficies of the Veſſel to the meaſure of the ſection of the Emiſſary, which was to be demonſtrated.

That which hath b.en demonſtrated in the Veſſel, falls out exactly alſo in our Lake of *Perugia*, and its Emiſsary; and becauſe the immenſity of the ſuperficies of the Lake is in proportion to the ſuperficies of the Emiſsary or Sluice, as many millions to one, as may be eaſily calculated; it is manifeſt, that ſuch abatement ſhall be imperceptible, and almoſt nothing, in two dayes ſpace, nay in four or ſix: and all this will be true, when we ſuppoſe that for that time there entreth no other Water into the Lake from Ditches or Rivolets, which falling into the Lake would render ſuch abatement yet leſs.

Now we ſee, that it's neceſsary to examine ſuch abatements and riſings, with excellent reaſons, or at leaſt, with accurate experiments, before we reſolve and conclude any thing; and how farre the vulgar are diſtant from a right judgement in ſuch matters.

APPENDIX XIII.

FOR greater confirmation of all this which I have ſaid, I will inſtance in another like caſe, which alſo I met with heretofore, wherein, for that the buſineſs was not rightly underſtood, many diſorders, vaſt expences, and conſiderable miſchiefs have followed. There was heretofore an Emiſsary or Sluice made to drain the Waters, which from Rains, Springs, and Rivolets fall into a Lake; to the end, the ſhores adjoyning on the Lake, ſhould be free from the overflowing of the Waters; but becauſe perhaps the enterprize was not well managed and carried on, it fell out, that the Fields adjacent to the ſaid Chanel could not drain, but continued under water; to which diſorders a preſent remedy hath been uſed, namely, in a time convenient to ſtop up the Sluice, by meanes of certain Floodgates kept on purpoſe for that end; and thus abating the Level of the Water in

in the Emiſſary, in the ſpace of three or four dayes, the Fields have been haply drained. But on the other part, the proprietors bordering on the Lake oppoſed this, grievouſly complaining, that whilſt the Floodgates are ſhut, and the courſe of the Water of the Sluice hindered, the Lake overflowes the Lands adjacent, by meanes of the Rivers that fell into it, to their very great damage; and ſo continuing their ſuits, they got more of vexation than ſatisfaction. Now, being asked my opinion herein, I judged it requiſite (ſince the point in controverſie was about the riſing and falling of the Lake) that the ſaid abatement, when the Floodgates are open, and increaſe when they are ſhut ſhould be exactly meaſured, and told them, that it might be eaſily done at a time when no extraordinary Waters fell into the Lake, neither of Rain, or otherwiſe; and the Lake was undiſturbed by winds that might drive the Water to any ſide, by planting neer to an Iſlet, which is about the middle of the Lake, a thick poſt, on which ſhould be made the marks of the Lakes riſing and falling for two or three dayes. I would not, at that time, pawn, or reſolutely declare, my judgment, in regard I might be, by divers accidents miſled. But this I told them, that (by what I have demonſtrated, and particularly that which I have ſaid above touching the Lake of *Perugia*) I inclined greatly to think, that theſe riſings and fallings would prove imperceptible, and inconſiderable; and therefore, that in caſe experience ſhould make good my reaſon, it would be to no purpoſe for them to continue diſputing and wrangling, which cauſeth, (according to the Proverb) *A great deal of cry, but produceth not much Wool.*

Laſtly, it importing very much to know what a Rain continued for many dayes can do in raiſing theſe Lakes, I will here inſert the Copy of a Letter, which I writ formerly to *Signior Galilæo Galilæi*, chief Philoſopher to the Grand Duke of *Tuſcany*, wherein I have delivered one of my conceits in this buſineſſe, and it may be, by this Letter, I may more ſtrongly confirm what I have ſaid above.

The Copy of a Letter to Signore GALILÆO GALILÆI, *Chief Philoſopher to the moſt Serene Great Duke of TUSCANY.*

Worthy and moſt Excellent SIR,

IN ſatisfaction of my promiſe, in my former Letters of repreſenting unto you ſome of my Conſiderations made upon the Lake *Thraſimeno*, I ſay, That in times paſt, being in *Perugia*, where we held our General Convention, having underſtood that the Lake *Thraſimeno*, by the great drought of many Moneths was much abated, It came into my head, to go privately and ſee this novelty, both for my particular ſatisfaction, as alſo that might I be able to relate the whole to my Patrons, upon the certitude of my own ſight of the place. And ſo being come to the Emiſſary of the Lake, I found that the Level of the Lakes ſurface was ebbed about five Roman Palmes of it's wonted watermark, inſomuch that it was lower than the tranſome of the mouth of the Emiſſary, by the length of —————— this deſcribed line, and therefore no Water iſſued out of the Lake, to the great prejudice of all the places and villages circumjacent, in regard that the Water which uſed to run from the ſaid Lake turned 22 Mills, which not going, neceſſitated the inhabitants of thoſe parts to go a dayes journey and more, to grinde upon the *Tiber*. Being returned to *Perugia*, there followed a Rain, not very great, but conſtant, and even, which laſted for the ſpace of eight hours, or thereabouts; and it came into my thoughts to examine, being in *Perugia*, how much the Lake was increaſed and raiſed by this Rain, ſuppoſing (as it was probable enough) that the Rain had been univerſal over all the Lake; and like to that which fell in *Perugia*, and to this purpoſe I took a Glaſſe formed like a Cylinder, about a palme high, and half a palme broad; and having put in water ſufficient to cover the bottome of the Glaſſe, I noted diligently the mark of the height of the Water in the Glaſſe, and afterwards expoſed it to the open weather, to receive the Raine-water, which fell into it; and I let it ſtand for the ſpace of an hour; and having obſerved that in that time the Water was riſen in the Veſſel the height of the following line——, I conſidered that if I had expoſed to the ſame rain ſuch other veſſels equal to that, the Water would have riſen in them all according to that meaſure: And thereupon concluded, that alſo in all the

the whole extent of the Lake, it was neceſſary the Water ſhould be raiſed in the ſpace of an hour the ſame meaſure. Yet here I conſidered two difficulties that might diſturb and altar ſuch an effect, or at leaſt render it inobſerveable, which afterwards well weighed, and reſolved, left me (as I will tell you anon) in the concluſion the more confirmed; that the Lake ought to be increaſed in the ſpace of eight hours, that the rain laſted eight times that meaſure. And whilſt I again expoſed the Glaſs to repeat the experiment, there came unto me an Ingeneer to talk with me touching certain affairs of our Monaſtary of *Perugia*, and diſcourſing with him, I ſhewed him the Glaſs out at my Chamber-window, expoſed in a Court-yard; and communicated to him my fancy, relating unto him all that I had done. But I ſoon perceived that this brave fellow conceited me to be but of a dull brain, for he ſmiling ſaid unto me; Sir, you deceive your ſelf: I am of opinion that the Lake will not be increaſed by this rain, ſo much as the thickneſſe of a * *Julio*. Hearing him pronounce this his opinion with freeneſs and confidence, I urged him to give me ſome reaſon for what he ſaid, aſſuring him, that I would change my judgement, when I ſaw the ſtrength of his Arguments: To which he anſwered, that he had been very converſant about the Lake, and was every day upon it, and was well aſſured that it was not at all increaſed. And importuning him further, that he would give me ſome reaſon for his ſo thinking, he propoſed to my conſideration the great drought paſſed, and that that ſame rain was nothing for the great parching: To which I anſwered, I believe Sir that the ſurface of the Lake, on which the rain had fallen was moiſtned; and therefore ſaw not how its drought, which was nothing at all, could have drunk up any part of the rain. For all this he perſiſting in his conceit, without yielding in the leaſt to my allegation; he granted in the end (I believe in civility to me) that my reaſon was plauſible and good, but that in practiſe it could not hold. At laſt to clear up all, I made one be called, and ſent him to the mouth of the Emiſſary of the Lake, with order to bring me an exact account, how he found the water of the Lake, in reſpect of the Tranſome of the Sluice. Now here, Signore *Galilo*, I would not have you think that I had brought the matter in hand to concern me in my honour; but believe me (and there are witneſſes of the ſame ſtill living) that my meſſenger returning in the evening to *Perugia*, he brought me word, that the water of the Lake began to run through the Cave; and that it was riſen almoſt a fingers breadth above the Tranſome: Inſomuch, that adding this meaſure, to that of the lowneſs of the ſurface of the Lake, beneath the Tranſome before the rain,

* A Coyn of Pope *Julius* worth ſix pence.

it

it was manifeſt that the riſing of the Lake cauſed by the rain, was to a hair thoſe four fingers breadth that I had judged it to be. Two dayes after I had another bout with the Ingencer, and related to him the whole buſineſs, to which he knew not what to anſwer.

Now the two difficulties which I thought of, able to impede my concluſion, were theſe following: Firſt, I conſidered that it might be, that the Wind blowing from the ſide where the Sluice ſtood, to the Lake-ward; the mole and maſs of the Water of the Lake might be driven to the contrary ſhore; on which the Water riſing, it might be fallen at the mouth of the Emiſſary, and ſo the obſervation might be much obſcured. But this difficulty wholly vaniſhed by reaſon of the Aires great tranquility; which it kept at that time, for no Wind was ſtirring on any ſide, neither whilſt it rained, nor afterwards.

The ſecond difficulty which put the riſing in doubt, was, That having obſerved in *Florence*, and elſewhere, thoſe Ponds into which the rain-water, falling from the houſe, is conveyed through the Common-ſhores: And that they are not thereby ever filled, but that they ſwallow all that abundance of water, that runs into them by thoſe conveyances which ſerve them with water; inſomuch that thoſe conveyances which in time of drought maintain the Pond, when there comes new abundance of water into the Pond, they drink it up, and ſwallow it: A like effect might alſo fall out in the Lake, in which there being many veins (as it is very likely) that maintain and feed the Lake; theſe veins might imbibe the new addition of the Rain-water, and ſo by that means annull the riſing; or elſe diminiſh it in ſuch ſort, as to render it inobſervable. But this difficulty was eaſily reſolved by conſidering my Treatiſe of the meaſure of Running-Waters; foraſmuch as having demonſtrated, that the abatement of a Lake beareth the reciprocal proportion to the velocity of the Emiſſary, which the meaſure of the Section of the Emiſſary of the Lake, hath to the meaſure of the ſurface of the Lake: making the calculation and account, though in groſs; by ſuppoſing that its veins were ſufficiently large, and that the velocity in them were notable in drinking up the water of the Lake; yet I found nevertheleſs, that many weeks and moneths would be ſpent in drinking up the new-come abundance of water by the rain, ſo that I reſted ſure, that the riſing would enſue, as in effect it did.

And becauſe many of accurate judgement, have again cauſed me to queſtion this riſing, ſetting before me, that the Earth being parched by the great drought, that had ſo long continued, it might be, that that Bank of Earth which environed the brink of the Lake, being dry, and imbibing great abundance of Water from

from the increaſing Lake, would not ſuffer it to increaſe in height: I ſay therefore, that if we would rightly conſider this doubt here propoſed, we ſhould, in the very conſideration of it, ſee it reſolved; for, it being ſuppoſed that that liſt or border of Banks which was to be occupied by the increaſe of the Lake, be a Brace in breadth quite round the Lake, and that by reaſon of its dryneſs it ſucks in water, and that by that means this proportion of water co-operates not in raiſing of the Lake: It is abſolutely neceſſary on the other hand, that we conſider, That the Circuit of the water of the Lake being thirty miles, as its commonly held, that is to ſay, Ninety thouſand Braces of *Florence* in compaſs; and therefore admitting for true, that each Brace of this Bank drink two quarts of water, and that for the ſpreading it require three quarts more, we ſhall finde, that the whole agregate of this portion of water, which is not imployed in the raiſing of the Lake, will be four hundred and fifty thouſand Quarts of water; and ſuppoſing that the Lake be ſixty ſquare miles, three thouſand Braces long, we ſhall finde, that to diſpence the water poſſeſt by the Bank about the Lake, above the total ſurface of the Lake, it ought to be ſpread ſo thin, that one ſole quart of water may over-ſpread ten thouſand ſquare Braces of ſurface: ſuch a thinneſs, as muſt much exceed that of a leaf of beaten Gold, and alſo leſs than that skin of water which covers the Bubbles of it: and ſuch would that be, which thoſe men would have ſubſtracted from the riſing of the Lake: But again, in the ſpace of a quarter of an hour at the beginning of the rain, all that Bank is ſoaked by the ſaid rain, ſo that we need not for the moiſtning of it, imploy a drop of that water which falleth into the Lake. Beſides we have not brought to account that abundance of water which runs in time of rain into the Lake, from the ſteepneſs of the adjacent Hills and Mountains; which would be enough to ſupply all our occaſions: So that, neither ought we for this reaſon to queſtion our pretended riſing. And this is what hath fallen in my way touching the conſideration of the *Thraſimenian* Lake.

After which, perhaps ſomewhat raſhly, wandring beyond my bounds, I proceeded to another contemplation, which I will relate to you, hoping that you will receive it, as collected with theſe cautions requiſite in ſuch like affairs; wherein we ought not too poſitively to affirm any thing of our own heads for certain, but ought to ſubmit all to the ſound and ſecure deliberation of the Holy Mother-Church, as I do this of mine, and all others; moſt ready to change my judgement, and conform my ſelf alwaies to the deliberations of my Superiors. Continuing

ing therefore my above-ſaid conceit about the riſing of the water in the glaſs tried before, it came into my minde, that the forementioned rain having been very gentle, it might well be, that if there ſhould have faln a Rain fifty, an hundred, or a thouſand times greater than this, and much more intenſe (which would inſue as oft as thoſe falling drops were four, five or ten times bigger than thoſe of the above-mentioned rain, keeping the ſame number) in ſuch a caſe its manifeſt, that in the ſpace of an hour the Water would riſe in our Glaſs, two, three, and perhaps more Yards or Braces; and conſequently, if ſuch a Raine ſhould fall upon a Lake, that the ſaid Lake would riſe, according to the ſame rate: And likewiſe, if ſuch a Rain were univerſall, over the whole Terreſtriall Globe, it would neceſſarily, in the ſpace of an hour, make a riſing of two, or three braces round about the ſaid Globe. And becauſe we have from Sacred Records, that in the time of the Deluge, it rained fourty dayes and fourty nights; namely, for the ſpace of 960 houres; its clear, that if the ſaid Rain had been ten times bigger than ours at *Perugia*, the riſing of the Waters above the Terreſtrial Globe would reach and paſs a mile higher than the tops of the Hills and Mountains that are upon the ſuperficies of the Earth; and they alſo would concur to increaſe the riſe. And therefore I conclude, that the riſe of the Waters of the Deluge have a rational congruity with natural Diſcourſes, of which I know very well that the eternal truths of the Divine leaves have no need; but however I think ſo clear an agreement is worthy of our conſideration, which gives us occaſion to adore and admire the greatneſſe of God in his mighty Works, in that we are ſometimes able, in ſome ſort, to meaſure them by the ſhort Standard of our Reaſon.

Many Leſſons alſo may be deduced from the ſame Doctrine, which I paſſe by, for that every man of himſelf may eaſily know them, having once ſtabliſhed this Maxime; That it is not poſſible to pronounce any thing, of a certainty, touching the quantity of Running Waters, by conſidering only the ſingle vulgar meaſure of the Water without the velocity; and ſo on the contrary, he that computes only the velocity, without the meaſure, ſhall commit very great errours; for treating of the meaſure of Running Waters, it is neceſſary, the water being a body, in handling its quantity, to conſider in it all the three dimenſions of breadth, depth, and length: the two firſt dimenſions are obſerved by all in the common manner, and ordinary way of meaſuring Running Waters; but the third dimenſion of length is omitted; and haply ſuch an overſight is committed, by reaſon the length of Running

ning Water is reputed in ſome ſenſe infinite, in that it never ceaſeth to move away, and as infinite is judged incomprehenſible; and ſuch as that there is no exact knowledge to be had thereof; & ſo there comes to be no account made thereof; but if we ſhould make ſtrict reflection upon our conſideration of the velocity of Water, we ſhould find, that keeping account of the ſame, there is a reckoning alſo made of the length; foraſmuch as whilſt we ſay, the Water of ſuch a Spring runs with the velocity of paſſing a thouſand or two thouſand paces an hour: this in ſubſtance is no other than if we had ſaid, ſuch a Fountain diſchargeth in an hour a Water of a thouſand or two thouſand paces long. So that, albeit the total length of Running water be incomprehenſible, as being infinite, yet nevertheleſſe its rendered intelligible by parts in its velocity. And ſo much ſufficeth to have hinted about this matter, hoping to impart on ſome other occaſion other more accurate Obſervations in this affair.

LAUS DEO.

GEOMETRICAL DEMONSTRATIONS OF THE MEASURE OF Running Waters.

BY

D. BENEDETTO CASTELLI,
Abbot of CASSINA, and Mathematician to
P. *URBAN. VIII.*

DEDICATED

To the moſt Illuſtrious, and moſt Excellent Prince

DON THADDEO BARBERINI,
PRINCE OF
PALESTRINA,
AND
GENERAL of the HOLY CHURCH.

LONDON,
Printed *Anno Domini*, MDCLXI.

OF THE MENSURATION OF Running Waters.

SUPPOSITION I.

LEt it be ſuppoſed, that the banks of the Rivers of which we ſpeak be erected perpendicular to the plane of the upper ſuperficies of the River.

SUPPOSITION II.

WE ſuppoſe that the plane of the bottome of the River, of which we ſpeak is at right angles with the banks.

SUPPOSITION III.

IT is to be ſuppoſed, that we ſpeak of Rivers, when they are at ebbe, in that ſtate of ſhallowneſſe, or at flowing in that ſtate of deepneſſe, and not, in their tranſition from the ebbe to the flowing, or from the flowing to the ebbe.

Declaration of Termes.

FIRST.

IF a River ſhall be cut by a Plane at right angles to the ſurface of the water of the River, and to the banks of the River, that ſame dividing Plane we call the Section of the River; and this Section, by the Suppoſitions above, ſhall be a right angled Parallelogram.

SECOND.

WE call thoſe Sections equally Swift, by which the water runs with equal velocity; and more ſwift and leſs ſwift that Section of another, by which the water runs with greater or leſſe velocity.

AXIOME I.

SEctions equal, and equally ſwift, diſcharge equal quantities of Water in equal times.

AXIOME II.

SEctions equally ſwift, and that diſcharge equal quantity of Water, in equal time, ſhall be equal.

AXIOME III.

SEctions equal, and that diſcharge equal quantities of Water in equal times, ſhall be equally ſwift.

AXIOME IV.

WHen Sections are unequal, but equally ſwift, the quantity of the Water that paſſeth through the firſt Section, ſhall have the ſame proportion to the quantity that paſſeth through the Second, that the firſt Section hath to the ſecond Section. Which is manifeſt, becauſe the velocity being the ſame, the difference of the Water that paſſeth ſhall be according to the difference of the Sections.

AXIOME V.

IF the Sections ſhall be equal, and of unequal velocity, the quantity of the Water that paſſeth through the firſt, ſhall have the ſame proportion to that which paſſeth through the ſecond, that the velocity of the firſt Section, ſhall have to the velocity of the ſecond Section. Which alſo is manifeſt, becauſe the Sections being equal, the difference of the Water which paſſeth, dependeth on the velocity.

PETITION.

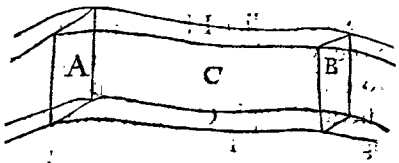
A Section of a River being given, we may ſuppoſe another equal to the given, of different breadth, heigth, and velocity.

PRO-

PROPOSITION I.

The Sections of the ſame River diſcharge equal quantities of Water in equal times, although the Sections themſelves be unequal.

LEt the two Sections be A and B, in the River C, running from A, towards B; I ſay, that they diſcharge equal quantity of Water in equal times; for if greater quantity of Water ſhould paſs through A, than paſſeth through B, it would



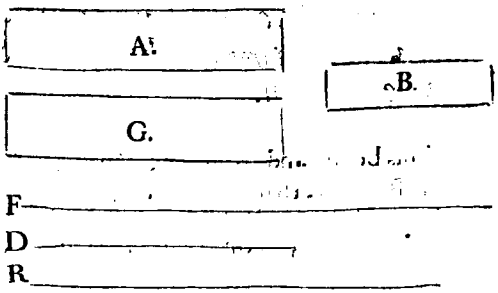
follow that the Water in the intermediate ſpace of the River C, would increaſe continually, which is manifeſtly falſe, but if more Water ſhould iſſue through the Section B, than entreth at the Section A, the Water in the intermediate ſpace C, would grow continually leſs, and alwaies ebb, which is likewiſe falſe; therefore the quantity of Water that paſſeth through the Section B, is equal to the quantity of Water which paſſeth through the Section A, and therefore the Sections of the ſame River diſcharge, *&c.* Which was to be demonſtrated.

PROPOSITION II.

In two Sections of Rivers, the quantity of the Water which paſſeth by one Section, is to that which paſſeth by the ſecond, in a Proportion compounded of the proportions of the firſt Section to the ſecond, and of the velocitie through the firſt, to the velocitie of the ſecond.

LEt A, and B be two Sections of a River; I ſay, that the quantity of Water which paſſeth through A, is to that which paſſeth through B, in a proportion compounded of the proportions of the firſt Section A; to the Section B; and of the velocity through A, to the velocity through B: Let a Section be ſuppoſed

ſuppoſed equal to the Section A, in magnitude; but of velocity equal to the Section B, and let it be G; and as the Section A is



to the Section B, ſo let the line F be to the line D; and as the velocity A, is to the velocity by B, ſo let the line D be to the line R: Therefore the Water which paſſeth thorow A, ſhall be to that which paſſeth through G (in regard the Sections A and G are of equal bigneſs, but of unequal velocity) as the velocity through A, to the velocity through G; But as the velocity through A, is to the velocity through G, ſo is the velocity through A, to the velocity through B; namely, as the line D, to the line R: therefore the quantity of the Water which paſſe the through A, ſhall be to the quantity which paſſeth through G, as the line D is to the line R; but the quantity which paſſeth through G, is to that which paſſeth through B, (in regard the Sections G, and B, are equally ſwift) as the Section G to the Section B; that is, as the Section A, to the Section B; that is, as the line F, to the line D: Therefore by the equal and perturbed proportionality, the quantity of the Water which paſſeth through A, hath the ſame proportion to that which paſſeth through B, that the line F hath to the line R; but F to R, hath a proportion compounded of the proportions of F to D, and of D to R; that is, of the Section A to the Section B; and of the velocity through A, to the velocity through B: Therefore alſo the quantity of Water which paſſeth through the Section A, ſhall have a proportion to that which paſſeth through the Section B, compounded of the proportions of the Section A, to the Section B, and of the velocity through A, to the velocity through B: And therefore in two Sections of Rivers, the quantity of Water which paſſeth by the firſt, *&c.* which was to be demonſtrated.

COROLLARIE.

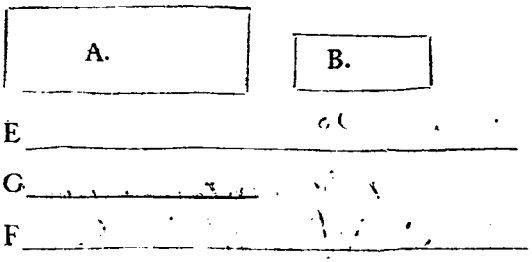
THe ſame followeth, though the quantity of the Water which paſſeth through the Section A, be equal to the quantity of Water which paſſeth through the Section B, as is manifeſt by the ſame demonſtration.

