35 kv. as compared to 55 kv. for the arc discharge on an ordinary day.

The experiment clearly showed that corona current flow in an atmosphere of high humidity is greatly reduced, and that spark discharges at relatively low voltages are apt to occur. The explanation of this phenomenon very likely is to be found in the reduction of the mobility of negative ions in air of high humidity, although the existence of a thin film of moisture on the electrodes may also play a part.

In this connection it may be pointed out that Elster and Geitel[1] have called attention to the fact that the mobility of gas ions in a fog is greatly reduced; also that Tamm[2] has found that the mobility of gas ions in air at 100% humidity was approximately 25% of that in dry air.

As is well known, with the wires *positive* with respect to the plate instead of *negative*, the corona current flow is greatly reduced and spark discharge sets in at a relatively low voltage even on dry days, so that the action of negative wires on wet days was similar to the action of positive wires on dry days, this is very likely due to the fact that humidity reduces the mobility of the negative ions while it leaves the positive ions unaffected.[3]

[1] *Ann. Phys.*, **2,** 425 (1900).

[2] *Ibid.*, **6,** 259 (1901).

[3] Graetz, *Handbuch der Elek. u. Mag.*, **1923,** Seeliger, III, p. 364.

THE SPARK SPECTRUM OF NEON

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By the use of a vacuum spectrograph in which the spectrum was excited by electron impacts at controlled voltages between a Wehnelt cathode and a wire grid anode, and in which rapid pumping enabled the gas pressure in the spectrograph to be maintained at less than 0.005 of that in the discharge tube, we have discovered an entire new series of lines of considerably shorter wave-length than any hitherto reported for neon. These lines are listed in table 1. That they are the fundamental lines of the neon spark spectrum is suggested by the experimental fact that they are entirely absent at 40-volt excitation, are developed weakly at 60 volts and strongly at 80 volts. This conclusion is confirmed spectroscopically by the appearance in every multiplet of the wave number difference 782 given by the two ionization limits of Ne I. The third, fourth and fifth lines in table 1 are combinations between the two "ground" ^2P states and the three $^4P'$ states discovered by de Bruin (*Zeits. f. Phys.*, **44,** 157,

1927) and serve to connect the new observations with his partial analysis of the near-visible spectrum of Ne II. (Kichlu, in *Proc. Phys. Soc. Lon.*, **39,** 424, 1927, gives several of the quartet terms of de Bruin, but interprets some of them differently.)

TABLE 1

NEW LINES IN SPECTRUM OF NE II

λ	INT.	ν	
462.38	7	216272	$2p\ {}^2P_1 - sp^6\ {}^2S_1$
460.72	12	217051	$2p\ {}^2P_2 - sp^6\ {}^2S_1$
456.35	4–	219130	$2p\ {}^2P_2 - 3s\ {}^4P'_3$
455.27	4	219650	$2p\ {}^2P_2 - 3s\ {}^4P'_2$
454.68	3	219935	$2p\ {}^2P_2 - 3s\ {}^4P'_1$
447.83	3	223299	$2p\ {}^2P_1 - 3s\ {}^2P'_2$
446.60	4	223914	$2p\ {}^2P_1 - 3s\ {}^2P'_1$
446.26	7	224085	$2p\ {}^2P_2 - 3s\ {}^2P'_2$
445.05	2	224694	$2p\ {}^2P_2 - 3s\ {}^2P'_1$
407.17	3	245598	$2p\ {}^2P_1 - 3s\ {}^2D_2$
405.88	5	246378	$2p\ {}^2P_2 - 3s\ {}^2D_{32}$
362.55