PROPO-

PROPOSITION III.

In two Sections unequal, through which paſs equal quantities of Water in equal times, the Sections have to one another, reciprocal proportion to their velocitie.

LEt the two unequal Sections, by which paſs equal quantities of Water in equal times be A, the greater; and B, the leſſer: I ſay, that the Section A, ſhall have the ſame Proportion to the Section B, that reciprocally the velocity through B, hath to the velocity through A; for ſuppoſing that as the Water that paſſeth through A, is to that which paſſeth through B, ſo is the



line E to the line F: therefore the quantity of water which paſſeth through A, being equal to that which paſſeth through B, the line E ſhall alſo be equal to the line F: Suppoſing moreover, That as the Section A, is to the Section B, ſo is the line F, to the line G; and becauſe the quantity of water which paſſeth through the Section A, is to that which paſſeth through the Section B, in a proportion compoſed of the proportions of the Section A, to the Section B, and of the velocity through A, to the velocity through B; therefore the line E, ſhall be the line to F, in a proportion compounded of the ſame proportions; namely, of the proportion of the Section A, to the Section B, and of the velocity through A, to the velocity through B; but the line E, hath to the line G, the proportion of the Section A, to the Section B, therefore the proportion remaining of the line G, to the line F, ſhall be the proportion of the velocity through A; to the velocity through B; therefore alſo the line G, ſhall be to the line E, as the velocity by A, to the velocity by B: And converſly, the velocity through B, ſhall be to the velocity through A, as the line E, to the line G; that is to ſay, as the Section A, to the Section B, and therefore in two Sections, &c. which was to be demonſtrated.

COROLLARIE.

HEnce it is manifeſt, that Sections of the ſame River (which are no other than the vulgar meaſures of the River) have betwixt themſelves reciprocal proportions to their velocities; for in the firſt Propoſition we have demonſtrated that the Sections of the ſame River, diſcharge equal quantities of Water in equal times; therefore, by what hath now been demonſtrated the Sections of the ſame River ſhall have reciprocal proportion to their velocities; And therefore the ſame running water changeth meaſure, when it changeth velocity; namely, increaſeth the meaſure, when it decreaſeth the velocity, and decreaſeth the meaſure, when it increaſeth the velocity.

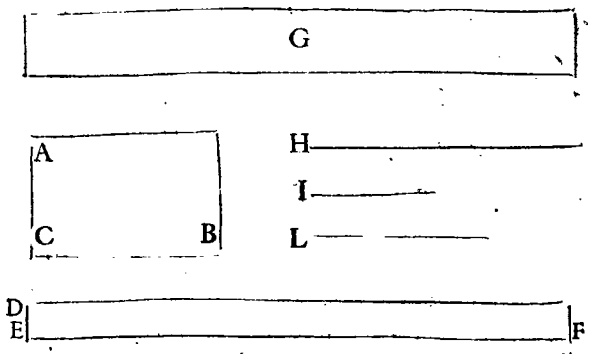
On which principally depends all that which hath been ſaid above in the *Diſcourſe*, and obſerved in the *Corollaries* and *Appendixes*; and therefore is worthy to be well underſtood and heeded.

PROPOSITION IV.

If a River fall into another River, the height of the firſt in its own Chanel ſhall be to the height that it ſhall make in the ſecond Chanel, in a proportion compounded of the proportions of the breadth of the Chanel of the ſecond, to the breadth of the Chanel of the firſt, and of the velocitie acquired in the Chanel of the ſecond, to that which it had in its proper and firſt Chanel.

LEt the River A B, whoſe height is A C, and breadth C B, that is, whoſe Section is A C B; let it enter, I ſay, into another River as broad as the line E F, and let it therein make the riſe or height D E, that is to ſay, let it have its Section in the River whereinto it falls D E F; I ſay, that the height A C hath to the height D E the proportion compounded of the proportions of the breadth E F, to the breadth C B, and of the velocity through D F, to the velocity through A B. Let us ſuppoſe the Section G, equal in velocity to the Section A B; and in breadth equal to E F, which carrieth a quantity of Water equal to that which the Section A B carrieth, in equal times, and conſequently, equal to that which D F carrieth. Moreover, as the breadth E F is to the breadth C B, ſo let the line H be to

the line I; and as the velocity of D F is to the velocity of A B, ſo let the line I be to the line L; becauſe therefore the two Sections A B and G are equally ſwift, and diſcharge equal quantity of Water in equal times, they ſhall be equal Sections; and

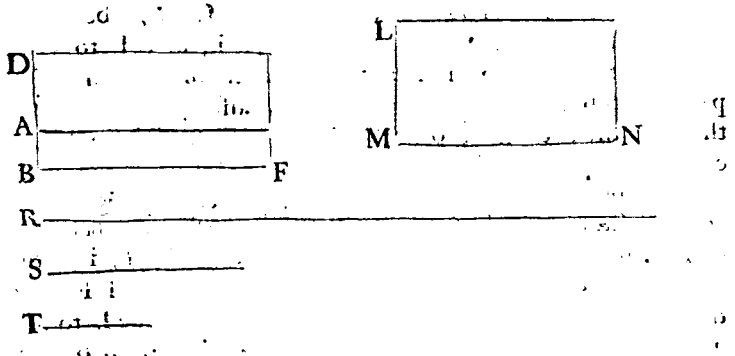


therefore the height of A *B* to the height of G, ſhall be as the breadth of G, to the breadth of A *B*, that is, as E F to C *B*, that is, as the line H to the line I: but becauſe the Water which paſſeth through G, is equal to that which paſſeth through D E F, therefore the Section G, to the Section D E F, ſhall have the reciprocal proportion of the velocity through D E F, to the velocity through G; but alſo the height of G, is to the height D E, as the Section G, to the Section D E F: Therefore the height of G, is to the height D E, as the velocity through D E F, is to the velocity through G; that is, as the velocity through D E F, is to the velocity through A *B*; That is, finally, as the line I, to the line L; Therefore, by equal proportion, the height of *A B*, that is, A C, ſhall be to the height D E; as H to L, that is, compounded of the proportions of the breadth E F, to the breadth C *B*, and of the velocity through D F, to the velocity through A *B*: So that if a River fall into another River, &c. which was to be demonſtrated.

PROPOSITION V.

If a River discharge a certain quantitie of Water in a certain time; and after that there come into it a Flood, the quantity of Water which is discharged in as much time at the Flood, is to that which was discharged before, whilst the River was low, in a proportion compounded of the proportions of the velocity of the Flood, to the velocity of the first Water, and of the height of the Flood, to the height of the first Water.

SUppose a River, which whilst it is low, runs by the Section A F; and after a Flood cometh into the same, and runneth through the Section D F, I say, that the quantity of the Water which is discharged through D F, is to that which is discharged



through A F, in a proportion compounded of the proportions of the velocity through D F, to the velocity through A F, and of the height D *B*, to the height A *B*; As the velocity through D F is to the velocity through A F, so let the line R, to the line S; and as the height D *B* is to the height A *B*, so let the line S, to the line T; and let us suppose a Section L M N, equal to D F in height and breadth; that is L M equal to D *B*, and M N equal to *B F*; but let it be in velocity equal to the Section A F, therefore the quantity of Water which runneth through D F, shall be to that which runneth through L N, as the velocity through D F, is to the velocity through L N, that is, to the velocity through *A F*; and the line R being to the line S, as the velocity through D *F*, to the velocity through *A F*; therefore the quantity which runneth through D *F*, to that which runneth through L N, shall have the proportion of R to S; but the quantity which runneth through L N, to that which runneth through *A F*, (the Sections being

being equally ſwift) ſhall be in proportion as the Section *L N*, to the Section A F; that is, as D B, to A B; that is as the line S, to the line T: Therefore by equal proportion, the quantity of the water which runneth through D F, ſhall be in proportion to that which runneth through A F, as R is to T; that is, compounded of the proportions of the height D B, to the height A B, and of the velocity through *D F*, to the velocity through *A F*; and therefore if a River diſcharge a certain quantity, *&c.* which was to be demonſtrated.

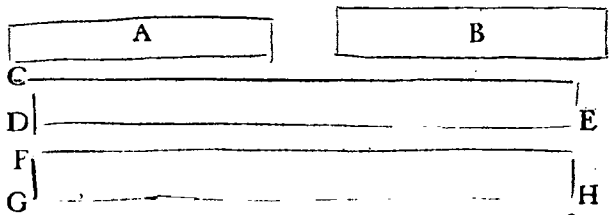
ANNOTATION.

THe ſame might have been demonſtrated by the ſecond Propoſition above demonſtrated, as is manifeſt.

PROPOSITION VI.

If two equal ſtreams of the ſame Torrent, fall into a River at divers times, the heights made in the River by the Torrent, ſhall have between themſelves the reciprocal proportion of the velocities acquired in the River.

LEt A and B, be two equal ſtreams of the ſame Torrent, which falling into a River at divers times, make the heights C D, and F G; that is the ſtream A, maketh the height C D, and the ſtream B, maketh the height F G; that is, Let their Sections in the River, into which they are fallen, be C E, and F H; I ſay, that the height C D, ſhall be to the height F G, in reciprocal proportion, as the velocity through F H, to the velocity through C E; for the quantity of water which paſſeth through A, being equal to the quantity which paſſeth through B, in equal times; alſo the quantity which paſſeth through C E, ſhall



be equal to that which paſſeth through F H: And therefore the proportion that the Section C E, hath to the Section F H, ſhall be the ſame that the velocity through F H, hath to the velocity through C E; But the Section C E, is to the Section F H, as C D, to F G, by reaſon they are of the ſame breadth: Therefore C D, ſhall be to F G, in reciprocal proportion, as the velocity through F H, is to the velocity through C E, and therefore if two equal ſtreams of the ſame Torrent, *&c.* which was to be demonſtrated.

OF THE MENSURATION OF Running Waters.

Lib. II.

HAving, in the close of my Treatise of the Mensuration of Running Waters promised to declare upon another occasion other particulars more obscure, and of very great concern upon the same argumement: I now do perform my promise on the occasion that I had the past year 1641. to propound my thoughts touching the state of the Lake of *Venice*, a business certainly most important, as being the concernment of that most noble and most admirable City; and indeed of all *Italy*, yea of all *Europe*, *Asia*, & *Africa*; & one may truly say of all the whole World. And being to proceed according to the method necessary in Sciences, I wil propose, in the first place certain Definitions of those Terms whereof we are to make use in our Discourse: and then, laying down certain Principles we will demonstrate some Problemes and Theoremes necessary for the understanding of those things which we are to deliver; and moreover, recounting sundry cases that have happened, we will prove by practice, of what utility this contemplation of the Measure of Running Waters is in the more important affairs both Publique and Private.

DEFINITION I.

TWo Rivers are said to move with equal velocity, when in equal times they passe spaces of equal length.

DEFINITION II.

RIvers are said to move with like velocity, when their proportional parts do move alike, that is, the upper parts alike to the upper, and the lower to the lower; so that if the upper part of one River shall be more swift than the upper part of another; then also the lower part of the former shall be more swift than the part correspondent to it in the second, proportionally.

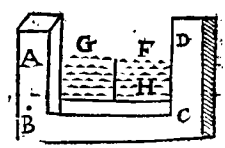
DEFI-

DEFINITON III.

TO measure a River, or running Water, is in our sense to finde out how many determinate measures, or weights of Water in a given time passeth through the River, or Channel of the Water that is to be measured.

DEFINITION IV.

IF a Machine be made either of Brick, or of Stone, or of Wood, so composed that two sides of the said Machine be placed at right angles upon the ends of a third side, that is supposed to be placed in the bottom of a River, parallel to the Horizon, in such a manner, that all the water which runneth through the said River, passeth thorow the said Machine: And if all the water coming to be diverted that runneth through the said River, the upper superficies of that third side placed in the bottom do remain uncovered and dry, and that the dead water be not above it; This same Machine shall be called by us *REGULATOR: And that third side of the Machine which standeth Horizontally is called the bottom of the Regulator; and the other two sides, are called the banks of the Regulator; as is seen in this first Figure: A B C D, shall be the Regulator; B C the bottom; and the other two sides A B, and C D are its banks.



*Or Sluice.

DEFINITION V.

BY the quick height, we mean the Perpendicular from the upper superficies of the River, unto the upper superficies of the bottom of the Regulator; as in the foregoing Figure the line. G H.

DEFINITION VI.

IF the water of a River be supposed to be marked by three sides of a Regulator, that Rightangled Parallelogram comprehended between the banks of the Regulator, and the bottom, and the superficies of the Water is called a Section of the River.

ANNOTA.

ANNOTATION.

HEre it is to be noted, that the River it ſelf may have ſundry and divers heights, in ſeveral parts of its Chanel, by reaſon of the various velocities of the water, and its meaſures; as hath been demonſtrated in the firſt book.

SUPPOSITION I.

IT is ſuppoſed, that the Rivers equal in breadth, and quick height, that have the ſame inclination of bed or bottom, ought alſo to have equal velocities, the accidental impediments being removed that are diſperſed throughout the courſe of the water, and abſtracting alſo from the external windes, which may velocitate, and retard the courſe of the water of the River.

SUPPOSITION II.

LEt us ſuppoſe alſo, that if there be two Rivers that are in their beds of equal length, and of the ſame inclination, but of quick heights unequal, they ought to move with like velocity, according to the ſenſe explained in the ſecond definition.

SUPPOSITION III.

BEcauſe it will often be requiſite to meaſure the time exactly in the following Problems, we take that to be an excellent way to meaſure the time, which was ſhewed me many years ſince by *Signore Galileo Galilei*, which is as followeth.

A ſtring is to be taken three Roman feet long, to the end of which a Bullet of Lead is to be hanged, of about two or three ounces; and holding it by the other end, the Plummet is to be removed from its perpendicularity a Palm, more or leſs, and then let go, which will make many ſwings to and again, paſſing and repaſſing the Perpendicular, before that it ſtay in the ſame: Now it being required to meaſure the time that is ſpent in any whatſoever operation, thoſe vibrations are to be numbred, that are made whilſt the work laſteth; and they ſhall be ſo many ſecond minutes of an hour, if ſo be, that the ſtring be three Roman feet long, but in ſhorter ſtrings, the vibrations are more frequent, and in longer, leſs frequent; and all this ſtill followeth, whether the Plummet be little or much removed from its Perpendicularity, or whether the weight of the Lead be greater or leſſer.

Theſe things being pre-ſuppoſed, we will lay down ſome fa-

miliar Problems, from which we ſhall paſs to the Notions and queſtions more ſubtil and curious; which will alſo prove profitable, and not to be ſleighted in this buſineſs of Waters.

PROPOSITION I. PROBLEME I.

A Chanel of Running-Water being given, the breadth of which paſsing through a Regulator, is three Palms; and the height one Palm, little more or leſs, to meaſure what water paſſeth through the Regulator in a time given.

FIrſt, we are to dam up the Chanel; ſo that there paſs not any water below the Dam; then we muſt place in the ſide of the Chanel, in the parts above the Regulator three, or four, or five Bent-pipes, or Syphons; according to the quantity of the water that runneth along the Chanel; in ſuch ſort, as that they may drink up, or draw out of the Chanel all the water that the Chanel beareth (and then ſhall we know that the Syphons drink up all the water, when we ſee that the water at the Dam doth neither riſe higher, nor abate, but alwaies keepeth in the ſame Level.) Theſe things being prepared, taking the Inſtrument to meaſure the time, we will examine the quantity of the water that iſſueth by one of thoſe Syphons in the ſpace of twenty vibrations, and the like will we do one by one with the other Syphons; and then collecting the whole ſumme, we will ſay, that ſo much is the water that paſſeth and runneth thorow the Regulator or Chanel (the Dam being taken away) in the ſpace of twenty ſecond minutes of an hour; and calculating, we may eaſily reduce it to hours, dayes, months, and years: And it hath fallen to my turn to meaſure this way the waters of Mills and Fountains, and I have been well aſſured of its exactneſs, by often repeating the ſame work.

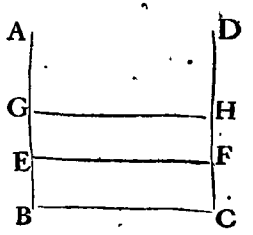
CONSIDERATION.

AND this method muſt be made uſe of in meaſuring the waters, that we are to bring into Conducts, and carry into Cities and Caſtles, for Fountains; and that we may be able afterwards to divide and ſhare them to particular perſons juſtly; which will prevent infinite ſuits and controverſies that every day happen in theſe matters..

PROPOSITION II. THEOREM I.

If a River moving with ſuch a certain velocitie through its Regulator, ſhall have a given quick height, and afterwards by new water ſhall increaſe to be double, it ſhall alſo increaſe double in velocitie.

LEt the quick height of a River in the Regulator A B C D, be the perpendicular F B, and afterwards, by new water that is added to the River, let the water be ſuppoſed to be raiſed to G, ſo that G B may be double to E B. I ſay, that all the water G C ſhall be double in velocity to that of E C: For the water G F, having for its bed the bottom E F, equally inclined as the bed B C, and its quick height G E being equal to the quick height E C, and having the ſame breadth B C, it ſhall have of it ſelf a velocity equal to the velocity of the firſt water F C: but becauſe, beſides its own motion, which is imparted to it by the motion of the water E C, it hath alſo over and above its own motion, the motion of E C. And becauſe the two waters G C, and E C, are alike in velocity, by the third Suppoſition; therefore the whole water G C ſhall be double in velocity to the water E C; which was that which we were to demonſtrate.



This demonſtration is not here inſerted, as perfect, the Authour having by ſeveral letters to his friends confeſſed himſelf unſatisfied therewith; and that he intended not to publiſh the Theorem *without a more ſolid demonſtration, which he was in hope to light upon. But being overtaken by Death, he could not give the finiſhing touch either to this, or to the reſt of the ſecond Book. In conſideration of which, it ſeemed good to the Publiſher of the ſame, rather to omit it, than to do any thing contrary to the mind of the Authour. And this he hints, by way of advertiſement, to thoſe that have Manuſcript Copies of this Book, with the ſaid demonſtration. For this time let the Reader content himſelf with the knowledge of ſo ingenious and profitable a Concluſion; of the truth of which he may, with ſmall expence and much pleaſure, be aſſured by means of the experiment to be made in the ſame manner, with that which is laid down in the ſecond Corollary of*

the fourth Theorem *of this, with its Table, and the uſe thereof annexed.*

COROLLARIE.

HEnce it followeth, that when a River increaſeth in quick height by the addition of new water, it alſo increaſeth in velocity; ſo that the velocity hath the ſame proportion to the velocity that the quick height hath to the quick height; as may be demonſtrated in the ſame manner.

PROPOS. III. PROBLEME II.

A Chanel of Water being given whoſe breadth exceeds not twenty Palms, or thereabouts, and whoſe quick height is leſs than five Palms, to meaſure the quantity of the Water that runneth thorow the Chanel in a time given.

PLace in the Chanel a Regulator, and obſerve the quick height in the ſaid Regulator; then let the water be turned away from the Chanel by a Chanellet of three or four Palms in breadth, or thereabouts: And that being done, meaſure the quantity of the water which paſſeth thorow the ſaid Chanellet, as hath been taught in the ſecond Propoſition; and at the ſame time obſerve exactly how much the quick height ſhall be abated in the greater Chanel, by means of the diverſion of the Chanellet; and all theſe particulars being performed, multiply the quick height of the greater Chanel into it ſelf, and likewiſe multiply into it ſelf the leſſer height of the ſaid bigger Chanel, and the leſſer ſquare being taken, from the greater, the remainder ſhall have the ſame proportion to the whole greater ſquare, as the water of the Chanellet diverted, hath to the water of the bigger Chanel: And becauſe the water of the Chanellet is known by the Method laid down in the firſt Theorem, and the terms of the Theorem being alſo known, the quantity of the water which runneth thorow the bigger Chanel, ſhall be alſo known by the Golden Rule, which was that that was deſired to be known. We will explain the whole buſineſs by an example.

Let a Chanel be, for example, 15 Palms broad, its quick height before its diverſion by the Chanellet ſhall be ſuppoſed to be 24 inches; but after the diverſion, let the quick height of the Chanel be onely 22 inches. Therefore the greater height to the leſſer, is as the number 11. to 12. But the ſquare of 11. is 121, and the ſquare of 12. is 144, the difference between the ſaid leſſer

ſquare

ſquare and the greater is 23. Therefore the diverted water, is to the whole water, as 23. to 144 : which is well near as 1 to 6 $\frac{1}{4}$: and that is the proportion that the quantity of the water which runneth through the Chanellet ſhall have, to all the water that runneth thorow the great Chanel. Now if we ſhould finde by the Rule mentioned above in the firſt Propoſition , that the quantity of the water that runneth through the Chanellet, is *v. g.* an hundred Barrels, in the ſpace of 15 ſecond minutes of an hour, it is manifeſt, that the water which runneth through the great Chanel in the ſaid time of 35 min. ſec. ſhall be about 600 Barrels.

The ſame operation performed another way.

AND becauſe very often in applying the Theory to Practice it happeneth, that all the neceſſary particulars in the Theory cannot ſo eaſily be put in execution ; therefore we will here add another way of performing the ſame Problem, if it ſhould chance to happen that the Chanellet could not commodiouſly be diverted from the great Chanel, but that it were eaſier for the water of another ſmaller Chanel to be brought into the greater Chanel ; which water of the ſmaller Chanel might be eaſily meaſured, as hath been ſhewen in the firſt Probleme ; or in caſe that there did fall into a greater Chanel, a leſſer Chanel that might be diverted and meaſured. Therefore I ſay in the firſt caſe, If we would meaſure the quantity of the water that runneth in a certain time thorow the greater Chanel, into which another leſſer Chanel that is meaſurable may be brought, we muſt firſt exactly meaſure the Chanellet, and then obſerve the quick height of the greater Chanel, before the introduction of the leſſer ; and having brought in the ſaid Chanellet , we muſt agnin find the proportion that the water of the Chanellet hath to all the water of the great Chanel ; for theſe terms of the proportion being known, as alſo the quantity of the water of the Chanellet , we ſhall alſo come to know the quantity of the water that runneth thorow the great Chanel. It is likewiſe manifeſt, that we ſhall obtain our intent, if the caſe were that there entered into the great Chanel, another leſſer Chanel that was meaſurable , and that might be diverted.

CONSIDERATION.

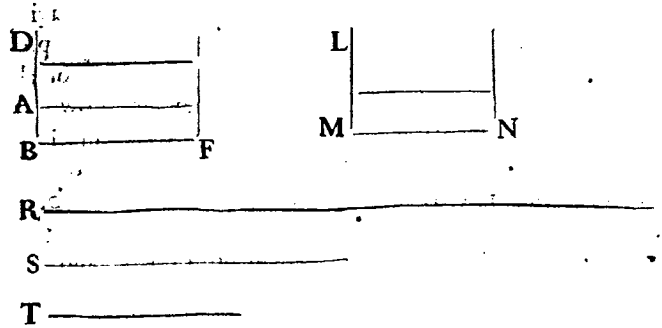
IT would be neceſſary to make uſe of this Doctrine in the diſtribution of the waters that are imploy'd to overflow the fields, as is uſed in the *Breſcian, Cremoneſe, Bergamaſe, Lodigian, Milaneſe,*

neſe territories, and many other places, where very great ſuits and differences ariſe, which not being to be determined with intelligible reaſons, come oftentimes to be decided, by force of armes; and inſtead of flowing their Grounds with Waters, they cruelly flow them with the ſhedding of humane blood, impiouſly inverting the courſe of Peace and Juſtice, ſowing ſuch diſorders and feuds, as that they are ſometimes accompanied with the ruine of whole Cities, or elſe unprofitably charge them with vain, and ſometimes prejudicial expences.

PROPOS. IV. THEOR. II.

If a River increaſe in quick height, the quantitie of Water which the River diſchargeth after the increaſe, hath the Proportion compounded of the Proportions of the Quick height to the Quick height, and of the velocity to the velocity.

LEt there be a River, which whilſt it is low, runneth thorow the Regulator D F, with the Quick height A B, and afterwards let a Flood come, and then let it run with the height D B, I ſay, that the quantity of the Water that is diſcharged through D F, to that which diſchargeth through A F, hath the proportion compounded of the proportions of the velocity through D F to the velocity through A F, and of the height D B to the height A B. As the velocity through D F is to the velocity through A F, ſo let the line R be to the line S; and as the height D B is to the height A B; ſo let the line S be to the



line T. And let a Section be ſuppoſed L M N equal to the Section D F in height and length, but let it be in velocity equal to the Section A F. Therefore the quantity of the Water that runneth through D F to that which runneth through L N, ſhall be

as

as the velocity through D F, to the velocity of L N, that is, to the velocity through L N, that is, to the velocity through *A F*. therefore the quantity of Water which runneth through D *F*, to that which paſſeth through L N, ſhall have the proportion that R hath to S; but the quantity of the Water that runneth through L N, to that which runneth through *A F*; (the Sections being equally ſwift) ſhall have the proportion that the Section L N hath to the Section A F, that is, that the height *B* D hath to the height *B* A, that is, that S hath to T. Therefore, by equal proportion, the quantity of the Water which runneth by D F, to that which runneth by A F, ſhall have the proportion of R to T, that is, ſhall be compounded of the proportions of the height D *B*, to the height A *B*; and of the velocity through D F, to the velocity through A F. And therefore if a River increaſe in quick height, the quantity of the Water that runneth after the increaſe, to that which runneth before the increaſe, hath the proportion compounded, &c. Which was to be demonſtrated.

COROLLARIE I.

HEnce it followeth, that we having ſhewn, that the quantity of the Water which runneth, whilſt the River is high, to that which ran, whilſt it was low, hath the proportion compounded of the velocity to the velocity, and of the height to the height. And it having been demonſtrated, that the velocity to the velocity is as the height to the height; it followeth, I ſay, that the quantity of the Water that runneth, whilſt the River is high, to that which runneth, whilſt it is low, hath duplicate proportion of the height to the height, that is, the proportion that the ſquares of the heights have.

COROLLARIE II.

VPon which things dependeth the reaſon of that which I have ſaid, in my ſecond Conſideration, that if by the diverſion of $\frac{2}{3}$ of the Water that entereth by the Rivers into the Moor or Fen, the Water be abated ſuch a meaſure, that ſame ſhall be only one third of its whole height; but moreover diverting the $\frac{1}{3}$, it ſhall abate two other thirds, a moſt principal point; and ſuch, that its not having been well underſtood, hath cauſed very great diſorders, and there would now, more than ever, follow extream dammage, if one ſhould put in execution the diverſion of the *Sile* and other Rivers; and it is manifeſt, that in the ſame manner, wherewith it hath been demonſtrated, that the quantity of the Water increaſing quadruple, the height would increaſe *onely* double

double, and the quantity increasing nonuple, the height increaseth triple; so that, by adding to units all the odde numbers, according to their Series, the heights increase according to the natural progression of all the numbers, from units. As for example, there passing thorow a Regulator such a certain quantity of Water in one time; adding three of those measures, the quick height is two of those parts, which at first was one; and continuing to adde five of those said measures, the height is three of those parts which at first were one; and thus adding seven, and then nine, and then 11. and then 13, &c. the heights shall be 4. then 5, then 6. then 7, &c. And for the greater facility of the Work, we have described the following Table, of which we will declare the use: The Table is divided into three Series or Progressions of Numbers: the first Series containeth all the Numbers in the Natural Progression, beginning at a Unit, and is called the Series of the Heights; the second containeth all the odde numbers, beginning at an unit, and is called the Series of the Additions: the third containeth all the square numbers, beginning at an unit, and is called the Series of Quantity.

Heights.	1	11	21	31	41	51	61	71	81	91	101	11
Additions.	1	11	31	51	71	91	111	113	115	117	191	21
Quantities.	1	11	41	91	116	125	136	149	164	181	1001	121

The use of the afore-mentioned Table.

First, if we suppose the whole quick height of a River of Running Water to be divided into any number of equal parts, at pleasure, and would abate the same one fift, by means of a division; let there be found in the Table in the Series of heights the number 5. the denominator of the part which the River is to abate, and take the number that is immediately under it in the row of Additions, which is 9. which let be substracted from the number 25. placed underneath the same in the row of Quantities, the remainder 16. signifieth that of the 25. parts of Water that ran in the River, whilst it was 5 measures high, there do onely run 16. parts; so that to make it abate $\frac{1}{5}$ it is necessary to take $\frac{9}{25}$ from the Water that the whole River did carry; so that with substracting somewhat more than one third of the Water of the River, it is abated but only one fift.

2. And thus, in the second place, if on the contrary, one would know how much water is to be added to the said River to make it increase one fift more in height, so as that it may run in the Regulator

Regulator 6. of thoſe parts high; of which it ran before but 5. let 6 be found in the row of heights, and let the number 11. ſtanding under the ſame be taken and added to the number 25. that is placed under the number 9. in the Additions, and 5. in the heights, and you ſhall have 36. which is the quantity of the water that runneth with the height of the River, when it is high 6 of thoſe parts, whereof it was before but 5.

3. But if it ſhould be deſired, to know how much water it is requiſite to add to make the River riſe ſo, as that it may run in height 8. of thoſe parts of which before it ran but 5; one ought to take the ſum of the number of the Series of Additions ſtanding under 8. 7. and 6, which are 15. 13. and 11. that is, 39. and this ſhall be the ſumme that muſt be added to 25: So that to make the River to run 8. of thoſe parts in height, of which it before did run 5, it will be neceſſary to add 39. of thoſe parts, of which the River before was 25.

4. Likewiſe the ſame Table giveth the quantity of water that runneth from time to time through a River, that increaſeth by the addition of new water to the ſame in one of its heights, the quantity of its water be known. As for example: If we knew that the River in one minute of an hour diſchargeth 2500. of thoſe meaſures of water, and runneth in height 5. parts in the Regulator, and afterwards ſhould ſee that it runneth 8 Palms high, finding in the row of quantity the number placed under 8. which is 64. we would ſay that the River heightned, carrieth of water 64. of thoſe parts whereof it carried before but 25; and becauſe before it carried 2500. meaſures, by the Golden Rule we will ſay, that the River carrieth 6400. of thoſe meaſures, of which before it carried 2500.

In this progreſs of Nature, is one thing really curious, and that at firſt ſight ſeemeth to be ſomewhat Paradoxal, that we proceeding ordinately in the diverſions and additions, with additions and diverſions ſo unequal, the abatings do notwithſtanding alwaies prove equal, and ſo do the riſings: And who would ever think that a River in height, *v. g.* 10. Palms, running and carrying an hundred meaſures in a minute of an hour, is to abate but one Palm, onely by the diverſion of 19. of thoſe meaſures; and then again, that the buſineſs cometh to that paſs, that it abateth likewiſe a Palm by the diverſion of three onely of thoſe meaſures, nay, by the diverſion of but one meaſure? and yet it is moſt certain: And this truth meets with ſo manifeſt proofs in experience, that it is very admirable! And for the full ſatisfaction of thoſe, who not being able to comprehend ſubtil demonſtrations, deſire to be clearly inform'd by the matters of fact, and to ſee with their bobily eyes, and touch with their hands, what their underſtanding and reaſon cannot reach unto: I will hear add another very eaſie way to reduce all to an experiment, the

which may be made in little, in great, or in very great; of which I make uſe frequently, to the admiration of ſuch as ſee it.

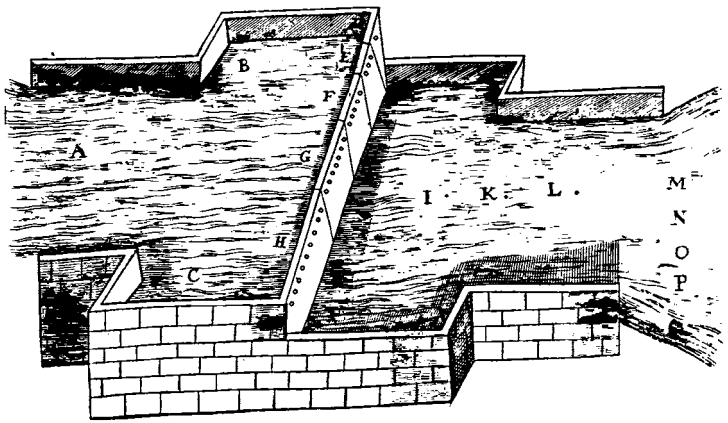
I prepared an hundred Siphons, or, if you will, bowed Pipes, all equal; and placed them at the brim of a Veſſel, wherein the water is kept at one and the ſame level (whether all the Syphons work, or but a certain number of them) the mouths by which the water iſſueth being all placed in the ſame level, parallel to the Horizon; but lower in level than the water in the Veſſel; and gathered all the water falling from the Syphons into another Veſſel ſtanding lower than the former, I made it to run away thorow a Chanel, in ſuch manner inclined, that wanting water from the Syphons, the ſaid Chanel remained quite dry.

And this done, I meaſured the quick height of the Chanel with care, and afterwards divided it exactly into 10 equal parts, and cauſing 19. of thoſe Syphons to be taken away, ſo that the Chanel did not run water, ſave onely with 81 of thoſe Syphons, I again obſerved the quick height of the water in the ſame ſite obſerved before, and found that its height was diminiſhed preciſely the tenth part of all its firſt height; and thus continuing to take away 17. other Syphons, the height was likewiſe diminiſhed $\frac{1}{10}$. of all its firſt quick height; and trying to take away 15. Syphons, then 13, then 11, then 9, then 7, then 5, and then 3. alwaies in theſe diverſions, made in order as hath been ſaid, there enſued ſtill an abatement of $\frac{1}{10}$. of the whole height.

And here was one thing worthy of obſervation, that the water encreaſing in [*or through*] the Chanel, its quick height was different in different ſites of the Chanel, that is ſtill leſſer, the more one approached to the Out-let; notwithſtanding which the abatement followed in all places proportionably, that is in all its ſites the firſt part of the height of that ſite diminiſhed: And moreover the water iſſued from the Chanel, and dilated into a broader courſe, from which likewiſe having divers Out-lets and Mouths; yet nevertheleſs in that breadth alſo the quick heights ſucceſſively varied and altered in the ſame proportions. Nor did I here deſiſt my obſervation, but the water being diminiſhed, that iſſued from the Syphons, and there being but one of them left that diſcharged water; I obſerved the quick height that it made in the above-ſaid ſites, (the which was likewiſe $\frac{1}{10}$. of all the firſt height) there being added to the water of that Syphon, the water of three other Syphons; ſo that all the water was of 4 Syphons, and conſequently quadruple to the firſt Syphon; but the quick height was onely double, and adding five Siphons, the quick height became triple, and with adding ſeven Syphons, the height increaſed quadruple; and ſo by adding of 9. it increaſed quintuple, and by adding of 11. it increaſed ſextuple, and by adding

ding of 13. it increaſed ſeptuple, and by adding of 15. octuple, and by adding of 17. nonuple, and laſtly by adding 19. Syphons; ſo that all the water was centuple to the water of one Syphon, yet nevertheleſs the quick height of all this water was onely decuple to the firſt height conjoyned by the water that iſſued from one onely Syphon.

For the more clear underſtanding of all which, I have made the following Figure; in which we have the mouth A, that maintaineth the water of the Veſſel B C in the ſame level; though it continually run; to the brim of the Veſſel are put 25. Syphons (and there may be many more) divided into 5 Claſſes, D E F G H, and the firſt D, are of one onely Syphon; the ſecond E, of three Syphons; the third F, of five; the fourth G, of 7; the fifth H, of 9; and one may ſuppoſe the ſixth of 11, the ſeventh of 13 Syphons, and ſo of the other Claſſes, all containing in conſequent odd numbers ſucceſſively (we are content to repreſent in the Figure no more but the five forenamed Claſſes to avoid confuſion) the gathered water D E F G H, which runneth thorow the Chanel I K L, and falleth into the out-let M N O P; and ſo much ſufficeth for the explanation of this experiment.



PROPOS. V. PROB. III.

Any River of any bigneſs, if being given to examine the quantity of the Water that runneth thorow the River in a time aſſigned.

BY what we have ſaid already in the two preceding Problems, we may alſo reſolve this that we have now before us; and it is done, by diverting in the firſt place from the great River a good big meaſurable Chanel, as is taught in the ſecond Probleme, and obſerving the abatement of the River, cauſed by the diverſion of the Chanel; and finding the proportion that the Water of the Chanel hath to that of the River, then let the Water of the Chanel be meaſured by the ſecond Probleme, and work as above, and you ſhall have your deſire.

CONSIDERATION. I.

AND although it ſeemeth as if it might prove difficult, and almoſt impoſſible to make uſe of the Regulator number, if one be about to meaſure the water of ſome great River, and conſequently would be impoſſible, or at leaſt very difficult to reduce the Theory of the firſt Probleme into practice: Yet nevertheleſs, I could ſay that ſuch great conceits of meaſuring the water of a great River, are not to come into the minds of any but great Perſonages, and potent Princes; of whom it is expected for their extraordinary concerns, that they will make theſe kinde of enquiries; as if here in *Italy* it ſhould be of the Rivers *Tyber*, *Velino*, *Chiana*, *Arno*, *Serchio*, *Adice*, in which it ſeemeth really difficult to apply the Regulator, to finde exactly the quick height of the River: But becauſe in ſuch like caſes ſometimes it would turn to account to be at ſome charge, to come to the exact and true knowledge of the quantity of water which that River carrieth, by knowledge whereof, other greater diſburſments might afterwards be avoided, that would oft times be made in vain; and prevent the diſguſts, which ſometimes happen amongſt Princes: Upon this ground I think it will be well to ſhew alſo the way how to make uſe of the Regulator in theſe great Rivers; in which if we will but open our eyes, we ſhall meet with good ones, and thoſe made without great coſt or labour, which will ſerve our turn.

For upon ſuch like Rivers there are Wears, or Lockes made, to

to cauſe the Waters to riſe, and to turn them for the ſervice of Mills, or the like. Now in theſe Caſes it is ſufficient, that one erect upon the two extreames of the Weare two Pilaſters either of Wood or Brick, which with the bottome of the Weare do compoſe our Regulator, wherewith we may make our deſired operation, yea the Chanel it ſelf diverted ſhall ſerve, without making any other diverſion or union. And in brief, if the buſineſſes be but managed by a judicious perſon, there may wayes and helps be made uſe of, according to occaſion, of which it would be too tedious to ſpeak, and therefore this little that hath been hinted ſhall ſuffice.

CONSIDERATION II.

FRom what hath been declared, if it ſhall be well underſtood, may be deduced many benefits and conveniences, not onely in dividing of Running Waters for infinite uſes that they are put to in turning of Corne-Mills, Paper-Mills, Gins, Powder-Mills, Rice-Mills, Iron-Mills, Oil-Mills, Sawing-Mills, Mirtle-Mills, Felling-Mills, Fulling-Mills, Silk-Mills, and ſuch other Machines; but alſo in ordering Navigable Chanels, diverting Rivers and Chanels of Waters, or terminating and limiting the ſizes of Pipes for Fountains: In all which affairs there are great errours committed, to the loſſe of much expence, the Chanels and Pipes that are made, ſometimes not being ſufficient to carry the deſigned Waters, and ſometimes they are made bigger than is neceſſary; which diſorders ſhall be avoided, if the Engineer be adviſed of the things aboveſaid: and in caſe that to theſe Notions there be added the knowledge of Philoſophy and Mathematicks, agreeable to the ſublime Diſcoveries of *Signore Galilæo*, and the further improvement thereof by *Signore Evangeliſta Torricelli*, Mathematician to the Grand *Duke of Tuſcany*, who hath ſubtilly and admirably handled this whole buſineſſe of Motion, one ſhall then come to the knowledge of particular notions of great curioſity in the Theoricks, and of extraordinary benefit in the Practicks that daily occur in theſe buſineſſes.

And to ſhew, in effect, of what utility theſe Notions are, I have thought fit to inſert, in this place, the Conſiderations by me made upon the Lake of *Venice*, and to repreſent, at large, by the experience of the laſt year 1641. the moſt Serene *Erizzo*, then Duke of the ſaid Republique. Being therefore at *Venice*, in the year aforeſaid, I was requeſted by the moſt Illuſtrious and moſt Excellent *Signore Giovanni Baſa-*

donna

Donna, a Senatour of great worth and merit, that I would ingenuouſly deliver my opinion touching the ſtate of the Lake of *Venice*; and after I had diſcourſed with his Honour ſeveral times, in the end I had order to ſet down the whole buſineſſe in writing, who having afterwards read it privately, the ſaid *Signore* imparted the ſame, with like privacy, to the moſt Serene PRINCE, and I received order to repreſent the ſame to the full *Colledge*, as accordingly I did in the Moneth of *May*, the ſame year, and it was as followeth.

CONSIDERATIONS
Concerning the
LAKE
OF
VENICE.

BY

D. BENEDETTO CASTELLI,
Abbot of S. *Benedetto Aloyſio*, Mathematician to Pope *URBAN VIII.* and Profeſſor in ROME.

CONSIDERATION I.

THough the principal cauſe be but one onely, that in my judgment threatneth irreparable ruine to the Lake of *Venice*, in the preſent ſtate in which it now ſtands; Yet nevertheleſſe, I think that two Heads may be conſidered. And this Conſideration may peradventure ſerve us for to facilitate and explain the opportune remedies, though not to render the ſtate of things abſolutely unchangeable and eternal: an enterprize impoſſible, and eſpecially in that which having had ſome beginning, ought likewiſe neceſſarily to have its end; or at leaſt to prevent the danger for many hundreds of years; and poſſibly it may, in the mean time, by the mutation it ſelf be brought into a better condition.

I ſay therefore, that the preſent diſorder may be conſidered under two Heads; One is the very notable diſcovery of Land that is obſerved at the time of low Water, the which, beſides the obſtructing of Navigation in the Lake and alſo in the Chanels, doth likewiſe threaten another miſchief and diſorder worthy

worthy of very particular conſideration, which is, That the Sun drying up that mudde, eſpecially in the times of hot Summers, doth raiſe thence the putrified and pernicious vapours, fogs, and exhalations that infect the Air, and may render the City unhabitable.

The ſecond Head is the great Stoppage that daily is growing in the Ports, eſpecially of *Venice*, at *Malamoco*; concerning which matters I will hint certain general points, and then will proceed to the more particular and important affairs.

And firſt, I ſay, that I hold it altogether impoſſible to effect any thing, though never ſo profitable, which doth not bring with it ſome miſchief; and therefore the good and the hurt ought to be very well weighed, and then the leſſe harmful part to be imbraced.

Secondly, I propoſe to conſideration, that the ſo notable diſcovery of Earth & Mud, hath not been long obſerved, as I underſtand, from old perſons that can remember paſſages for fifty years paſt; which thing being true, as to me it ſeemeth moſt true, it ſhould appear that it could not but be good to reduce matters to that paſſe that they were at formerly, (laying aſide all affection or paſſion that ſelf-flattering minds have entertained for their own conceits) or at leaſt it ſhall be neceſſary ſpeedily to conſult the whole.

Thirdly, I hold that it is neceſſary to weigh, whether from the foreſaid diſcovery of Land, it followeth, that onely the Earth riſeth, as it is commonly thought by all, without diſpute; or whether the Waters are abated and faln away; or elſe whether it proceedeth from both the one and other cauſe. And here it would be ſeaſonable to enquire, what ſhare the ſaid cauſes may have, each conſidered apart in the foreſaid effect. For, in the firſt caſe, if the Earth have been raiſed, it would be neceſſary to conſider of taking it down, and removing it: But if the Waters have failed or abated, I believe that it would be extreamly neceſſary to reſtore and raiſe them: And if both theſe reaſons have conſpired in this effect, it will be neceſſary to remedy them each apart. And I do, for my part, think, that the ſo notable appearance of Shelves at the time of low Water, proceeds principally from the decreaſe and abatement of the Waters, which may confidently be affirmed to need no other proof, in regard that the *Brent* hath been actually diverted which did formerly diſcharge its Water into the Lake.

As to the other point of the great Stoppage of Ports, I hold, that all proceedeth from the violence of the Sea, which being ſometimes diſturbed by windes, eſpecially at the time of the waters flowing, doth continually raiſe from its bottome immenſe heaps

heaps of ſand, carrying them by the tide; and force of the waves into the Lake; it not having on its part any ſtrength of current that may raiſe and carry them away, they ſink to the bottom, and ſo they choke up the Ports. And that this effect happeneth in this manner, we have moſt frequent experiences thereof along the Sea-coaſts: And I have obſerved in *Tuſcany* on the *Roman-ſhores*, and in the Kingdom of of *Naples*, that when a river falleth into the Sea, there is alwaies ſeen in the Sea it ſelf, at the place of the rivers out-let, the reſemblance, as it were, of an half-Moon, or a great ſhelf of ſettled ſand under water, much higher then the reſt of the ſhore, and it is called in *Tuſcany*, *il Cavallo*; and here in *Venice*, *lo Scanto*: the which cometh to be cut by the current of the river, one while on the right ſide, another while on the left, and ſometimes in the midſt, according as the Wind ſits. And a like effect I have obſerved in certain little Rillets of water, along the Lake of *Bolſena*; with no other difference, ſave that of ſmall and great.

Now whoſo well conſidereth this effect, plainly ſeeth that it proceeds from no other, than from the contrariety of the ſtream of the River, to the *impetus* of the Sea-waves; ſeeing that great abundance of ſand which the Sea continually throws upon the ſhore, cometh to be driven into the Sea by the ſtream of the river; and in that place where thoſe two impediments meet with equal force, the ſand ſetleth under water, and thereupon is made that ſame Shelf or *Cavallo*; the which if the river carry water, and that any conſiderable ſtore, it ſhall be thereby cut and broken; one while in one place, and another while in another; as hath been ſaid, according as the Wind blows: And through that Chanel it is that Veſſels fall down into the Sea, and again make to the river, as into a Port. But if the Water of the river ſhall not be continual or ſhall be weak, in that caſe the force of the Sea-Wind ſhall drive ſuch a quantity of ſand into the mouth of the Port, and of the river, as ſhall wholly choak it up. And hereupon there are ſeen along the Sea-ſide, very many Lakes and Meers, which at certain times of the year abound with waters, and the Lakes bear down that encloſure, and run into the Sea.

Now it is neceſſary to make the like reflections on our Ports of *Venice*, *Malamocco*, *Bondolo*, and *Chiozza*; which in a certain ſenſe are no other than Creeks, mouths, and openings of the ſhore that parts the Lake from the main Sea; and therefore I hold that if the Waters in the Lake were plentiful, they would have ſtrength to ſcowr the mouths of the Ports thorowly, & with great force; but the Water in the Lake failing, the Sea will without any oppoſal, bring ſuch a drift of ſand into the Ports; that if

it doth not wholly choke them up, it ſhall render them at leaſt unprofitable, and impoſſible for Barks and great Veſſels.

Many other conſiderations might be propounded concerning theſe two heads of the ſtoppage of the Ports, and of the appearance of the Ouze and Mud in the Lakes, but ſo much ſhall ſuffice us to have hinted, to make way for diſcourſing of the operations about the oportune remedies.

Yet before that I propound my opinion, I ſay, That I know very well that my propoſal, at firſt ſight, will ſeem abſurd and inconvenient; and therefore, as ſuch, will perhaps be rejected by the moſt: and ſo much the rather, for that it will prove directly contrary to what hath hitherto been, and as I hear, is intended to be done: And I am not ſo wedded to my opinions, but that I do conſider what others may judge thereof: But be it as it will, I am obliged to ſpeak my thoughts freely, and that being done, I will leave it to wiſer men than my ſelf; when they ſhall have well conſidered my reaſons, to judge and deliberate of the *quid agendum*: And if the ſentence ſhall go againſt me, I appeal to the moſt equitable and inexorable Tribunal of Nature, who not caring in the leaſt to pleaſe either one party or another, will be alwaies a punctual and inviolable executrix of her eternal Decrees, againſt which neither humane deliberations, nor our vain deſires, ſhall ever have power to rebell. I added by word of mouth that which followeth.

Though your Highneſs intereſt your ſelf in this Noble Colledge, and cauſe it to be confirmed in the * Senate by univerſal Vote, that the Winds do not blow, that the Sea doth not fluctuate, that the Rivers do not run; yet ſhall the Winds be alwaies deaf, the Sea ſhall be conſtant in its inconſtancy, and the Rivers moſt obſtinate: And theſe ſhall be my Judges, and to their determination I refer my ſelf.

* In *Pregadi*, a particular Council, the Senators of which have great Authority.

By what hath been ſaid, in my opinion, that is made very clear and manifeſt, which in the beginning of this diſcourſe I glanced at; namely, That the whole diſorder, although it be divided into two heads; into the diſcovery of the Mud, and of the ſtoppage Ports; yet nevertheleſs, by the application of one onely remedy, and that in my eſteem very eaſie, the whole ſhall be removed: And this it is; That there be reſtored into the Lake as much Water as can be poſſible, and in particular from the upper parts of *Venice*, taking care that the Water be as free from Mud as is poſſible. And that this is the true and real remedy of the precedent diſorders, is manifeſt: For in the paſſage that this Water ſhall make thorow the Lakes, it ſhall of it ſelf by degrees clear the Chanels in ſundry parts of them, according to the currents that it ſhall ſucceſſively acquire, and in this manner being diſperſed

perſed thorow the Lake, it ſhall maintain the waters in the ſame, and in the Chanels much higher, as I ſhall prove hereafter; a thing that will make Navigation commodious; and that, which moreover is of great moment in our buſineſſe; thoſe Shelves of Mud which now diſcover themſelves at the time of Low-Waters ſhall be alwayes covered, ſo that the putrefaction of the Air ſhall alſo be remedied.

And laſtly, this abundance of Water being alwayes to diſcharge it ſelf into the Sea by the Ports, I do not doubt, but that their bottomes will be ſcoured. And that theſe effects muſt follow, Nature her ſelf ſeemeth to perſwade, there remaining onely one great doubt, whether that abundance of Water that ſhall be brought into the Lake may be really ſufficient to make the Waters riſe ſo much as to keep the Shelves covered, and to facilitate Navigation, which ought to be at leaſt half a * Brace, or thereabouts. And indeed it ſeemeth at firſt ſight to be impoſſible, that the ſole Water of the * *Brent* let into the Lake, and diſperſed over the ſame, can occaſion ſo notable an height of water; and the more to confirm the difficulties, one might ſay, reducing the reaſon to calculation, that in caſe the *Brent* were 40. Braces broad, and two and an half high, and the breadth of the Lake were 20000. Braces, it would ſeem neceſſary that the height of the water of the *Brent* dilated and diſtended thorow the Lake would be but onely $\frac{1}{100}$ of a Brace in height, which is imperceptible, and would be of no avail to our purpoſe; nay more, it being very certain that the *Brent* runneth very muddy and foul, this would occaſion very great miſchief, filling and contracting the Lake, and for that reaſon this remedy ought, as pernicious, to be totally excluded and condemned.

* A *Venice* Brace is $\frac{11}{12}$ of our yard.

* A River of that name.

I here confeſſe that I am ſurprized at the forme of the Argument, as if I were in a certain manner convinced, that I dare not adventure to ſay more, or open my mouth in this matter; but the ſtrength it ſelf of the Argument, as being founded upon the means of Geometrical and Arithmetical Calculation, hath opened me the way to diſcover a very crafty fraud that is couched in the ſame Argument, which fraud I will make out to any one that hath but any inſight in *Geometry* and *Arithmetick*. And as it is impoſſible, that ſuch an argument ſhould be produced by any but ſuch as have taſted of theſe, in ſuch affairs, moſt profitable, and moſt neceſſary Sciences; ſo do not I pretend to make my ſelf underſtood, ſave onely by ſuch, to whom I will evince ſo clearly, as that more it cannot be deſired, the errour and fraud wherein thoſe Ancients and Moderns have been, and alwayes are intangled, that have in any way yet handled this matter of conſidering the Meaſure and Quantity of the Waters that move.

And ſo great is the eſteem that I have for that which I am now about to ſay touching this particular, that I am content that all the reſt of my Diſcourſe be rejected; provided, that that be perfectly underſtood, which I am hereafter to propoſe, I holding and knowing it to be a main Principle, upon which all that is founded that can be ſaid either well or handſomely on this particular. The other Diſcourſes may have an appearance of being probable, but this hits the mark as full as can be deſired, arriving at the higheſt degree of certainty.

I have, ſeventeen years ſince, as I repreſented to the moſt Serene Prince, and to the Right Honourable the Preſident of the Lords the Commiſſioners of the *Sewers, written a Treatiſe of the Meaſure of the waters that move, in which I Geometrically demonſtrate and declare this buſineſſe, and they who ſhall have well underſtood the ground of my Diſcourſe, will reſt fully ſatisfied with that which I am now about to propoſe: But that all may become rhe more eaſie, I will more briefly explicate and declare ſo much thereof as I have demonſtrated in the Diſcourſe, which will ſuffice for our purpoſe: And if that ſhould not be enough, we have alwayes the experiment of a very eaſie and cheap way to clear up the whole buſineſſe. And moreover I will take the boldneſſe to affirm, that in caſe there ſhould not for the preſent any deliberation be made concerning this affair, according to my opinion; yet nevertheleſſe it will be, at ſome time or other; or if it be not, things will grow worſe and worſe.

* *I. Savii dell' Acque*, a particular Council that take care of the Lakes and other Aquatick affairs.

For more clear underſtanding, therefore, it ought to be known, that it being required, as it is generally uſed, to meaſure the waters of a River, its breadth and its depth is taken, and theſe two dimenſions being multiplied together, the product is affirmed to be the quantity of that River: As for example, if a River ſhall be 100. feet broad, and 20. feet high, it will be ſaid, that that River is 2000 feet of Water, and ſo if a Ditch ſhall be 15. feet broad, and 5. feet high, this ſame Ditch will be affirmed to be 75. feet of Water: And this manner of meaſuring Running Water hath been uſed by the Ancients, and by Moderns, with no other difference, ſave onely that ſome have made uſe of the Foot, others of the Palme, others of the Brace, and others of other meaſures.

Now becauſe that in obſerving theſe Waters that move, I frequently found, that the ſame Water of the ſame River was in ſome ſites of its Chanel pretty big, and in others much leſſe, not arriving in ſome places to the twentieth, nor to the hundreth part of that which it is ſeen to be in other places; therefore this vulgar way of meaſuring the Waters that move, for that they did not

not give me a certain and ſtable meaſure and quantity of Water, began deſervedly to be ſuſpected by me, as difficult and defective, being alwayes various, and the meaſure, on the contrary, being to be alwayes determinate, and the ſame; it is therefore written, that *Pondus & Pondus, Menſura & Menſura, utrumque abominabile eſt apud Deum*, Exod. I conſidered that in the Territory of *Breſcia*, my native Countrey, and in other places, where Waters are divided to overflow the Grounds, by the like way of meaſuring them, there were committed grievous and moſt important errours, to the great prejudice of the Publique and of Private perſons, neither they that ſell, nor they that buy underſtanding the true quantity of that which is ſold and bought: In regard that the ſame ſquare meaſure, as is accuſtomed in thoſe parts, aſſigned one particular perſon, carried to ſometimes above twice or thrice as much water, as did the ſame ſquare meaſure aſſigned to another. Which thing proveth to be the ſame inconvenience, as if the meaſure wherewith Wine and Oil is bought and ſold, ſhould hold twice or thrice as much Wine or Oil at one time as at another. Now this Conſideration invited my minde and curioſity to the finding out of the true meaſure of Running Waters. And in the end, by occaſion of a moſt important buſineſſe that I was imployed in ſome years ſince, with great intenſeneſſe of minde, and with the ſure direction of *Geometry*, I have diſcovered the miſtake, which was, that we being upon the buſineſſe of taking the meaſure of the Waters that move, do make uſe of two dimenſions onely, namely, breadth and depth, keeping no account of the length. And yet the Water being, though running, a Body, it is neceſſary in forming a conceit of its quantity, in relation to another, to keep account of all the three Dimenſions, that is of length, breadth, and depth.

Here an objection hath been put to me, in behalf of the ordinary way of meaſuring Running Waters, in oppoſition to what I have above conſidered and propoſed: and I was told, Its true, that in meaſuring a Body that ſtands ſtill, one ought to take all the three Dimenſions; but in meaſuring a Body that continually moveth, as the Water, the caſe is not the ſame: For the length is not to be had, the length of the water that moveth being infinite, as never finiſhing its running; and conſequently is incomprehenſible by humane underſtanding, and therefore with reaſon, nay upon neceſſity it cometh to be omitted.

In anſwer to this, I ſay, that in the aboveſaid Diſcourſe, two things are to be conſidered diſtinctly; Firſt, whether it be poſſible to frame any conceit of the quantity of the Body of the Water with two Dimenſions onely. And ſecondly, whether this length be to be found. As to the firſt, I am very certain that no man, let him

him be never ſo great a Wit, can never promiſe to frame a conceit of the quantity of the Body of Water, without the third Dimenſion of length: and hereupon I return to affirm, that the vulgar Rule of meaſuring Running water is vain and erroneous. This point being agreed on, I come to the ſecond, which is, Whether the third Dimenſion of length may be meaſured. And I ſay, that if one would know the whole length of the water of a Fountain or River, thereby to come to know the quantity of all the Water, it would prove an impoſſible enterprize, nay the knowing of it would not be uſeful. But if one would know how much water a Fountain, or a River carrieth in a determinate time of an hour, of a day, or of a moneth, &c. I ſay, that it is a very poſſible and profitable enquiry, by reaſon of the innumerable benefits that may be derived thence, it much importing to know how much Water a Chanel carrieth in a time given; and I have demonſtrated the ſame above in the beginning of this Book; and of this we ſtand in need in the buſineſſe of the Lake, that ſo we may be able to determine how much ſhall be the height of the *Brent*, when it is ſpread all over the Lake: For the three dimenſions of a Body being given, the Body is known; and the quantity of a Body being given, if you have but two dimenſions, the third ſhall be known. And thus diving farther and farther into this Conſideration, I found that the Velocity of the courſe of the water may be an hundred times greater or leſſer in one part of its Chanel than in another. And therefore although there ſhould be two mouths of Waters equal in bigneſſe; yet nevertheleſs it might come to paſſe, that one might diſcharge an hundred or a thouſand times more water than another: and this would be, if the water in one of the mouths ſhould run with an hundred or a thouſand times greater velocity, than the other; for that it would be the ſame as to ſay, that the ſwifter was an hundred or a thouſand times longer, than the ſlower: and in this manner I diſcovered that to keep account of the velocity, was the keeping account of the Length.

And therefore it is manifeſt, that when two Mouths diſcharge the ſame quantity of Water in an equal velocity, it is neceſſary that the leſs ſwift Mouth be ſo much bigger than the more ſwift; as the more ſwift exceedeth in velocity the leſs ſwift; as for example.

In caſe two Rivers ſhould carry equal quantity of water in equal times, but that one of them ſhould be four times more ſwift than the other, the more ſlow ſhould of neceſſity be four times more large. And becauſe the ſame River in any part thereof alwaies diſchargeth the ſame quantity of Water in equal times (as is demonſtrated in the firſt Propoſition of the firſt Book

Book* of the measure of Running Waters;) but yet doth not run thorowout with the same velocity: Hence it is, that the vulgar measures of the said River, in divers parts of its Chanel, are alwaies divers; insomuch, that if a River passing through its chanel had such velocity, that it ran 100 Braces in the ½ of an hour, and afterwards the said River should be reduced to so much tardity of motion, as that in the same time it should not run more than one Brace, it would be necessary that that same River should become 100. times bigger in that place where it was retarded; I mean, 100. times bigger than it was in the place where it was swifter. And let it be kept well in mind, that this point rightly understood, will clear the understanding to discover very many accidents worthy to be known. But for this time let it suffice, that we have onely declared that which makes for our purpose, referring apprehensive and studious Wits to the perusal of my aforenamed Treatise; for therein he shall finde profit and delight both together.

* He here intends the Demonstrations following, at the end of the first Book

Now applying all to our principal intent, I say, That by what hath been declared it is manifest, that if the *Brent* were 40. Braces broad, and 2½ high, in some one part of its Chanel, that afterwards the same Water of the *Brent* falling into the Lake, and passing thorow the same to the Sea, it should lose so much of its velocity, that it should run but one Brace, in the time wherein whilst it was in its Chanel at the place aforesaid, it ran 100. Braces. It would be absolutely necessary, that increasing in measure, it should become an hundred times * thicker; and therefore if we should suppose that the Lake were 20000. Braces, the *Brent* that already hath been supposed in its Chanel 100. Braces, being brought into the Lake, should be 100. times 100. Braces; that is, shall be 10000. Braces in thickness, and consequently shall be in height half a Brace; that is, 1/200 of a Brace, and not ½ of a Brace, as was concluded in the Argument.

* Deeper.

Now one may see into what a gross errour of 99. in 100. one may fall through the not well understanding the true quantity of Running Water, which being well understood, doth open a direct way to our judging aright in this most considerable affair. And therefore admitting that which hath been demonstrated, I say, that I would (if it did concern me) greatly encline to consult upon the returning of the *Brent* again into the Lake: For it being most evident, that the *Brent* in the Chanel of its mouth, is much swifter than the *Brent* being brought into the Lake, it will certainly follow thereupon, that the thickness of the Water of *Brent* in the Lake, shall be so much greater than that of *Brent* in *Brent*, by how much the *Brent* in *Brent* is swifter than the *Brent* in the Lake.

1. From

1. From which operation doth follow in the firſt place, that the Lake being filled and increaſed by theſe Waters, ſhall be more Navigable, and paſſible, than at preſent we ſee it to be.

2. By the current of theſe Waters, the Chanels will be ſcoured, and will be kept clean from time to time.

3. There will not appear at the times of low-waters ſo many Shelves, and ſuch heaps of Mud, as do now appear.

4. The Ayr will become more wholeſom, for that it ſhall not be ſo infected by putrid vapours exhaled by the Sun, ſo long as the Miery Ouze ſhall be covered by the Waters.

5. Laſtly, in the current of theſe advantagious Waters, which muſt iſſue out of the Lake into the Sea, beſides thoſe of the Tyde, the Ports will be kept ſcoured, and clear: And this is as much as I ſhall offer for the preſent, touching this weighty buiſineſs; alwaies ſubmitting my ſelf to ſounder judgements.

Of the above-ſaid Writing I preſented a Copy at *Venice*, at a full Colledge, in which I read it all, and it was hearkned to with very great attention; and at laſt I preſented it to the Duke, and left ſome Copies thereof with ſundry Senators, and went my way, promiſing with all intenſeneſs to apply my pains with reiterated ſtudies in the publick ſervice; and if any other things ſhould come into my minde, I promiſed to declare them ſincerely, and ſo took leave of *His ſerenity*, and that Noble Council. When I was returned to *Rome*, this buſineſs night and day continually running in my mind, I hapned to think of another admirable and moſt important conceit, which with effectual reaſons, confirmed by exact operations, I with the Divine aſſiſtance, made clear and manifeſt; and though the thing at firſt ſight ſeemed to me a moſt extravagant Paradox, yet notwithſtanding, having ſatisfied my ſelf of the whole buſineſs, I ſent it in writing to the moſt Illuſtrious and moſt Noble *Signore Gio. Baſadonna*; who after he had well conſidered my Paper, carried it to the Council; and after that thoſe Lords had for many months maturely conſidered thereon, they in the end reſolved to ſuſpend the execution of the diverſion which they had before conſulted to make of the River *Sile*, and of four other Rivers, which alſo fall into the Lake; a thing by me blamed in this ſecond Paper, as moſt prejudicial, and harmful. The writing ſpake as followeth.

CONSIDERATIONS
Concerning the
LAKE
OF
VENICE.

CONSIDERATION II.

IF the diſcourſing well about the truth of things, Moſt Serene Prince, were as the carrying of Burdens, in which we ſee that an hundred Horſes carry a greater weight than one Horſe onely; it would ſeem that one might make more account of the opinion of many men, than of one alone; But becauſe that diſcourſing more reſembleth running, than carrying Burdens, in which we ſee that one Barb alone runneth faſter than an hundred heavy-heel'd Jades; therefore I have ever more eſteemed one Concluſion well managed, and well conſidered by one underſtanding man, although alone, than the common and Vulgar opinions; eſpecially, when they concern abſtruce and arduous points: Nay in ſuch caſes the opinions moulded and framed by the moſt ignorant and ſtupid Vulgar, have been ever ſuſpected by me as falſe, for that it would be a great wonder if in difficult matters a common capacity ſhould hit upon that which is handſom, good, and true. Hence I have, and do hold in very great veneration the ſumme of the Government of the moſt Serene, and eternal Republick of *Venice*; which although, as being in nature a Common-wealth, it ought to be governed by the greater part; yet nevertheleſs, in arduous affairs, it is alwaies directed by the Grave Judgement of few, and not judged blindly,

by the *Plebeian* Rout. Tis true, that he that propoundeth Propoſitions far above the reach of common capacity, runneth a great hazard of being very often condemned without further Proceſs, or knowledge of the Cauſe; but yet for all that, the truth is not to be deſerted in moſt weighty affairs, but ought rather to be explained in due place and time with all poſſible perſpicuity; that ſo being well underſtood, and conſidered, it may come afterwards for the Common good to be embraced.

This which I ſpeak in general, hath often been my fortune in very many particulars, not onely when I have kept within the bounds of meer ſpeculation, but alſo when I have chanced to deſcend to Practice, and to Operations: and your Highneſs knoweth very well what befel me the laſt Summer 1641. when in obedience to your Soveraign Command, I did in full Colledge repreſent my thoughts touching the ſtate of the Lake of *Venice*; for there not being ſuch wanting, who without ſo much as vouchſafing to underſtand me, but having onely had an inkling, and bad apprehenſion of my opinion, fell furiouſly upon me, and by violent means both with the Pen and Preſs, full of Gall, did abuſe me in reward of the readineſs that I had expreſt to obey and ſerve them: But I was above meaſure encouraged and pleaſed, to ſee that thoſe few who vouchſafed to hear me, were all either thorowly perſwaded that my opinion was well grounded, or at leaſt ſuſpended their prudent verdict to more mature deliberation. And though at the firſt bout I chanced to propoſe a thing that was totally contrary to the moſt received and antiquated opinion, and to the reſolutions and conſultations taken above an hundred years ago: Moved by theſe things, and to ſatisfie alſo to the promiſe that I had made of tendering unto them what ſhould farther offer it ſelf unto me touching the ſame buſineſs; I have reſolved to preſent to the Throne of your Highneſs, another Conſideration of no leſs importance, which perhaps at firſt ſight will appear a ſtranger Paradox; but yet brought to the Teſt and Touch-ſtone of experience, it ſhall prove moſt clear and evident. If it ſhall be accounted of, ſo that it ſucceedeth to the benefit of your Highneſs, I ſhall have obtained my deſire and intent: And if not, I ſhall have ſatisfied my ſelf, and ſhall not have been wanting to the Obligation of your moſt faithful Servant, and native ſubject.

That which I propounded in the Mouths paſs, touching the moſt important buſineſs of the Lake, though it did onely expreſly concern the point of the diverſion of the Mouth of the Lake, already made and put in execution; yet it may be underſtood and applyed alſo to the diverſion under debate, to be made of the other five Rivers, and of the *Sile* in particular.

Now

Now touching this, I had the fortune to offer an admirable accident that we meet with when we come to the effect, which I verily believe will be an utter ruine to the Lake of *Venice*.

I ſay therefore, that by diverting theſe five Rivers, that remain, although their water that they diſcharge for the preſent into the Lake is not all taken together 4 parts of what the *Brent* alone did carry, yet nevertheleſſe the abatement of the water of the Lake which ſhall enſue upon this laſt diverſion of four parts, which was the whole water, ſhall prove double to that which hath happened by the diverſion of *Brent* onely, although that the *Brent* alone carried five parts of that water, of which the Rivers that are to be diverted carry four: A wonder really great, and altogether unlikely; for the reducing all this Propoſition to be underſtood, is as if we ſhould ſay, that there being given us three Rivers, of which the firſt diſchargeth five parts, the ſecond three, and the third one, and that from the diverſion of the firſt, there did follow ſuch a certain abatement or fall; from the taking away of the ſecond there ought to follow alſo ſo much more abatement; And laſtly, from the withdrawing of the third the water ought to fall ſo much more, which is wholly impoſſible: And yet it is moſt certain, and beſides the demonſtration that perſwades me to it, which I ſhall explain in due time, I can ſet before your eyes ſuch an experiment as is not to be denied by any one, although obſtinate: and I will make it plainly ſeen and felt, that by taking away only four parts of the five, which ſhall have been taken away, the abatement proveth double to the abatement enſuing upon the diverting firſt of the five onely; which thing being true, as moſt certainly it is, it will give us to underſtand how pernicious this diverſion of five Rivers is like to prove, if it ſhall be put in execution.

By this little that I have hinted, and the much that I could ſay, let your Highneſſe gather with what circumſpection this buſineſſe ought to be managed, and with how great skill he ought to be furniſhed who would behave himſelf well in theſe difficult affairs.

I have not at this time explained the demonſtration, nor have I ſo much as propounded the way to make the Experiment, that I am able to make in confirmation of what I have ſaid, that ſo by ſome one or others miſ-apprehending the Demonſtration, and maiming the Experiment, the truth may not happen to ſhine with leſſe clarity than it doth, when all miſts of difficulty are removed: and if ſo be, no account ſhould be made of the Reaſons by me alledged, and that men ſhould ſhut their eyes againſt the Experiments that without coſt or charge may be made, I do de-

clare and proteſt that there ſhall follow very great dammages to the Fields of the main Land, and extraordinary ſummes ſhall be expended to no purpoſe. The Lake undoubtedly will become almoſt dry, and will prove impaſſible for Navigation, with a manifeſt danger of corrupting the Air: And in the laſt place there will unavoidably enſue the choaking and ſtoppage of the Ports of *Venice*.

Upon the 20th. of *December*, 1641. I imparted this my ſecond Conſideration to the moſt Excellent *Signore Baſadonna*, preſenting him with a Copy thereof amongſt other Writings, which I have thought good to inſert, although they ſeem not to belong directly to our buſineſſe of the Lake.

The way to examine the MUD and SAND that entereth and remaineth in the LAKE of *VENICE*.

To the moſt Excellent SIGNORE GIO. BASADONNA.

TWo very conſiderable Objections have been made againſt my opinion concerning the Lake of *Venice*: One was that, of which I have ſpoken at large in my firſt Conſideration, namely, that the *Brents* having been taken out of the Lake, cannot have been the occaſion of the notable fall of the Waters in the Lake, as I pretend, and conſequently, that the turning *Brent* into the Lake would be no conſiderable remedy, in regard that the water of *Brent*, and the great expanſion of the Lake over which the water of *Brent* is to diffuſe and ſpread being conſidered, it is found that the riſe proveth inſenſible.

The ſecond Objection was, that the *Brent* is very muddy, and therefore if it ſhould fall muddy into the Lake, the Sand would ſink and fill up the ſame.

Touching the firſt Query, enough hath been ſaid in my firſt Conſideration, where I have plainly diſcovered the deceipt of the Argument, and ſhewn its fallacy; It remaineth now to examine the

the ſecond : to which in the firſt place I ſay, that one of the firſt things that I propoſed in this affair was, that I held it impoſſible to do any act, though never ſo beneficial, that was not alſo accompanied by ſome inconvenience and miſchief; and therefore we are to conſider well the profit, and the loſſe and prejudice; and they both being weighed, we ſhall be able to chooſe the leſſer evil: Secondly, I admit it to be moſt true, that *Brent* is at ſome times muddy, but it is alſo true, that for the greater part of the year it is not muddy. Thirdly, I do not ſee nor underſtand what ſtrength this objection hath, being taken ſo at large, and in general; and methinks that it is not enough to ſay, that the *Brent* runneth muddy, and to aſſert that it depoſeth its Muddineſſe in the Lake, but we ought moreover to proceed to particulars, and ſhew how much this Mud is, and in what time this choaking up of the Ports may be effected. For the Reaſons are but too apparent and particular, that conclude the ruine of the Lake, and that in a very ſhort time, (for mention is made of dayes) the Waters diverſion being made, and moreover we have the circumſtance of an Experiment, the ſtate of things being obſerved to have grown worſe ſince the ſaid diverſion. And I have demonſtrated, that in caſe the Diverſion of the *Silk* and the other Rivers ſhould be put in execution, the Lake would in a few dayes become almoſt dry; and the Ports would be loſt, with other miſchievous conſequences. But on the other ſide, although that we did grant the choaking of them, we may very probably ſay, that it will not happen, ſave onely in the ſucceſſion of many and many Centuries of years. Nor can I think it prudent counſel to take a reſolution and imbrace a Deſigne now, to obtain a benefit very uncertain, and more than that, which only ſhall concern thoſe who are to come very many Ages after us, and thereby bring a certain inconvenience upon our ſelves, and upon our children that are now alive and preſent.

Let it be alledged therefore, (although I hold it falſe) that by the diverſions of the Rivers the Lake may be kept in good condition for ſeveral years to come.

But I ſay confidently, and hope to demonſtrate it; That the Diverſions will bring the Lake, even in our dayes, to be almoſt dry, and at leaſt will leave ſo little water in it, that it ſhall ceaſe to be Navigable, and the Ports ſhall moſt infallibly be choaked up. I will therefore lay upon experience, in anſwer to this Objection, that it is very neceſſary firſt well to diſcourſe, and rationally to particularize and aſcertain the beſt that may be this point of the quantity of this ſinking Mud or Sand.

Now I fear I ſhall make my ſelf ridiculous to thoſe, who meaſuring the things of Nature with the ſhallowneſſe of their brains

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do think that it is abſolutely impoſſible to make this enquiry, and will ſay unto me, *Quis menſus eſt pugillo aquas, & terram palmo ponderavit* ? Yet nevertheleſs I will propound a way whereby, at leaſt in groſs, one may find out the ſame.

Take a Veſſel of Cylindrical Figure, holding two barrels of water, or thereabouts ; and then fill it with the water of *Brent*, at its Mouth or Fall into the Lake ; but in the Lake at the time that the *Brent* runneth muddy, and after it hath begun to run muddy for eight or ten hours, to give the mud time to go as far as S. *Nicolo*, to iſſue into the Sea ; and at the ſame time take another Veſſel, like, and equal to the firſt, and fill it with the water of the Lake towards S. *Nicolo*, (but take notice that this operation ought to be made at the time when the waters go out, and when the Sea is calm) and then, when the waters ſhall have ſetled in the aforeſaid Veſſels, take out the clear water, and conſider the quantity of Sand that remains behind, and let it be ſet down, or kept in mind : And I am eaſily induced to think, that that ſhall be a greater quantity of Sand which ſhall be left in the firſt Veſſel, than that left in the ſecond Veſſel. Afterwards when the *Brent* ſhall come to be clear, let both the operations be repeated, and obſerve the quantity of Sand in the aforeſaid Veſſels ; for if the Sand in the firſt Veſſel ſhould be moſt, it would be a ſign, that in the revolution of a year the *Brent* would depoſe Sand in the Lake : And in this manner one may calculate to a ſmall matter what proportion the Sand that entreth into the Lake, hath to that which remains : And by that proportion one may judge how expedient it ſhall be for publick benefit. And if at ſeveral times of the year you carefully repeat the ſame operations, or rather obſervations, you would come to a more exact knowledge in this buſineſs : And it would be good to make the ſaid operations at thoſe times, when the Lake is diſturbed by ſtrong high Winds, and made muddy by its own Mud, raiſed by the commotion of the Waters.

This notion would give us great light, if the ſame obſervations ſhould be made towards the Mouth of *Lio*, at ſuch time as the waters flow and ebb, in calm ſeaſons ; for ſo one ſhould come to know whether the waters of the Lake are more thick at the going out, than at the entrance. I have propounded the foregoing way of meaſuring Sands and Mud, to ſhew that we are not ſo generally, and inconſiderately to pronounce any ſentence, but proceed to ſtricter inquiries, and then deliberate what ſhall be moſt expedient to be done. Others may propoſe more exquiſite examinations, but this ſhall ſerve me for the preſent.

I will add onely, that if any one had greater curioſity (it would be profitable to have it) in inveſtigating more exactly the quantity

tity of the Water that entereth into the Lake, by the means that I have ſhewen in the beginning of this Book: When he ſhall have found the proportion of the quantity of water to the quantity of Sand or Mud, he ſhall come to know how much Sand the *Brent* ſhall leave in the Lake in the ſpace of a year. But to perform theſe things, there are required perſons of diſcretion, and fidelity, and that are imployed by publick Order; for there would thence reſult eminent benefit and profit.

Here are wanting LETTERS *from ſeveral perſons.*

To the Reverend Father, *Franceſco di* S. GIUSEPPE.

IN execution of the command that you laid upon me in your former Letters, by order from the moſt Serene, my Lord, *Prince Leopold*; that I ſhould ſpeak my judgement concerning the diſimboguement of the River called *Fiume morto*, whether it ought to be let into the Sea, or into *Serchio*; I ſay, that I chanced 18. years ſince to be preſent, when the ſaid Mouth was opened into the Sea, and that of *Serchio* ſtopt; which work was done to remedy the great Innundation that was made in all that Country, and Plain of *Piſa*, that lyeth between the River *Arno*, and the Mountains of *S. Giuliano*, and the River *Serchio*; which Plain continued long under water, inſomuch that not onely in the Winter, but alſo for a great part of the Summer, thoſe fields were overflowed; and when that the Mouth of *Fiume morto* was effectually opened into the Sea, the place was preſently freed from the waters. and drained, to the great ſatisfaction of the Owners of thoſe Grounds. And here I judge it worth your notice, that for the generality of thoſe that poſſeſs eſtates in thoſe parts, they deſired that the Mouth of *Fiume morto* might ſtand open to the Sea; and thoſe who would have it open into *Serchio*, are perſons that have no other concernment there, ſave the hopes of gaining by having the diſpoſe of Commiſſions, and the like, &c,

But for the more plain underſtanding of that which is to be ſaid, it muſt be known, That the reſolution of opening the ſaid Mouth into *Serchio*, was taken in the time of the Great Duke *Ferdinando* the firſt, upon the ſame motives that are at this time again propoſed, as your Letters tell me, Since that, it manifeſtly appearing, that *Fiume morto* had, and hath its Mouth open to the Sea, the Plain hath been kept dry; and it being alſo true, that the

the fury of the South, and South-Weſt-Winds carryed ſuch abundance of ſand into the Mouth, or Out-let of *Fiume morto*, that it wholly ſtopt it up: eſpecially when the waters on *Piſa* ſide were low and ſhallow, And they think, that turning the Lake of *Fiume morto* into *Serchio*, and the *Serchio* maintaining continually its own Mouth with the force of its waters open to the Sea, and conſequently alſo *Fiume morto*, they would have had the Out-let clear and open; and in this manner they think, that the Plain of *Piſa* would have been freed from the waters. The buſineſs paſſeth for current, at firſt ſight; but experience proveth the contrary, and Reaſon confirmeth the ſame: For the height of the water of thoſe Plains, was regulated by the height of the waters in the Mouth of *Fiume morto*; that is, The waters at the Mouth being high, the waters alſo do riſe in the fields; and when the waters at the Mouth are low, the waters of the fields do likewiſe abate: Nor is it enough to ſay, That the Out-let or Vent of *Fiume morto* is continual, but it muſt be very low: Now if *Fiume morto* did determine in *Serchio*, it is manifeſt that it would determine high; for *Serchio* terminating in the Sea, when ever it more and more aboundeth with water, and riſeth, it is neceſſary that alſo *Fiume morto* hath its level higher, and conſequently ſhall keep the waters in the Plains higher. Nay, it hath happened ſometimes (and I ſpeak it upon my own ſight) that *Fiume morto* hath reverſed its courſe upwards towards *Piſa*; which caſe will ever happen, whenſoever the *Piſan* waters chance to be lower than the level of thoſe of *Serchio*; for in that caſe the waters of *Serchio* return back upon the Plains thorow *Fiume morto* in ſuch ſort, that the Muddineſſes, and the *Serchio* have been obſerved to be carried by this return as farr as the Walls of *Piſa*; and then before ſuch time as ſo great waters can be aſſwaged, which come in with great fury, and go out by little and little, there do paſs very many days, and moneths, nay ſometimes one being never able to find the waters of *Serchio*, when at the ſhalloweſt, ſo low as the Sea in level; (which is the loweſt place of the waters) it thence doth follow, that the waters of *Fiume morto* ſhould never at any time of the year, ſo long as they determine in *Serchio*, be ſo low, as they come to be when the ſame *Fiume morto* determineth in the Sea. Tis true indeed, that the Mouth of *Fiume morto*, opened into the Sea, is ſubject to the inconvenience of being ſtopt up by the force of Winds: But in this caſe, it is neceſſary to take ſome pains in opening it; which may eaſily be done, by cutting that Sand a little which ſtayeth in the Mouth, after that the Wind is laid; and it is enough if you make a Trench little more than two Palms in breadth; for the water once beginning to run into it, it will in a few hours carry

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that Sand away with it, and there will enſue a deep and broad Trench that will drain away all the water of the Plains in very little time. And I have found by practice, that there having been a great quantity of Sand driven back, by the fury of the South-Weſt-Wind, into the Mouth of *Fiume morto*, I having cauſed the little gutter to be made in the Morning, ſomewhat before Noon, a Mouth hath been opened of 40. Braces wide, and notably deep, inſomuch that the water, which before had incommoded all the Champian ran away in leſs than three dayes, and left the Country free and dry, to the admiration of all men. There was preſent upon the place, at this buſineſs, the ſame day that I opened the Mouth, the moſt Serene great Duke, the moſt Serene Arch-Dutcheſs Mother, all the Commiſſioners of Sewers, with many other Perſons and Peaſants of thoſe parts; and they all ſaw very well, that it was never poſſible that a little Bark of eight Oars, which was come from *Legorn* to wait upon the great Duke, ſhould ever be able to maſter the Current, and to make up into *Fiume morto*; and his Highneſs, who came with an intent to cauſe the ſaid Mouth towards the Sea to be ſtopt; and that into *Serchio* to be opened, changed his judgement, giving order that it ſhould be left open towards the Sea, as it was done. And if at this day it ſhall return into *Serchio*, I am very certain that it will be neceſſary to open it again into the Sea. And there was alſo charge and order given to a perſon appointed for the purpoſe, that he ſhould take care to open the ſaid Mouth, as hath been ſaid upon occaſion. And thus things have ſucceeded very well unto this very time. But from the middle of *October*, until this firſt of *February*, there having continued high South, and South-Weſt-Winds, with frequent and abundant Rains; it is no wonder that ſome innundation hath happened; but yet I will affirm, that greater miſchiefs would have followed, if the Mouth had been opened into *Serchio*. This which I have hitherto ſaid, is very clear and intelligible to all ſuch as have but competent inſight, and indifferent skill in theſe affairs. But that which I am now about to propoſe farther, will, I am very certain, be underſtood by your ſelf, but it will ſeem ſtrange and unlikely to many others. The point is, that I ſay, That by raiſing the level of *Fiume morto*, one half Brace, onely at its Mouth, (it will penipenitrate into *Serchio* farther than it would into the Sea) it ſhall cauſe the waters to riſe three, or perhaps more Braces upon the fields towards *Piſa*, and ſtill more by degrees as they ſhall recede farther from the Sea-ſide; and thus there will follow very great Innundations, and conſiderable miſchiefs. And to know that this is true, you are to take notice of an accident, which I give warning of in my diſcourſe of the Meaſure of Running Waters:

* *Lib.* 1.

where alſo I give the reaſon thereof, * *Coroll.* 14. The accident is this, That there coming a Land-Flood, for example, into *Arno*, which maketh it to riſe above its ordinary Mouth within *Piſa*, or a little above or below the City ſix or ſeven Braces; this ſame height becometh alwaies leſſer and leſſer, the more we approach towards the Sea-ſide; inſomuch, that near to the Sea the ſaid River ſhall be raiſed hardly half a Brace: Whence it followeth of neceſſary conſequence, that ſhould I again be at the Sea-ſide, and knowing nothing of what hapneth, ſhould ſee the River *Arno* raiſed by the acceſſion of a Land-flood, one third of a Brace; I could certainly infer, that the ſame River was raiſed in *Piſa* thoſe ſame ſix or ſeven Braces. And that which I ſay of *Arno*, is true of all Rivers that fall into the Sea. Which thing being true, it is neceſſary to make great account of every ſmall riſing, that *Fiume morto* maketh towards the Sea-ſide by falling into *Serchio*. For although the riſing of *Fiume morto*, by being to diſgorge its Waters into *Serchio*, towards the Sea, were onely a quarter of a Brace; we might very well be ſure, that farr from the Sea, about *Piſa*, and upon thoſe fields the riſe ſhall be much greater, and ſhall become two or three Braces: And becauſe the Countrey lyeth low, that ſame riſe will cauſe a continual Innundation of the Plains, like as it did before; I cauſed the Mouth to be opened into the Sea. And therefore I conclude that the Mouth of *Fiume morto*, ought by no means to be opened into *Serchio*, but ought to be continued into the Sea, uſing all diligence to keep it open after the manner aforeſaid, ſo ſoon as ever the Wind ſhall be laid. And if they ſhall do otherwiſe, I confidently affirm, that there will daily follow greater damages; not onely in the Plains, but alſo in the wholeſomneſs of the Air; as hath been ſeen in times paſt. And again, It ought with all care to be procured, that no waters do by any means run or fall from the Trench of *Libra*, into the Plain of *Piſa*, for theſe Waters being to diſcharge into *Fiume morto*, they maintain it much higher than is imagined, according to that which I have demonſtrated in my conſideration upon the ſtate of the Lake of *Venice*. I have ſaid but little, but I ſpeak to you, who underſtandeth much, and I ſubmit all to the moſt refined judgment of our moſt Serene Prince *Leopold*, whoſe hands I beſeech you in all humility to kiſs in my name, and implore the continuance of his Princely favour to me; and ſo deſiring your prayers to God for me, I take my leave.

Your moſt affectionate Servant,

Rome 1. Feb. 1642.

D. BENEDETTO CASTELLI.

The

The anſwer to a Letter written by BARTOLOTTI, touching the difficultyes obſerved.

The former part of the Letter is omitted, and the diſcourſe beginneth at the firſt Head.

AND firſt I ſay, Whereas I ſuppoſe that the level of the *Serchio* is higher than that of *Fiume morto*; this is moſt true, at ſuch time as the waters of *Fiume morto* are diſcharged into the Sea; but I did never ſay that things could never be brought to that paſs, as that the level of *Fiume morto* ſhould be higher than *Serchio*: and ſo I grant that it will follow, that the waters of *Fiume morto* ſhall go into *Serchio*, and its very poſſible, that the Drain of *Fiume morto* into *Serchio* may be continuate; and I farther grant, that its poſſible, that the *Serchio* doth never diſgorge thorow *Fiume morto* towards *Piſa*; Nay, I will yet farther grant that it might have happened, that *Fiume morto* might have had ſuch a fall into *Serchio*, as would have ſufficed to have turned Mills: But then I add withall, that the Plains of *Piſa*, and the City it ſelf muſt be a meer Lake.

2. *Signore Bartolotti* ſaith confidently, that when the Sea ſwelleth by the South-Weſt, or other Winds, the level of *Serchio* in the place marked A in the Platt, diſtant about 200. Braces, riſeth very little: But that *Fiume morto* in D, and in E, many miles more up into Land riſeth very much, and that certain Fiſhermen confirm this, and ſhew him the ſignes of the riſing of the Water. I grant it to be very true, and I have ſeen it with my own eyes: But this cometh to paſs, when the Mouth of *Fiume morto* is ſtopt up by the Sea; as I ſhall ſhew by and by. And this riſing near the Sea-ſide, is of no conſiderable prejudice to the fields. And this is as much as I find to be true in the aſſertion of *Signore Bartolotti*, (without his confirming it by any other proof; as indeed it needs none) That the level of *Fiume morto* riſeth in E, and many miles farther upwards it riſeth much; nor did I ever affirm the contrary.

3. Concerning the difficulty of opening the Mouth of *Fiume morto* into the Sea, that which *Il Caſtellano* ſaith is moſt certain; namely, That at the entrance upon the opening of the Mouth, it is neceſſary to make a deep Trench: But I ſay, that at that time it is difficult to open it, unleſs upon great occaſions; for that the

difficulty proceedeth from the waters of *Fiume morto* being low, and the fields drained.

4. As to the particular of the Cauſes that you tell me men preſs ſo much unto the moſt *Serene Grand Duke*, and to the Prince, I have not much to ſay, becauſe it is not my profeſſion; nor have I conſidered of the ſame: Yet I believe, that when the Prince and his Highneſſe ſee the benefit of his People and Subjects in one ſcale of the Ballance, and the accomodation of Huntſmen in the other, his Highneſſe will incline to the profit of his ſubjects; ſuch have I alwayes found his Clemency and Nobleneſſe of minde. But if I were to put in my vote upon this buſineſſe, I would ſay, that the points of Spears, and the mouths of Guns, the yelping of Dogs, the wilyneſſe of Huntſmen, who run thorow and narrowly ſearch all thoſe Woods, Thickets and Heathes, are the true deſtroyers of Bucks and Boares, and not a little Salt-water, which ſetleth at laſt in ſome low places, and ſpreadeth not very far. Yet nevertheleſſe, I will not enter upon any ſuch point, but confine my ſelf ſolely to the buſineſſe before me.

5. That Experiment of joyning together the water of *Fiume morto*, and that of *Serchio* by a little trench to ſee what advantage the Level E hath upon the Level I, doth not give me full ſatisfaction, taken ſo particularly, for it may come to paſſe, that ſometimes E may be higher, and ſometimes A lower, and I do not queſtion but that when *Serchio* is low, and *Fiume morto* full of Water, the level of *Fiume morto* will be higher than that of *Serchio*. But *Serchio* being full, and *Fiume morto* ſcant of Water, the contrary will follow, if the Mouth ſhall be opened to the Sea. And here it ſhould ſeem to me, that it ought to be conſidered, that there is as much advantage from E to the Sea through the little Trench opened anew into *Serchio*, as from E to the Sea by the Mouth of *Fiume morto*. But the difficulty (which is that we are to regard in our caſe) is, that the courſe of the Waters thorow the Trench is three times longer than the courſe of the Mouth of *Fiume morto*, as appeareth by the Draught or Plat which you ſent me, which I know to be very exactly drawn, for that the ſituation of thoſe places are freſh in my memory. Here I muſt give notice, that the waters of *Fiume morto* determining thorow the Trench in *Serchio* (the waters of which *Fiume morto* are, for certain, never ſo low as the Sea) their pendency or declivity ſhall, for two cauſes, be leſſe than the pendency of thoſe waters through the Mouth towards the Sea, that is, becauſe of the length of the line through the Trench, and becauſe of the height of their entrance into *Serchio*, a thing which is of very great import in diſcharging the waters which come ſuddenly, as he

he ſhall plainly ſee, who ſhall have underſtood my Book of the Meaſure of Running Waters. And this was the Reaſon why all the Countrey did grow dry upon the opening of the Mouth into the Sea. And here I propoſe to conſideration that which the Peaſants about *Piſa* relate, namely, That the Water in the Fields doth no conſiderable harm by continuing there five or ſix, yea, or eight dayes. And thetefore the work of the Countrey is to open the Mouth of *Fiume morto*, in ſuch manner, that the Water being come, they may have the Trench free and ready, when that the Water cometh it may have a free drain, and may not ſtay there above eight or nine dayes, for then the overflowings become hurtful. It is to be deſired alſo, that if any Propoſition is produced touching theſe affairs, it might be propounded the moſt diſtinctly that may be poſſible, and not conſiſt in generals, eſpecially when the Diſpute is of the riſings, of velocity, of tardity, of much and little water; things that are all to be ſpecified by meaſures.

6. Your Letter ſaith, in the next place, that *Signore Bartolotti* confeſſeth, that if the Mouth of the *Fiume morto* might alwayes be kept open, it would be better to let it continue as it is: the which, that I may not yield to him in courteſie, I confeſſe, for the keeping it ſtopt on all ſides would be a thing moſt pernicious. But admitting of his confeſſion I again reply, that *Fiume morto* ought not to be let into *Serchio*, but immediately into the Sea; becauſe although ſometimes the Mouth to Seawards be ſtopt up, yet for all that, the raiſing of the Bank above the Plains (which is all the buſineſſe of importance) ſhall be ever leſſer, if we make uſe of the Mouth leading to the Sea, than uſing that of *Serchio*.

7. I will not omit to mention a kinde of ſcruple that I have concerning the poſition of *Sign. Bartolotti*, that is, where he ſaith that the two Mouths A and D are equal to the like Mouths into the Sea; Now it ſeems to me, that the Mouth A of *Fiume morto* into *Serchio* is abſolutely within *Serchio*, nor can it be made lower, and is regulated by the height of *Serchio*: But the Mouth of *Fiume morto* terminates, and ought to be underſtood to terminate in the Sea it ſelf, the loweſt place. And this I believe was very well perceived by *Sig. Bartolotti*, but I cannot tell why he paſt it over without declaring it: and we ſee not that the Mouth D falleth far from the Sea, which Mouth ought to be let into the Sea it ſelf, and ſo the advantage of the Mouth into the Sea more clearly appeareth.

8. That which *Sig. Bartolotti* addeth, that when it is high Waters, at ſuch time as the Waters are out, and when Winds choak up *Fiume morto*, they not only retard it, but return the courſe

courſe of the Waters upwards very leaſurely, perſwadeth me more readily to believe that *Sig. Bartolotti* knoweth very well, that the Mouth of *Fiume morto* let into *Serchio* is hurtful: for by this he acknowledgeth that the Mouth towards the Sea doth in ſuch ſort drain the Countrey of the Waters, as that they become very low; and therefore upon every little *impetus* the waters turn their courſe: And from the motions, being exceeding ſlow, is inferred, that the abundance of Sea-water that cometh into *Fiume morto*, is ſo much as is believed, and as *Sig. Bartolotti* affirmeth.

9. After that *Sig. Bartolotti* hath ſaid what he promiſeth above, namely, that when the Windes blowing ſtrongly do ſtop up *Fiume morto*, and not onely retard but turn the courſe upwards, the time being Rainy, and the Mouth of *Fiume morto* ſhut up, the Waves of the Sea paſſe over the Bank of *Fiume morto*; at that time, ſaith *Signore Bartolotti*, the Champain ſhall know the benefit of *Fiume morto* diſcharged into *Serchio*, and the mouth A ſhall ſtand alwayes open; and *Fiume morto* may alwayes conſtantly run out, as alſo the Rains and Rain-waters, although the hurtful Tempeſt ſhould laſt many dayes, &c. And I reply, that all the Art conſiſts in this; for the benefit of thoſe Fields doth not depend on, or conſiſt in ſaying, that *Fiume morto* is alwayes open, and *Fiume morto* draineth continually; But all the buſineſſe of profit lyeth and conſiſteth in maintaining the Waters low in thoſe Plaines, and thoſe Ditches, which ſhall never be effected whilſt the World ſtands, if you let *Fiume morto* into *Serchio*; but yet it may, by opening the mouth into the Sea: and ſo much reaſon and nature proveth, and (which importeth) Experience confirmeth.

10. In the tenth place I come to conſider the anſwer that was made to another Propoſition in the Letter which I writ to Father *Franceſco*, which prudently of it ſelf alone might ſerve to clear this whole buſineſſe. I ſaid in my Letter, That great account is to be made of every ſmall riſing and ebbing of the Waters neer to the Sea in *Fiume morto*, for that theſe riſings and fallings, although that they be ſmall neer to the Sea-ſide, yet nevertheleſſe, they operate and are accompanied by notable riſings and fallings within Land, and far from the Sea-ſide, and I have declared by an example of *Arno*, in which a Land-flood falling, that made it increaſe above its ordinary height within *Piſa* ſix or ſeven Braces, that this height of the ſame Flood becometh ſtill leſſer, the neerer we approach to the Sea-coaſts. Nor ſhall the ſaid River be raiſed hardly half a Brace; whereupon it neceſſarily followeth, that if I ſhould return to the Sea-ſide, and not knowing any thing of that which happeneth at *Piſa*, and ſeeing the

the River *Arno* raiſed by a Land-flood half a Brace, I might confidently affirm the ſaid River to be raiſed in *Piſa* thoſe ſix or ſeven Braces, &c. From ſuch like accidents I conclude in the ſame Letter, that it is neceſſary to make great account of every little riſe that *Fiume morto* ſhall make towards the Sea. Now cometh *Bartolotti* (and perhaps becauſe I knew not how to expreſs my ſelf better, underſtandeth not my Propoſition) and ſpeaketh that which indeed is true, but yet beſides our caſe: Nor have I ever ſaid the contrary; and withall doth not apply it to his purpoſe. Nay I ſay, that if he had well applyed it, this alone had been able to have made him change his opinion. And becauſe he ſaith, that I ſaid, that it is true, when the abatement proceedeth from ſome cauſe above, as namely by Rain, or opening of Lakes; But when the cauſe is from below, that is, by ſome ſtop, as for inſtance ſome Fiſhers Wears or Locks, or ſome impediment remote from the Sea, although at the Level it ſhall riſe ſome Braces where the impediment is, yet that riſing ſhall go upwards; and here he finiſheth his Diſcourſe, and concludeth not any thing more. To which I ſay firſt, that I have alſo ſaid the ſame in the Propoſition, namely, that a Flood coming (which maketh *Arno* to riſe in *Piſa* ſix or ſeven Braces (which I take to be a ſuperiour cauſe whether it be Rain or the opening of Lakes, as beſt pleaſeth *Bartolotti*) in ſuch a caſe I ſay, and in no other (for towards the Sea-coaſts it ſhall not cauſe a riſing of full half a Brace; and therefore ſeeing *Arno* at the Sea-ſide to be raiſed by a Flood, whether of Rain, or of opening of Lakes half a Brace) it may be inferred, that at *Piſa* it ſhall be raiſed thoſe ſix or ſeven Braces; which variety, well conſidered, explaineth all this affair in favour of my opinion: For the riſing that is made by the impediment placed below, of Fiſhing Weares and Locks, operateth at the beginning, raiſing the Waters that are neer to the impediment; and afterwards leſs and leſs, as we retire upwards from the impediment: provided yet that we ſpeak not of a Flood that commeth by acceſſion, but onely of the ordinary Water impeded. But there being a new acceſſion, as in our caſe, then the Water of the Flood, I ſay, ſhall make a greater riſing in the parts ſuperiour, far from the impediment; and theſe impediments ſhall come to be thoſe that ſhall overflow the Plains, as happened eighteen or nineteen years ago, before the opening of *Fiume morto* into the Sea, The ſame will certainly follow, if *Fiume morto* be let into *Serchio*. Here I could alledge a very pretty caſe that befell me in *la* * *Campagna di Roma*, neer to the Sea-ſide. where I drained a Bog or Fen, of the nature of the Waters of *Piſa*, and I ſucceeded in the enterprize, the Waters in their ſite towards the Sea abating only three Palmes, and yet in the Fen

* The Countrey or Province lying round the City heretofore called *Latium*.

Fen they fell more than fifteen Palmes. But the buſineſſe would be long, and not ſo eaſily to be declared, and I am certain that *Sig. Bartolotti* having conſidered this, would alter his judgment, and withall would know that remitting that impediment anew, which I had left for leſſe than three Palmes towards the Sea, the Waters in the Fen would return with the firſt Floods and Raines to the ſame height as before, as likewiſe *Fiume morto* will do if it ſhall be let again into *Serchio*.

Here I intreat your Honour to do me the favour to importune *P. Franceſco* in my behalf, that he would be pleaſed to declare my meaning in the aforeſaid Letter to *Sig. Bartolotti*, for I hope that if he will underſtand this point, he will be no longer ſo tenacious in his opinion.

Next that theſe Lords in the Commiſſion of Sewers, with the Right Honourable the Marqueſſe of S. *Angelo*, and your Honour do approve of my judgment, doth very much rejoyce me; but becauſe that I know that they do it not in deſign to complement me, but onely to ſerve his Highneſs our Grand Duke, I freely profeſs that I will pretend no farther obligations from them therein, than I account my ſelf to owe to thoſe whoſe opinions are contrary to mine, for that I know that they have the ſame end. The definitive ſentence of this whole buſineſs is, that they give theſe Plains, theſe Draines, and theſe Waters farre fetcht appellations.

11. As to the quantity of the Water that *Fiume morto* diſchargeth into the Sea, there are very great diſputes about it, and I have been preſent at ſome of them. But let your Honour believe me, that as this is not continual, but only during a few dayes, ſo it will never be of any great prejudice to theſe Fields; and if your Lordſhip would be aſcertained thereof, you may pleaſe to go to *Fiume morto* at about a mile's diſtance from the Sea, in the time of theſe ſtrong Windes, and obſerve the current from thence upwards, for you ſhall finde it extream ſlow, and conſequently will know that the quantity of the Water that is repuls'd is very ſmall. And this ſeems to be contradicted by the rule of Riſings proceeding from cauſes below, which occaſion no conſiderable alteration far from the Sea.

I am neceſſitated to go to morrow out of *Rome* with his Eminence Cardinal *Gaetano* about certain affairs touching Waters, therefore I ſhall not farther inlarge, but for a cloſe to this tedious Diſcourſe, I conclude in few words, that *Fiume morto* is by no means to be let into *Serchio*, nor are there any means intermediate courſes to be taken, for they will alwayes be prejudicial; but *Fiume morto* is to be diſcharged immediately into the Sea. When it is ſtopt up by the fury of the Sea-wayes, I affirm that it is a

ſign

ſign that there is no need of opening it; and if there be any occaſion to open it, it is eaſily done. As for the reſt your Lordſhip may pleaſe to keep account of all the particulars that occur, for the memory of things paſt is our Tutreſſe in thoſe that are to come. If occaſion ſhall offer, I intreat you to bow humbly in my name to His Highneſs the Grand Duke, and the moſt Serene Prince *Leopold*; and to attend the ſervice of Their Highneſſes, for you ſerve Princes of extraordinary merit; And to whom I my ſelf am alſo exceedingly obliged. In the controverſies that ariſe reſpect the pious end of ſpeaking the Truth, for then every thing will ſucceed happily. I kiſs the hands of *Padre Franceſco*, of *Sig. Bartolotti*, and of your Lordſhip.

Your Honours

Rome, 14. *March* 1642.

moſt Obliged Servant

D. *BENEDETTO CASTELLI.*

Upon this occaſion I will here inſert a Diſcourſe that I made upon the Draining and improvement of the *Pontine Fens*, for that I think that whatſoever may be done well and to purpoſe in this matter hath abſolute dependance on the perfect knowledge of that ſo important Propoſition, by me demonſtrated and explained in my Treatiſe of the *Menſuration* of *Running Waters*, namely, That the ſame water of a River doth continually change Meaſures, according as it altereth and changeth the velocity of its courſe; ſo that the meaſure of the thickneſſe of a River in one Site, to the meaſure of the ſame River in another Site, hath the ſame proportion reciprocally that the velocity in this ſite hath to the velocity in the firſt ſite. And this is a Truth ſo conſtant and unchangeable, that it altereth not in the leaſt point on any occurrences of the Waters that change: and being well underſtood, it openeth the way to the knowledge of ſundry advertiſements in theſe matters, which are all reſolved by this ſole Principle; and from it are derived very conſiderable benefits; and without theſe it is impoſſible to do any thing with abſolute perfection.

A

CONSIDERATION

Upon the

DRAINING

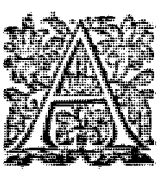
OF THE

Pontine Fenns.

BY

D. BENEDETTO CASTELLI, Abbot of S. BENEDETTO ALOISIO, and Professor of the *Mathematicks* to P. *Urban* VIII. in the University of *ROME*.

CONSIDERATION III.



Mongſt the enterprizes by me eſteemed, if not abſolutely impoſſible, , at leaſt exceeding difficult, one was that famous one of Draining the *Pontine Fenns*; and therefore I was thorowly reſolved never to apply my minde thereunto, although by my Patrons I ſhould be commanded to the ſame: accounting that it was an occaſion rather of loſing reputation by the miſcarriage of the attempt, than of gaining fame by reducing things to a better paſs then they now are at. Yet nevertheleſs, having of late years obſerved the place, and ſailed through thoſe Chanels, and thoſe Waters; after I had made ſome reflection thereupon, I thought that the enterprize was not ſo difficult as I had at firſt conceited it to be; and I am the more confirmed in this opinion, upon the inducement of that which I have written

Geometrically in my Treatiſe of the Menſuration of Running Waters; ſo that talking with ſeveral perſons, I adventured to affirm, in diſcourſe, that this improvement might poſſibly be brought into a good eſtate.

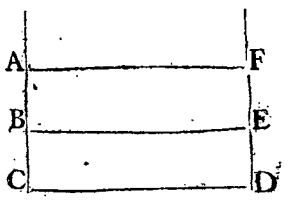
Now I have reſolved to ſet down my thoughts in writing, and to honour this my Paper with the Noble Name of your Lordſhip, to render it the more credible and conſpicuous at the firſt view, if it ſhould chance that the Subject I treat of, were not of ſuch moment, as that it did deſerve to be valued for any other reaſon. Pardon me, Sir, if I have been too bold, and continue me in the number of your Servants.

The enterprize of Draining a great part of the Territories of the *Pontine Fenns*, hath been undertaken both in the time of the antient *Romans*, and laſt of all, in our days; yea in the late times by *Sixtus* V. I do not doubt in the leaſt, but that it will be poſſible yet to reduce things to a very good paſs; and if I be not miſtaken, with a very ſmall charge in compariſon of the profit that would be received from thoſe rich Grounds. This improvement was of great expence in the time of *Sixtus Quintus*, but by reaſon the thing was not rightly underſtood, there were made many Drains, a great part of which were unprofitable and vain: and amongſt ſo many operations, there hapned ſome to be made that ſucceeded, as was deſired; but not being underſtood, they were held in no account; and this the buſineſs being neglected, the waters are returned into the ſame ſtate as they were at firſt, before the improvement. Here I have by familiar diſcourſes with my friends, explained this enterprize undertaken by *Sixtus* V. and haply alſo by ſome more antient, with the example of the Fable of *Orilo*, in *Arioſto*. This Monſter was made up with ſuch enchantment, that men fought with him alwayes in vain; for though in the Combate he were cut in pieces, thoſe divided Members preſently re-united, and returned to the fight more fierce then ever. But the *Páladine Aſtolfo* coming to undertake him, after a long diſpute, at the end he cut his head ſheer off from the ſhoulders at one blow; and nimbly alighting from his Horſe, took the Monſtrous head, and mounting again, as he rid away he fell to ſhave the Pole of that Monſter, and ſo he loſt the Lock of Hair, in which alone the enchantment lay; and then the horrible Head in an inſtant manifeſted ſigns of death, and the trunk which ran, ſeeking to reunite to it anew, gave the laſt gaſp, and in this manner the enchantment ended. The Book of Fate ſerved admirably to the *Paladine*, whereby he came to underſtand that Charm; for by ſhaving his whole head, the enchanted hairs came to be cut off amongſt the reſt: In the ſame manner, I ſay, that it hath ſometimes happened in Draining thoſe Fields;

for

for that amongſt ſo many tryals as have been made, that alſo was light upon, on which the improvement and remedy to the diſorder did depend. And to us my fore-named Treatiſe ſhall ſerve for a Rule, which being well underſtood, ſhall make us to know wherein conſiſteth, and whereon dependeth this miſcarriage, and conſequently it will be eaſie to apply thereunto a ſeaſonable remedy.

And firſt I ſay, That there is no doubt but that the waters continue ſo high on thoſe Plains becauſe they are ſo high in the principal River, which ought to receive them, and carry them into the Sea. Now the Cauſes of the height of the River, may in my judgement be reduced to one alone; which is that by me ſo often mentioned for the moſt Potent one, and declared in my afore-named Tractate; to wit, The tardity of the motion of the waters, which doth alwayes infallibly, and preciſely cauſe the ſelf ſame Running Water to change the meaſure of its thickneſs at ſuch a rate, that the more it encreaſeth in velocity, the more it decreaſeth in meaſure; and the more it decreaſeth in velocity, the more it encreaſeth in meaſure: As for example; If a River run in ſuch a place with the velocity of moving a mile in the ſpace of an hour, and afterwards the ſame River in another place doth encreaſe in velocity, ſo as to make three miles an hour; that ſame River ſhall diminiſh in thickneſs two thirds: And on the contrary, If it ſhall diminiſh in velocity ſo, as that it runneth but half a mile in the ſame time, it ſhall encreaſe the double in thickneſs and meaſure. And in a word, look what proportion the velocity in the firſt place, hath to the velocity in the ſecond, and ſuch hath reciprocally the meaſure of the thickneſs in the ſecond place, to the meaſure in the firſt; as I have clearly demonſtrated in my Treatiſe: Which I repeat ſo frequently, that I fear the Profeſſors of Polite Learning will charge me with Tuatologie, and vain Repetition. But I am ſo deſirous in this moſt important point to be well underſtood, becauſe it will then be eaſie to comprehend all the reſt; and without this it is impoſſible (I will not ſay difficult, but abſolutely impoſſible) to underſtand, or ever to effect any thing to purpoſe. And the better to explain the example, let it be ſuppoſed,



That the water of a River A D, runneth high at the level of A F, with ſuch a certain velocity; and let it, by the ſame water, be velocitated three times more; I ſay, that it will abate ⅔, and ſhall ſtand at the level in B E; and if it ſhall more velocitate, it will abate the more at the Sea; But if it ſhould retard

more

more than it did at the level A F, it would riſe yet more above the ſaid level A F; although that the ſelf ſame quantity of water runneth all the while. By the above-named ſolid Principle I reſolve extravagant Problems in my Treatiſe, and aſſign the Reaſons of admirable effects of Running Waters: But as for what concerneth our purpoſe of the *Pontine Fenns*, we have the Cauſes very plain and clear; for which, by the trampling of Cattle which paſs thorow the *Draining River*, the waters abate ſo notably, that it is as it were a miracle for thoſe Reeds, Flags, and Weeds that ſpring up, encreaſe, and ſpread all over the River, ſtop and impede that velocity of the waters which they would have by meaus of their declivity. But that paſſage of thoſe Beaſts, treading down thoſe Weeds unto the bottom of the River, in ſuch ſort, as that they no longer hinder the Current of the Water; and the ſame Waters increaſing in their courſe; they do diminiſh in meaſure and height; and by this meanes the Ditches of the Plains empty into the ſame ſucceſsfully, and leave them free from Waters, and Drained. But theſe Weeds in a ſhort time ſprouting up anew, and raiſing their ſtalkes thorow the body of the Waters, they reduce things to the ſame evil ſtate, as before, retarding the velocity of the Water, making it to increaſe in height, and perhaps do occaſion greater miſchiefs; ſeeing that thoſe many knots which each plant ſhoots forth, begets a greater multitude of Stalks, which much more incumbering the Water of the River, are a greater impediment unto its velocity, and conſequently make the height of the waters to encreaſe ſo much the more, and do more miſchief than before.

Another head to which theſe harms may be reduced, but proceeding from the ſame Root, which hath a great part in this diſorder, is the impediment of thoſe Wears in the River which are made by heightning the bed of the ſame, for placing of fiſhing-nets; of which *Piſcaries* I reckoned above ten, when I made a voyage thorow thoſe waters to *Sandolo*. And theſe Fiſhing-Wears are ſuch impediments, that ſome one of them makes the water of the River in the upper part to riſe half a Palm, and ſometimes a whole Palm, and more; ſo that when they are all gathered together, theſe impediments amount to more than ſeven, or poſſibly than eight Palms.

There concurreth for a third moſt Potent Cauſe of the waters continuing high in the evacuating, or Draining Chanel, and conſequently on the Plains; The great abundance of water that iſſueth from *Fiume Siſto*, the waters of which do not keep within its Banks when they are abundant; but encreaſing above its Chanel, they unite with thoſe of the Evacuator, and diſperſing thorow the

the Fens are raiſed with great prejudice, and much greater than is conceived, according to what hath been demonſtrated in the Second Conſideration upon the *Lake of Venice*. Nor is it to any purpoſe to ſay, that if we ſhould meaſure all the Waters that disimbogue from *Fiume Siſto*, and gather them into one ſumme; we ſhould not finde them to be ſuch as that they ſhall be able to make the Waters of the Fens to increaſe, by reaſon of the great expanſion of them, over which that body of water is to diſtend: for to this inſtance we anſwer with that which we have given notice of in the Firſt Conſideration touching the *Lake of Venice*, treating of the abatement that is cauſed by the *Brent* let into the Lake. And moreover, if I ſhall adde thereto that which I write in the Second Conſideration, it will be very apparent how greatly harmfull and prejudicial theſe excurſions of Waters from *Fiume Siſto* may be, which are not kept under, and confined within the River: Therefore, proceeding to the proviſions, and operations that are to be accounted Principall; I reduce them to three Heads.

In the firſt place it is neceſſary to throw down thoſe Weares, and to take the Piſciaries quite away, obſerving a Maxime, in my judgment, infallible, that Fiſhing and Sowing are two things that can never conſiſt together; Fiſhing being on the Water, and Sowing on land.

Secondly, it will be neceſſary to cut under Water in the bottome of the River thoſe Weeds and Plants that grow and increaſe in the River, and leave them to be carried into the Sea by the Stream; for by this means theſe Reeds ſhall not ſpring up and diſtend along the bottome of the River, by means of the Beaſts treading upon them; And the ſame ought to be done often, and with care, and muſt not be delaied till the miſchief increaſe, and the Champain Grounds be drowned, but one ought to order matters ſo, as that they may not drown. And I will affirm, that otherwiſe this principal point would become a moſt conſiderable inconvenience.

Thirdly, it is neceſſary to make good the Banks of *Fiume Siſto* on the left hand, and to procure that thoſe Waters may run in the Chanel, and not break forth. And it is to be noted, that it is not enough to do one or two of thoſe things, but we are to put them all in execution; for omitting any thing, the whole machine will be out of tune, and ſpoiled. But proceeding with due care, you ſhall not only Drain the *Pontine Fens*, but by means of this laſt particular the Current of *Fiume Siſto* ſhall ſcowr its own Chanel of its ſelf, even to the carrying part of it away: and haply with this abundance of water that it ſhall

bear

bear, the Mouth *della Torre* may be opened, and kept open into the Sea. And it would, laſt of all, be of admirable benefit to cleanſe *Fiume Siſto* from many Trees and Buſhes wherewith it is overgrown.

And with this I conclude, that the Improvement or Drain poſſible to be made conſiſteth in theſe three particulars. Firſt, in taking away the Fiſhing Weares, leaving the Courſe of the Waters free. Secondly, in keeping the Principal Rivers clear from Weeds and Plants. Thirdly, in keeping the water of *Fiume Siſto* in its own Chanel. All which are things that may be done with very little charge, and to the manifeſt benefit of the whole Country, and to the rendering the Air wholſomer in all thoſe Places adjoyning to the *Pontine Fens.*

A

CONSIDERATION

Upon the

DRAINING

Of the Territories of

Bologna, Ferrara,

AND

Romagna.

BY

D. BENEDETTO CASTELLI, Abbot of S. BENEDETTO ALOISIO, *Mathematician* to P. *Urban* VIII. and Profeſſor in the Univerſity of *ROME*.

THe weighty buſineſſe of the Draining of the Territories of *Bologna*, *Ferrara*, and *Romagna* having been punctually handled and declared in writing from the excellent memory of the Right Honourable and Noble *Monſignore Corſini*, who was heretofore Deputed Commiſſary General, and Viſitor of thoſe Waters; I am not able to make ſuch another Diſcourſe upon the ſame Subject, but will only ſay ſomewhat for farther confirmation of that which I have ſaid in this Book upon the *Lake of Venice*, upon the *Pontine Fens*, and upon the Draining of thoſe Plains of *Piſa*, lying between the Rivers *Arno* and *Serchio*; whereby it is manifeſt, that in all the

aforementioned Caſes, and in the preſent one that we are in hand with, there have, in times paſt, very groſſe Errours been committed, through the not having ever well underſtood the true meaſure of Running waters; and here it is to be noted, that the buſineſſe is, that in *Venice*, the diverſion of the waters of the Lake, by diverting the *Brent* was debated, and in part executed, without conſideration had how great abatement of water might follow in the Lake, if the *Brent* were diverted, as I have ſhewn in the firſt Conſideration upon this particular, from which act there hath inſued very bad conſequences, not only the difficulty of Navigation, but it hath infected the wholſomneſſe of the Air, and cauſed the ſtoppage of the Ports of *Venice*. And on the contrary, the ſame inadvertency of not conſidering what riſing of the Water the *Reno*, and other Rivers being opened into the Valleys of *Bologna* and *Ferrara*, might cauſe in the ſaid Valleys, is the certain cauſe that ſo many rich and fertile Fields are drowned under water, converting the happy habitations and dwellings of men into miſerable receptacles for Fiſhes: Things which doubtleſſe would never have happened, if thoſe Rivers had been kept at their height, and *Reno* had been turn'd into *Main-Po*, and the other Rivers into that of *Argenta*, and of *Volano*. Now there having ſufficient been ſpoken by the above-named *Monſig. Corſini* in his Relation, I will only adde one conceit of my own, which after the Rivers ſhould be regulated, as hath been ſaid, I verily believe would be of extraordinary profit, I much doubt indeed that I ſhall finde it a hard matter to perſwade men to be of my mind, but yet nevertheleſs I will not queſtion, but that thoſe, at leaſt, who ſhall have underſtood what I have ſaid and demonſtrated concerning the manners and proportions, according to which the abatements and riſings of Running waters proceed, that are made by the Diverſions and Introductions of VVaters, will apprehend that my conjecture is grounded upon Reaſon. And although I deſcend not to the exactneſſe of particulars, I will open the way to others, who having obſerved the requiſite Rules of conſidering the quantity of the waters that are introduced, or that happen to be diverted, ſhall be able with punctuality to examine the whole buſineſſe, and then reſolve on that which ſhall be expedient to be done.

Reflecting therefore upon the firſt Propoſition, that the Riſings of a Running Water made by the acceſſion of new water into the River, are to one another, as the Square-Roots of the quantity of the water that runneth; and conſequently, that the ſame cometh to paſs in the Diverſions: Inſomuch, that a River running in height one ſuch a certain meaſure, to make it encreaſe double in height, the water is to be encreaſed to three times as much

much as it ran before; so that when the water shall be quadruple, the height shall be double; and if the water were centuple, the height would be decuple onely, and so from one quantity to another: And on the contrary, in the Diversions; If of the 100. parts of water that run thorow a River, there shall be diverted $\frac{10}{100}$, the height of the River diminisheth onely $\frac{1}{10}$, and continuing to divert $\frac{10}{100}$, the height of the River abateth likewise $\frac{1}{10}$, and so proceeding to divert $\frac{10}{100}$ and then $\frac{10}{100}$, and then $\frac{10}{100}$, and then $\frac{10}{100}$, and then $\frac{10}{100}$, and then $\frac{10}{100}$, and then $\frac{10}{100}$, alwaies by each of these diversions, the height of the Running Water diminisheth the tenth part: although that the diversions be so unequal. Reflecting I say upon this infallible Truth, I have had a conceit, that though the *Reno* and other Rivers were diverted from the Valleyes, and there was onely left the *Chanel of Navigation*, which was onely the $\frac{1}{10}$ part of the whole water that falleth into the Valleys; yet nevertheless, the water in those same Valleyes would retain a tenth part of that height that became conjoyned by the concourse of all the Rivers: And therefore I should think that it were the best resolution to maintain the *Chanel of Navigation* (if it were possible) continuate unto the Po of *Ferrara*, and from thence to carry it into the Po of *Volano*; for besides that it would be of very great ease in the Navigation of *Bologna*, and *Ferrara*, the said water would render the Po of *Volano* navigable as far as to the very Walls of *Ferrara*, and consequently the Navigation would be continuate from *Bologna* to the Sea-side.

But to manage this enterprize well, it is necessary to measure the quantity of the Water that the Rivers discharge into the Valleys, and that which the *Chanel of Navigation* carryeth, in manner as I have demonstrated ✠ the beginning of this Book; for this once known, we shall also come to know, how profitable this diversion of the *Chanel of Navigation* from the Valleys is like to prove; which yet would still be unprofitable, if so be that all the Rivers that discharge their waters into the Valleys, should not first be Drained, according to what hath been above advertised.

Abbot CASTELLI, *in the present consideration referring himself to the Relation of* Monsig. Corsini, *grounded upon the Observations and Precepts of the said Abbot; as is seen in the present Discourse. I thought it convenient for the compleating of the Work of our Authour, upon these subjects, to insert it in this place.*

A Relation of the Waters in the Territories of *Bologna* and *Ferrara.*

BY

The Right Honourable and Illuſtrious, *Monſignore* CORSINI, a Native of *Tuſcany*, Superintendent of the general DRAINS, and Preſident of *Romagna.*

THE *Rheno*, and other Brooks of *Romagna*, were by the advice of *P. Agoſtino Spernazzati* the Jeſuite, towards the latter end of the time of *Pope Clement* VIII. notwithſtanding the oppoſition of the *Bologneſi*, and others concerned therein, diverted from their Chanels, for the more commodious cleanſing of the *Po* of *Ferrara*, and of its two Branches of *Primaro*, and *Volano*; in order to the introducing the water of the *Main-Po* into them, to the end that their wonted Torrents being reſtored, they might carry the Muddy-water thence into the Sea, and reſtore to the City the Navigation which was laſt, as is manifeſt by the Brief of the ſaid *Pope Clement*, directed to the *Cardinal San Clemence*, bearing date the 22. of *Auguſt*, 1604.

The work of the ſaid cleanſing, and introducing of the ſaid *Po*, either as being ſuch in it ſelf, or by the contention of the *Cardinal Legates* then in theſe parts; and the jarrings that happened betwixt them, proved ſo difficult, that after the expence of vaſt ſumms in the ſpace of 21. years, there hath been nothing done, ſave the rendring of it the more difficult to be effected.

Interim, the Torrents with their waters, both muddy and clear, have damaged the Grounds lying on the right hand of the *Po* of *Argenta*, and the *Rheno* thoſe on its Banks; of which I will ſpeak in the firſt place, as of that which is of greater importance, and from which the principal cauſe of the miſchiefs that reſult from the reſt doth proceed.

* Or Lordſhip. This *Rheno* having overflowed the * Tennency of *Sanmartina*, in circumference about fourteen miles given it before, and part of that of *Cominale* given it afterwards, as it were, for a receptacle; from whence, having depoſed the matter of its muddineſs, it iſſued clear by the Mouths of *Maſi*, and of *Lievaloro*, into the *Po* of *Primaro*, and of *Volano*; did break down the encompaſſing

passing Bank or Dam towards S. *Martino*, and that of its new Chanel on the right hand neer to *Torre del Fondo*.

By the breaches on this side it streamed out in great abundance from the upper part of *Cominale*, and in the parts about *Raveda*, *Pioggio*, *Caprara*, *Ghiare di Reno*, *Sant' Agostino*, *San Prospero*, *San Vincenzo*, and others, and made them to become incultivable: it made also those places above but little fruitful, by reason of the impediments that their Draines received, finding the Conveyances called *Riolo* and *Scorsuro*, not only filled by *la Motta* and *la Belletta*, but that they turned backwards of themselves.

But by the Mouths in the inclosing Bank or Dam at *Borgo di* S. *Martino* issuing with violence, it first gave obstruction to the ancient Navigation of *la Torre del la Fossa*, and afterwards to the moderne of the mouth of *Masi*, so that at present the Commerce between *Bologna* and *Ferrara* is lost, nor can it ever be in any durable way renewed, whilst that this exceeds its due bounds, and what ever moneys shall be imployed about the same shall be without any equivalent benefit, and to the manifest and notable prejudice of the * Apostolick Chamber.

* The Popes Exchequer.

Thence passing into the Valley of *Marzara*, it swelleth higher, not only by the rising of the water, but by the raising of the bottome, by reason of the matter sunk thither after Landfloods, and dilateth so, that it covereth all the Meadows thereabouts, nor doth it receive with the wonted facility the Drains of the upper Grounds, of which the next unto it lying under the waters that return upwards by the Conveyances, and the more remote, not finding a passage for Rain-waters that settle, become either altogether unprofitable or little better.

From this Valley, by the Trench or Ditch of *Marzara*, or of *la Duca* by *la Buova*, or mouth of *Castaldo de Rossi*, and by the new passage it falleth into the *Po* of *Argenta*, which being to receive it clear, that so it may sink farther therein, and receiving it muddy, because it hath acquired a quicker course, there will arise a very contrary effect.

Here therefore the superficies of the water keeping high, until it come to the Sea, hindereth the Valleys of *Ravenna*, where the River *Senio*, those of *San Bernardino* where *Santerno* was turned, those of *Buon'acquisto*, and those of *Marmorto*, where the *Idice*, *Quaderna*, *Sellero* fall in, from swallowing and taking in their Waters by their usual In-lets, yet many times, as I my self have seen in the *Visitation*, they drink them up plentifully, whereupon, being conjoyned with the muddinesse of those Rivers that fall into the same, they swell, and dilate, and overflow some grounds, and deprive others of their Drains in like manner

as

as hath been ſaid of that of *Marrara*, inſomuch that from the Point of S. *Giorgio*, as far as S. *Alberto* all thoſe that are between the Valleys and *Po* are ſpoiled, of thoſe that are between Valley and Valley many are in a very bad condition, and thoſe that are ſome conſiderable ſpace above not a little damnified.

In fine, by raiſing the bottom or ſand of the Valleys, and the bed of *Reno*, and the too great repletion of the *Po* of *Primaro* with waters, the Valleys of *Comacchio* (on which ſide the Banks are very bad) and * *Poleſine di* S. *Giorgio* are threatned with a danger, that may in time, if it be not remedied, become irreparable, and at preſent feeleth the incommodity of the Waters, which penetrating thorow the pores of the Earth do ſpring up in the ſame, which they call *Purlings*, which is all likely to redound to the prejudice of *Ferrara*, ſo noble a City of *Italy*, and ſo important to the *Eccleſiaſtick State*.

† *Poleſine* is a plat of Ground almoſt ſurrounded with Bogs or waters, like an Iſland

Which particulars all appear to be atteſted under the hand of a Notary in the *Viſitation* which I made upon the command of His Holineſſe, and are withall known to be true by the **Ferrareſi* themſelves, of whom (beſides the requeſt of the *Bologneſi*) the greater part beg compaſſion with ſundry *Memorials*, and remedies, aſwell for the miſchiefs paſt, as alſo for thoſe in time to come, from which I hold it a duty of Conſcience, and of Charity to deliver them.

* People of *Ferrara*.

Pope *Clement* judged, that the ſufficient means to effect this was the ſaid Introduction of the *Main Po* into the Chanel of *Ferrara*; a reſolution truly Heroical, and of no leſſe beauty than benefit to that City, of which I ſpeak not at preſent, becauſe I think that there is need of a readier and more accomodate remedy.

So that I ſee not how any other thing can be ſo much conſiderable as the removal of *Reno*, omitting for this time to ſpeak of * incloſing it from Valley to Valley untill it come to the Sea, as the Dukes of *Ferrara* did deſign, foraſmuch as all thoſe *Ferrareſi* that have intereſt in the *Poleſine di* S. *Giorgio*, and on the right hand of the *Po* of *Argenta* do not deſire it, and do, but too openly, proteſt againſt it; and becauſe that before the Chanel were made as far as the Sea, many hundreds of years would be ſpent, and yet would not remedy the damnages of thoſe who now are agrieved, but would much increaſe them, in regard the Valleys would continue ſubmerged, the Drains ſtopped, and the other Brooks obſtructed, which would of neceſſity drown not a few Lands that lie between Valley and Valley; and in fine, in regard it hath not from *San Martina* to the Sea for a ſpace of fifty miles a greater fall then 19, 8, 6, feet, it would want that force which they themſelves who propound this project do require it to have

* In Chanels made by hand.

have, that ſo it may not depoſe the matter of the muddineſs when it is intended to be let into *Volana*.

So that making the Line of the bottome neer to *Vigarano*, it would riſe to thoſe prodigious termes that they do make bigger, and they may thence expect thoſe miſchiefs, for which they will not admit of introducing it into the ſaid *Po* of *Volana*.

Amongſt the wayes therefore that I have thought of for effecting that ſame remotion, and which I have cauſed to be viewed by skilful men that have taken a level thereof, (with the aſſiſtance of the venerable Father, *D. Benedetto Caſtelli* of *Caſina*, a man of much fidelity and honeſty, and no leſs expert in ſuch like affairs touching waters, than perfect in the *Mathematick* Diſciplines) two onely, the reſt being either too tedious, or too dangerous to the City, have ſeemed to me worthy, and one of them alſo more than the other, to offer to your Lordſhip.

The one is to remit it into the Chanel of *Volana*, thorow which it goeth of its own accord to the Sea.

The other is to turn it into *Main-Po* at *Stellata*, for, as at other times it hath done, it will carry it to the Sea happily.

As to what concerns the making choice of the firſt way, that which ſeemeth to perſwade us to it is, that we therein do nothing that is new, in that it is but reſtored to the place whence it was removed in the year 1522. in the time of Pope *Adrian*, by an agreement made in way of contract, between *Alfonſo*, Duke of *Ferrara*, and the *Bologneſi*; and that it was diverted for reaſons that are either out of date, or elſe have been too long time deferred.

In like manner the facility wherewith it may be effected, letting it run into the divided *Po*, whereby it will be turned to *Ferrara*, or elſe carrying it by *Torre del Fondo*, to the mouth of *Maſi*, and from thence thorow the Trench made by the *Ferrareſi*, along by *Panaro*, where alſo finding an ample Bed, and high and thick Banks, that will ſerve at other times for it, and for the waters of *Po*, there may a great expence be ſpared.

That what ever its Fall be, it would maintain the ſame, not having other Rivers, which with their Floods can hinder it; and that running confined between good Banks, without doubt it would not leave *la Motto* by the way; but eſpecially, that it would be ſufficient if it came to *Codigoro*, where being aſſiſted by the Ebbing and Flowing of the Sea, it would run no hazard of having its Chanel filled up from thence downwards.

That there might thence many benefits be derived to the City, by means of the Running Waters, and alſo no mean Navigation might be expected.

On the contrary it is objected, That it is not convenient to think

think of returning this Torrent into the divided *Po*, by reaſon of the peril that would thence redound to this City.

And that going by *Torre del Fondo*, through *Sanmartina* to the Mouth *de Maſi* by the Chappel of *Vigarano* unto the Sea, it is by this way 70. miles; nor is the Fall greater than 26.5.6. Feet, ſo that it would come to fall but 4. inches & an half, or thereabouts in a mile; whereas the common opinion of the skilfull (to the end that the Torrents may not depoſe their ſand that they bring with them in Land-Floods) requireth the twenty fourth part of the hundredth part of their whole length, which in our caſe, accounting according to the meaſure of theſe places, is 16. inches a * mile; whereupon the ſinking of the Mud and Sand would moſt certainly follow, and ſo an immenſe heightning of the Line of the Bottom, and conſequently a neceſſity of raiſing the Banks, the impoſſibility of maintaining them, the danger of breaches and decayes, things very prejudicial to the *Iſlets* of this City, and of *San Giorgio*, the obſtruction of the Drains, which from the Tower of *Tienne* downwards, fall into the ſaid Chanel; to wit, thoſe of the Sluices of *Goro*, and the Drains, of the Meadows of *Ferrara*: And moreover, the damages that would ariſe unto the ſaid *Iſlet* of S. *Giorgio*, and the Valleys of *Comachio*, by the waters that ſhould enter into the *Goro* or Dam of the Mills of *Belriguardo*, thorow the Trenches of *Quadrea*, which cannot be ſtopt, becauſe they belong to the Duke of *Modena*, who hath right of diverting the waters of that place at his pleaſure to the work of turning Mills.

* The inch of theſe places is ſomewhat bigger than ours.

The greater part of which Objections, others pretend to prove frivolous, by ſaying, that its running there till at the laſt it was turned another way, is a ſign that it had made ſuch an elevation of the Line, of its Bed as it required; denying that it needeth ſo great a declivity as is mentioned above; and that for the future it would riſe no more.

That the ſaid Drains and Ditches did empty into the ſame, whilſt *Po* was there; ſo that they muſt needs be more able to do ſo when onely *Reno* runs that way.

That there would no Breaches follow, or if they did, they would be onely of the water of *Reno*, which in few hours might be taken away (in thoſe parts they call damming up of Breaches, and mending the Bank, *taking away the Breaches*) and its a queſtion whether they would procure more inconvenience than benefit, for that its Mud and Sand might in many places, by filling them up, occaſion a ſeaſonable improvement.

Now omitting to diſcourſe of the ſolidity of the reaſons on the one ſide, or on the other, I will produce thoſe that move me to ſuſpend my allowance of this deſign.

The

The first is, that although I dare not subscribe to the opinion of those that require 16. inches Declivity in a mile to *Reno*, to prevent its deposing of Mud; yet would I not be the Author that should make a trial of it with so much hazard, for having to satisfie my self in some particulars caused a Level to be taken of the Rivers *L'amone*, *Senio*, and *Santerno*, by *Bernardino Alcotti*, we found that they have more Declivity by much than Artists require; as also the *Reno* hath from *la Botta de Ghislieri* to the Chappel of *Vigarano*, for in the space of four miles its Bottom-Line falleth five feet and five inches. So that I hold it greater prudence to depend upon that example, than to go contrary to a common opinion, especially since, that the effects caused by *Reno* it self do confirm me in the same, for when it was forsaken by the *Po*, after a few years, either because it had choaked up its Chanel with Sand, or because its too long journey did increase it, it also naturally turned aside, and took the way of the said *Po* towards *Stellata*. Nay, in those very years that it did run that way, it only began (as relations say) to make Breaches, an evident sign that it doth depose Sand, and raise its Bed; which agreeth with the testimony of some that were examined in the *Visitation* of the Publique Notary, who found great benefit by having Running Water, and some kind of passage for Boats, and yet nevertheless affirm that it for want of Running Water had made too high Stoppages and Shelfes of Sand; so that if it should be restored to the Course that it forsook, I much fear that after a short time, if not suddenly, it would leave it again.

The second I take from the observation of what happened to *Panaro*, when with so great applause of the *Ferarese*, it was brought by Cardinal *Serra* into the said Chanel of *Volana*; for that notwithstanding that it had Running Waters in much greater abundance than *Reno*; yet in the time that it continued in that Chanel it raised its Bed well neer five feet, as is to be seen below the Sluice made by Cardinal *Capponi* to his new Chanel; yea, the said Cardinal *Serra* who desired that this his undertaking should appear to have been of no danger nor damage, was constrained at its Overflowings, to give it Vent into *Sanmartina*, that it might not break in upon, and prejudice the City; which danger I should more fear from *Reno*, in regard it carrieth a greater abundance of Water and Sand.

Thirdly, I am much troubled (in the uncertainty of the success of the affair) at the great expence thereto required; For in regard I do not approve of letting it in, neer to the Fortresse, for many respects, and carrying it by *la Torre del Fondo* to the Mouth *de Mesi*, it will take up eight miles of double Banks, a

thing not eaſie to be procured, by reaſon that the Grounds lie under Water; but from the Mouth *de Maſi* unto *Codigoro*, it would alſo be neceſſary to make new Scowrings of the Chanel; to the end, that the Water approaching (by wearing and carrying away the Earth on both ſhores, might make a Bed ſufficient for its Body, the depth made for *Panaro* not ſerving the turn, as I conceive; and if it ſhould ſuffice, when could the people of *Ferrara* hope to be re-imburſed and ſatisfied for the charge thereof?

Fourthly, it ſerves as an Argument with me, to ſee that the very individual perſons concerned in the Remotion or Diverſion of the ſaid Torrent, namely, the *Bologneſi* do not incline unto it, and that the whole City of *Ferrara*, even thoſe very perſons who at preſent receive damage by it, cannot indure to hear thereof. The reaſon that induceth theſe laſt named to be ſo averſe thereto, is, either becauſe that this undertaking will render the introduction of the Water of *Main-Po* more difficult; or becauſe they fear the danger thereof; The others decline the Project, either for that they know that *Reno* cannot long continue in that Courſe, or, becauſe they fear that it is too much expoſed to thoſe mens revengeful Cutting of it who do not deſire it ſhould; and if a man have any other wayes, he ought, in my opinion, to forbear that, which to ſuch as ſtand in need of its Removal, is leſſe ſatisfactory, and to ſuch as oppoſe it, more prejudicial.

To conclude, I exceedingly honour the judgment of Cardinal *Capponi*, who having to his Natural Ability and Prudence added a particular Study, Obſervation, and Experience of theſe Waters for the ſpace of three years together, doth not think that *Reno* can go by *Volana*; to which agreeth the opinion of Cardinal S. *Marcello*, Legate of this City, of whom, for his exquiſite underſtanding, we ought to make great account. But if ever this ſhould be reſolved on, it would be materially neceſſary to unite the Quick and Running Waters of the little Chanel of *Gento*, of the Chanel *Navilio*, of *Guazzaloca*, and at its very beginning thoſe of *Dardagna*, which at preſent, is one of the Springs or Heads of *Panaro*, that ſo they might aſſiſt it in carrying its Sand, and the matter of its Muddineſs into the Sea; and then there would not fail to be a greater evacuation and ſcowring; but withall the Proprietors in the Iſlet of *San Giorgio* and of *Ferrara* muſt prepare themſelves to indure the inconveniences of Purlings or Sewings of the Water from the River thorow the Boggy Ground thereabouts.

I ſhould more eaſily incline therefore to carry it into *Main-Po* at *Stellata*, for the Reaſons that Cardinal *Capponi* moſt ingeniouſly enumerates in a ſhort, but well-grounded Tract of his: not becauſe

becauſe that indeed it would not both by Purlings and by Breaches occaſion ſome inconvenience; eſpecially, in the beginning: but becauſe I hold this for the incomodities of it, to be a far leſs evil than any of the reſt; and becauſe that by this means there is no occaſion given to them of *Ferrara*, to explain that they are deprived of the hope of ever ſeeing the *Po* again under the Walls of their City: To whom, where it may be done, it is but reaſon that ſatisfaction ſhould be given.

It is certain that *Po* was placed by Nature in the midſt of this great Valley made by the *Appennine* Hills, and by the Alps, to carry, as the Maſter-Drain to the Sea, that is the grand receptacle of all Waters; thoſe particular ſtreams which deſcend from them.

That the *Reno* by all Geographers; *Strabo*, *Pliny*, *Solimas*, *Mella*, and others is enumerated among the Rivers that fall into the ſaid *Po*.

That although *Po* ſhould of it ſelf change its courſe, yet would *Reno* go to look it out, if the works erected by humane induſtry did not obſtruct its paſſage; ſo that it neither is, nor ought to ſeem ſtrange, if one for the greater common good ſhould turn it into the ſame.

Now at *Stellata* it may go ſeveral waies into *Po*, as appeareth by the levels that were taken by my Order; of all which I ſhould beſt like the turning of it to *la Botta de' Ghiſlieri*, carrying it above *Bondeno* to the Church of *Gambarone*, or a little higher or lower, as ſhall be judged leaſt prejudicial, when it cometh to the execution, and this for two principal reaſons: The one becauſe that then it will run along by the confines of the Church Patrimony, without ſeparating *Ferrara* from the reſt of it; The other is, Becauſe the Line is ſhorter, and conſequently the fall greater; for that in a ſpace of ten miles and one third, it falleth twenty ſix feet, more by much than is required by Artiſts; and would go by places where it could do but little hurt, notwithſtanding that the perſons interreſſed ſtudy to amplifie it incredibly.

On the contrary, there are but onely two objections that are worthy to be examined; One, That the Drains and Ditches of S. *Bianca*, of the Chanel of *Cento*, and of *Burana*, and all thoſe others that enter into *Po*, do hinder this diverſion of *Reno*, by the encreaſing of the waters in the *Po*. The other is that *Po* riſing about the Tranſom of the *Pilaſter*-Sluice, very near 20 feet, the *Reno* would have no fall into the ſame; whereupon it would riſe to a terrible height, at which it would not be poſſible to make, or keep the Banks made, ſo that it would break out and drown the Meadowes, and cauſe miſchiefs, and damages unſpeakable, and irreparable; as is evident by the experiment made upon

P*anaro*, which being confined between Banks, that it might go into P*o*, this not being neither in its greateſt excreſcenſe, it broke out into the territories of *Final*, and of *Ferrara*. And though that might be done, it would thereupon enſue, that there being let into the Chanel of P*o*, 2800. ſquare feet of water (for ſo much we account thoſe of *Reno* and P*anaro*, taken together in their greateſt heights) the ſuperficies of it would riſe at leaſt four feet, inſomuch that either it would be requiſite to raiſe its Banks all the way unto the Sea, to the ſame height, which the treaſures of the *Indies* would not ſuffice to effect; or elſe there would be a neceſſity of enduring exceſſive Breaches. To theſe two Heads are the Arguments reduced, which are largely amplified againſt our opinion; and I ſhall anſwer firſt to the laſt, as moſt material.

I ſay therefore, that there are three caſes to be conſidered: Firſt, P*o* high, and *Reno* low. Secondly, *Reno* high, and P*o* low. Thirdly, *Reno* and P*o* both high together.

As to the firſt and ſecond, there is no difficulty in them; for if P*o* ſhall not be at its greateſt height, *Reno* ſhall ever have a fall into it, and there ſhall need no humane Artifice about the Banks: And if *Reno* ſhall be low, P*o* ſhall regurgitate and flow up into the Chanel of it; and alſo from thence no inconvenience ſhall follow. The third remains, from which there are expected many miſchiefs; but it is a moſt undoubted truth, that the excreſcencies of *Reno*, as coming from the adjacent *Appennines* and Rains, are to continue but ſeven, or eight hours at moſt, and ſo would never, or very rarely happen to be at the ſame time with thoſe of P*o*, cauſed by the melting of the ſnowes of the Alps, at leaſt 400. miles diſtance from thence. But becauſe it ſometimes may happen, I reply, that when it cometh to paſs, *Reno* ſhall not go into P*o*, but it ſhall have allowed it one or two Vents; namely, into the Chanel of *Ferrara*, as it hath ever had; and into *Sanmartina*, where it runneth at preſent, and wherewith there is no doubt, but that the perſons concerned will be well pleaſed, it being a great benefit to them, to have the water over-flow their grounds once every four or five years, inſtead of ſeeing it anoy them continually. Yea, the Vent may be regulated, reſerving for it the Chanel in which *Reno* at preſent runneth; and inſtead of turning it by a Dam at *la Betta de Ghiſlieri*, perhaps, to turn it by help of ſtrong Sluices, that may upon all occaſions be opened and ſhut. And for my part, I do not queſtion but that the Proprietors themſelves in *Sanmartina* would make a Chanel for it; which receiving, and confining it in the time of the Vents, might carry the Sand into the P*o* of *Primaro*: Nor need there thence be feared any ſtoppage by Mud and Sand, ſince that it is ſuppoſed that there will but very ſeldom be any neceſſity of uſing it; ſo that time

time would be allowed, upon occaſion, to ſcowr and cleanſe it.

And in this manner all thoſe Prodigies vaniſh that are raiſed with ſo much fear from the enterance of the Water of *Reno* ſwelled into *Po*, when it is high, to which there needeth no other anſwer; yet nevertheleſſe we do not take that quantity of Water, that is carried by *Reno*, and by *Panaro*, to be ſo great as is affirmed: For that P. D. *Benedetto Caſtelli* hath no leſſe accutely than accurately obſerved the meaſures of this kind, noting that the breadth and depth of a River is not enough to reſolve the queſtion truly, but that there is reſpect to be had to the velocity of the Waters, and the term of time, things hitherto not conſidered by the Skilful in theſe affairs; and therefore they are not able to ſay what quantity of Waters the ſaid Rivers carry, nor to conclude of the riſings that will follow thereupon. Nay, it is moſt certain, that if all the Rivers that fall into *Po*, which are above thirty, ſhould riſe at the rate that theſe compute *Reno* to do, an hundred feet of Banks would not ſuffice, and yet they have far fewer: So that this confirmes the Rule of R. P. D. *Benedetto*, namely, that the proportion of the height of the Water of *Reno* in *Reno* to the height of the Water of *Reno* in *Po*, is compounded of the proportion of the breadth of the Chanel of *Po* to that of *Reno*, and of the velocity of the Water of *Reno* in *Po* to the velocity of the Water of *Reno* in *Reno*; a manifeſt argument that there cannot in it, by this new augmentation of Waters follow any alteration that neceſſitates the raiſing of its Banks, as appeareth by the example of *Panaro*, which hath been ſo far from ſwelling *Po*, that it hath rather aſſwaged it, for it hath carried away many Shelfs and many Iſlets that had grown in its Bed, for want of Waters ſufficient to bear away the matter of Land-floods in ſo broad a Chanel; and as is learnt by the trial made by us in *Panaro* with the Water of *Burana*; for erecting in the River ſtanding marks, and ſhutting the ſaid Sluice, we could ſee no ſenſible abatement, nor much leſs after we had opened it ſenſible increaſment; by which we judge that the ſame is to ſucceed to *Po*, by letting in of *Reno*, *Burana* having greater proportion to *Panaro* than *Reno* to *Po*, conſidering the ſtate of thoſe Rivers in which the Obſervation was made. So that there is no longer any occaſion for thoſe great raiſings of Banks, and the danger of the ruptures as well of *Reno* as of *Po* do vaniſh, as alſo the fear leſt that the Sluices which empty into *Po* ſhould receive obſtruction: which if they ſhould, yet it would be over in a few hours. And as to the Breaches of *Panaro* which happened in 1623. I know not why, ſeeing that it is confeſſed that the *Po* was not, at that time, at its height, one ſhould rather charge it with

with the crime, than quit it thereof. The truth is, that the Bank was not made of proof, ſince that the ſame now continueth whole and good, and *Panaro* doth not break out; nay, there was, when it brake more than a foot and half of its Banks above the Water, and to ſpare; but it broke thorow by a Moles working, or by the hole of a Water-Rat, or ſome ſuch vermine; and by occaſion of the badneſs of the ſaid Banks, as I finde by the teſtimony of ſome witneſſes examined by my command, that I might know the truth thereof. Nor can I here forbear to ſay, that it would be better, if in ſuch matters men were more candid and ſincere. But to ſecure our ſelves nevertheleſſe, to the utmoſt of our power, from ſuch like Breaches which may happen at the firſt, by reaſon of the newneſſe of the Banks, I preſuppoſe that from *Po* unto the place whence *Reno* is cut, there ought to be a high and thick Fence made with its Banks, ſo that there would be no cauſe to fear any whatſoever acceſſions of Water, although that concurrence of three Rivers; which was by ſome more ingeniouſly aggravated than faithfully ſtated by that which was ſaid above were true; to whom I think not my ſelf bound to make any farther reply, neither to thoſe who ſay that *Po* will aſcend upwards into *Reno*, ſince that theſe are the ſame perſons who would introduce a ſmall branch of the ſaid *Po* into the Chanel of *Ferrara*, that ſo it may conveigh to the Sea, not *Reno* onely, but alſo all the other Brooks of which we complained; and becauſe that withal it is impoſſible, that a River ſo capacious as *Po* ſhould be incommoded by a Torrent, that, as I may ſay, hath no proportion to it.

I come now to the buſineſſe of the Ditches and Draines; and as to the Conveyance of *Burana*, it hath heretofore been debated to turn it into *Main*-*Po*, ſo that in this caſe it will receive no harm, and though it were not removed, yet would it by a Trench under ground purſue the courſe that it now holdeth, and alſo would be able to diſ-imbogue again into the ſaid new Chanel of *Reno*, which conforming to the ſuperficies of the Water of *Po*, would continue at a lower level than that which *Panara* had when it came to *Ferrara*, into which *Burana* did nevertheleſſe empty it ſelf for ſome time.

The Conveyance or Drain of *Santa Bianca*, and the little Chanel of *Cento* may alſo empty themſelves by two ſubterranean Trenches, without any prejudice where they run at preſent, or without any more works of that nature, they may be turned into the ſaid new Chanel, although with ſomewhat more of inconvenience; and withall, the Chanel of *Ferrara*, left dry, would be a ſufficient receptacle for any other Sewer or Drain whatſoever, that ſhould remain there.

All

All which Operations might be brought to perfection with 150. thouſand Crowns, well and faithfully laid out; which ſumm the *Bologneſi* will not be unwilling to provide; beſides that thoſe *Ferrareſi* ought to contribute to it, who ſhall partake of the benefit.

Let me be permitted in this place to propoſe a thing which I have thought of, and which peradventure might occaſion two benefits at once, although it be not wholly new. It was in the time of *Pope Paul* V. propounded by one *Creſcenzio* an Ingineer, to cut the *Main*-*Po*, above *le Papozze*; and having made a ſufficient evacuation to derive the water thereof into the *Po* of *Adriano*, and ſo to procure it to be Navigable, which was not at that time effected, either by reaſon of the oppoſitions of thoſe, whoſe poſſeſſions were to be cut thorow, or by reaſon of the great ſum of money that was neceſſary for the effecting of it; But in viewing thoſe Rivers, we have obſerved, that the ſedge cutting might eaſily be made below *le Papozze*, in digging thorow the Bank called *Santa Maria*, & drawing a Trench of the bigneſs, that skilful Artiſts ſhall judge meet unto the *Po* * of *Ariano*, below the *Secche* of the ſaid S. *Maria*; which as being a work of not above 160. Perches in length, would be finiſhed with onely 12000. Crowns.

* Of *Adriano*.

Firſt; it is to be believed, that the waters running that way, would not fail to open that Mouth into the Sea, which at preſent is almoſt choakt up by the Shelf of Sand, which the new Mouth of *Ponto Virro* hath brought thither; and that it would again bring into uſe the Port *Goro*, and its Navigation.

And haply experience might teach us, that the ſuperficies of *Po* might come to fall by this aſſwagement of Water, ſo that the acceſſion of *Reno* would queſtionleſs make no riſing in it: Whereupon, if it ſhould ſo fall out, thoſe Princes would have no reaſon to complain; who ſeem to queſtion, leſt by this new acceſſion of water into *Po*, the Sluices might be endangered. Which I thought not fit to omit to repreſent to your Lordſhip; not, that I propoſe it to you as a thing abſolutely certain, but that you might, if you ſo pleaſed, lay it before perſons whoſe judgements are approved in theſe affairs.

I return now from where I degreſt, and affirm it as indubitable, that *Reno* neither can, nor ought to continue longer where it at this day is; and that it cannot go into any other place but that, whither *Cardinal Capponi* deſigned to carry it, and which at preſent pleaſeth me better than any other; or into *Volana*, whence it was taken away; the vigilance of Men being able to obviate part of thoſe miſchiefs, which it may do there.

But from its Removal, beſides the alleviation of the harm which

which by it ſelf is cauſed, there would alſo reſult the diminution of that which is occaſioned by the other Brooks, to the right hand of the *Po* of *Argenta*; foraſmuch as the ſaid *Po* wanting all the water of *Reno*, it would of neceſſity come to ebb in ſuch manner, that the Valleys would have a greater Fall into the ſame, and conſequently it would take in, and ſwallow greater abundance of water; and by this means the Ditches and Draines of the Up-Lands would likewiſe more eaſily Fall into them; eſpecially if the ſcouring of *Zenzalino* were brought to perfection, by which the waters of *Marrara* would fall into *Marmorta*: And if alſo that of *Baſtia* were enlarged, and finiſhed, by which there might enter as much water into the ſaid *Po* of *Argenta*, as is taken from it by the removal of *Reno*; although that by that meanes the water of the Valleys would aſſwage double: Nor would the people of *Argenta*, the Iſles of S. *Giorgio*, and *Comacchio* have any cauſe to complain; for that there would not be given to them more water than was taken away: Nay ſometimes whereas they had Muddy waters, they would have clear; nor need they to fear any riſing: And furthermore, by this means a very great quantity of ground would be reſtored to culture; For the effecting of all which, the ſumm of 50. thouſand Crowns would go very far, and would ſerve the turn at preſent touching thoſe Brooks, carrying them a little farther in the mean time, to fill up the greater cavities of the Valleys, that we might not enter upon a vaſter and harder work, that would bring with it the difficulties of other operations, and ſo would hinder the benefit which theſe people expect from the paternal charity of His Holineſs.

TO

TO
The Right Honourable,
MONSIGNORE
D. Ferrante Ceſarini.

MY Treatiſe of the MENSURATION of RUNNING WATERS, Right Honourable, and moſt Noble Sir, hath not a greater Prerogative than its having been the production of the command of Pope *Urban* VIII. when His Holineſs was pleaſed to enjoyn me to go with *Monſignore Corſini*, in the Viſitation that was impoſed upon him in the year 1625. of the Waters of *Ferrara*, *Bologna*, *Romagna*, and *Romagnola*; for that, on that occaſion applying my whole Study to my ſervice and duty, I publiſhed in that Treatiſe ſome particulars till then not rightly underſtood and conſidered (that I knew) by any one; although they be in themſelves moſt important, and of extraordinary conſequence. Yet I muſt render thanks to Your Lordſhip for the honour you have done to that my Tract; but wiſh withal, that your Eſteem of it may not prejudice the univerſal Eſteem that the World hath of Your Honours moſt refined judgement.

As to that Point which I touch upon in the Concluſion, namely, That the conſideration of the Velocity of Running Water ſupplyeth the conſideration of the * Length omitted in the common way of meaſuring Running Waters; Your Lordſhip having commanded me that in favour of *Practiſe*, and for the perfect diſcovery of the diſorder that commonly happeneth now adayes in the diſtribution of the Waters of Fountains, I ſhould demonſtrate that the knowledge of the Velocity ſerveth for the finding of the Length: I have thought fit to ſatisfie your Command by relating a Fable; which, if I do not deceive my ſelf, will make out to us the truth thereof; inſomuch that the reſt of my Treatiſe ſhall thereby alſo become more manifeſt and intelligible, even to

* Larghezza, but miſprinted.

thoſe who finde therein ſome kinde of obſcurity.

In the dayes of yore, before that the admirable Art of Weaving was in uſe, there was found in *Perſia* a vaſt and unvaluable Treaſure, which conſiſted in an huge multitude of pieces of Ermeſin, or Damask, I know not whether; which, as I take it, amounted to near two thouſand pieces; which were of ſuch a nature, that though their Breadth and Thickneſs were finite and determinate, as they uſe to be at this day; yet nevertheleſs, their Length was in a certain ſenſe infinite, for that thoſe two thouſand pieces, day and night without ceaſing, iſſued out with their ends at ſuch a rate, that of each piece there iſſued 100. Ells a day, from a deep and dark Cave, conſecrated by the Superſtition of thoſe people, to the fabulous *Arachne*. In thoſe innocent and early times (I take it to have been, in that ſo much applauded and deſired Golden age) it was left to the liberty of any one, to cut off of thoſe pieces what quantity they pleaſed without any difficulty: But that felicity decaying and degenerating, which was altogether ignorant of *Meum* and *Tuum*; terms certainly moſt pernicious, the Original of all evils, and cauſe of all diſcords; there were by thoſe people ſtrong and vigilant Guards placed upon the Cave, who reſolved to make merchandize of the Stuffes; and in this manner they began to ſet a price upon that ineſtimable Treaſure, ſelling the propriety in thoſe pieces to divers Merchants; to ſome they ſold a right in one, to ſome in two, and to ſome in more. But that which was the worſt of all, There was found out by the inſatiable avarice of theſe men crafty inventions to deceive the Merchants alſo; who came to buy the aforeſaid commodity, and to make themſelves Maſters, ſome of one ſome of two, and ſome of more ends of thoſe pieces of ſtuff; and in particular, there were certain ingenuous Machines placed in the more ſecret places of the Cave, with which at the pleaſure of the Guards, they did retard the velocity of thoſe Stuffs, in their iſſuing out of the Cave; inſomuch, that he who ought to have had 100. Ells of Stuff in a day, had not above 50, and he who ſhould have had 400, enjoyed the benefit of 50. onely; and ſo all the reſt were defrauded of their Rights, the ſurpluſage being ſold, appropriated, and ſhared at the will of the corrupt Officers: So that the buſineſs was without all order or juſtice, inſomuch that the Goddeſs *Arachne* being diſpleaſed at thoſe people, deprived every one of their benefit, and with a dreadful Earthquake for ever cloſing the mouth of the Cave, in puniſhment of ſo much impiety and malice: Nor did it avail them to excuſe themſelves, by ſaying that they allowed the Buyer the Breadth and Thickneſs bargained for; and that of the Length, which was infinite,

there

there could no account be kept: For the wiſe and prudent Prieſt of the Sacred *Grotto* anſwered, That the deceit lay in the length, which they were defrauded of, in that the velocity of the ſtuffe was retarded, as it iſſued out of the Cave: and although the total length of the Piece was infinite, for that it never ceaſed coming forth, and ſo was not to be computed; yet nevertheleſs its length conſidered, part by part, as it came out of the Cave, and was bargained for, continued ſtill finite, and might be one while greater, and another while leſſer, according as the Piece was conſtituted in greater or leſſer velocity; and he added withall, that exact Juſtice required, that when they ſold a piece of ſtuff, and the propriety or dominion therein, they ought not only to have aſcertained the breadth and thickneſſe of the Piece, but alſo to have determined the length, determining its velocity.

The ſame diſorder and confuſion, that was repreſented in the Fable, doth come to paſſe in the Hiſtory of the Diſtribution of the Waters of Conduits and Fountains, ſeeing that they are ſold and bought, having regard only to the two Dimenſions, I mean of Breadth and Height of the Mouth that diſchargeth the Water; and to remedy ſuch an inconvenience, it is neceſſary to determine the length in the velocity; for never ſhall we be able to make a gueſſe at the quantity of the Body of Running VVater, with the two Dimenſions only of Breadth and Height, without Length.

And to the end, that the whole buſineſs may be reduced to a moſt eaſie practice, by which the waters of Aqueducts may be bought and ſold juſtly, and with meaſures alwayes exact and conſtant.

Firſt, the quantity of the Water ought diligently to be examined, which the whole principal Pipe diſchargeth in a time certain, as for inſtance, in an hour, in half an hour, or in a leſſe interval of time, (for knowing which I have a moſt exact and eaſie Rule) and finding that the whole principal pipe diſchargeth *v. g.* a thouſand Tuns of Water in the ſpace of one or more hours, in ſelling of this water, it ought not to be uttered by the ordinary and falſe meaſure, but the diſtribution is to be made with agreement to give and maintain to the buyer ten or twenty, or a greater number of Tuns, as the bargain ſhall be made, in the ſpace of an hour, or of ſome other ſet and determinate time. And here I adde, that if I were to undertake to make ſuch an adjuſtment, I would make uſe of a way to divide and meaſure the time with ſuch accurateneſſe, that the ſpace of an hour ſhould be divided into four, ſix, or eight thouſand parts

without the leaſt errour; which Rule was taught me by my Maſter *Sign. Galilæo Galilæi*, Chief Philoſopher to the moſt Serene *Grand Duke* of *Tuſcany*. And this way will ſerve eaſily and admirably to our purpoſe and occaſion; ſo that we ſhall thereby be able to know how many Quarts of Water an Aqueduct will diſcharge in a given time of hours, moneths, or years. And in this manner we may conſtitute a Cock that ſhall diſcharge a certain and determinate quantity of water in a time given.

And becauſe daily experience ſhews us, that the Springs of Aqueducts do not maintain them alwayes equally high, and full of Water, but that ſometimes they increaſe, and ſometimes decreaſe, which accident might poſſibly procure ſome difficulty in our diſtribution: Therefore, to the end that all manner of ſcruple may be removed, I conceive that it would be convenient to provide a Ciſtern, according to the occaſion, into which there might alwayes fall one certain quantity of water, which ſhould not be greater than that which the principal pipe diſchargeth in times of drought, when the Springs are bare of water, that ſo in this Ciſtern the water might alwayes keep at one conſtant height. Then to the Ciſtern ſo prepared we are to faſten the Cocks of particular perſons, to whom the Water is ſold by the Reverend Apoſtolique Chamber, according to what hath been obſerved before; and that quantity of Water which remaineth over and above, is to be diſcharged into another Ciſtern, in which the Cocks of the Waters for publick ſervices, and of thoſe which people buy upon particular occaſions are to be placed. And when the buſineſſe ſhall have been brought to this paſſe, there will likewiſe a remedy be found to the ſo many diſorders that continually happen; of which, for brevity ſake, I will inſtance in but four only, which concern both publique and private benefit, as being, in my judgment, the moſt enormous and intolerable.

The firſt inconvenience is, that in the common way of meaſuring, diſpenſing, and ſelling the Waters of Aqueducts, it is not underſtood, neither by the Buyer nor Seller, what the quantity truly is that is bought and ſold; nor could I ever meet with any either Engineer or Architect, or Artiſt, or other that was able to decypher to me, what one, or two, or ten inches of water was. But by our above declared Rule, for diſpenſing the Waters of Aqueducts we may very eaſily know the true quantity of Water that is bought or ſold, as that it is ſo many Tuns an hour, ſo many a day, ſo many in a year, &c.

The ſecond diſorder that happeneth, at preſent, in the diſtributing

bution of Aqueducts is, that as the buſineſſe is now governed, it lieth in the power of a lordid Maſon to take unjuſtly from one, and give undeſervedly to another more or leſſe Water than belongeth to them of right: And I have ſeen it done of my own experience. But in our way of meaſuring and diſtributing Waters, there can no fraud be committed; and putting the caſe that they ſhould be committed, its an eaſie matter to know it, and amend it, by repairing to the Tribunal appointed.

Thirdly, it happens very often, (and we have examples thereof both antient and modern) that in diſpenſing the Water after the common and vulgar way; there is ſometimes more Water diſpended than there is in the Regiſter, in which there will be regiſtred, as they ſay, two hundred inches (for example) and there will be diſpenſed two hundred and fifty inches, or more. Which paſſage happened in the time of *Nerva* the Emperour, as *Giulio Frontino* writes, in his 2. Book, *De Aquaductibus Urbis Romæ*, where he obſerveth that they had *in Commentariis* 12755. *Quinaries* of Water; and found that they diſpenſed 14018. *Quinaries*. And the like Errour hath continued, and is in uſe alſo modernly until our times. But if our Rule ſhall be obſerved, we ſhall incur no ſuch diſorder, nay there will alwayes be given to every one his ſhare, according to the holy end of exact juſtice, which *dat unicuique quod ſuum eſt*. As on the contrary, it is manifeſt, that His Divine Majeſty hateth and abominateth *Pondus & pondus*, *Menſura & menſura*, as the Holy Ghoſt ſpeaketh by the mouth of *Solomon* in the *Proverbs*, *Chap.* 20. *Pondus & Pondus*, *Menſura & Menſura*, *utrumque abominabile eſt apud Deum*. And therefore who is it that ſeeth not that the way of dividing and meaſuring of VVaters, commonly uſed, is expreſly againſt the Law of God. Since that thereby the ſame meaſure is made ſometimes greater, and ſometimes leſſer; A diſorder ſo enormous and execrable, that I ſhall take the boldneſs to ſay, that for this ſole reſpect it ought to be condemned and prohibited likewiſe by human Law, which ſhould Enact that in this buſineſs there ſhould be imployed either this our Rule, or ſome other that is more exquiſite and practicable, whereby the meaſure might keep one conſtant and determinate tenor, as we make it, and not, as it is now, to make *Pondus & Pondus*, *Menſura & Menſura*.

And this is all that I had to offer to Your moſt Illuſtrious Lordſhip, in obedience to your commands, reſerving to my ſelf the giving of a more exact account of this my invention, when the occaſion ſhall offer, of reducing to practice ſo holy, juſt, and neceſſary

neceſſary a reformation of the Meaſure of Running Waters and of Aqueducts in particular: which Rule may alſo be of great benefit in the diviſion of the greater Waters to over-flow Grounds, and for other uſes: I humbly bow,

Your Moſt Devoted,

and

Moſt Obliged Servant,

D. Benedetto Caſtelli, *Abb. Caſis.*

FINIS.

A TABLE

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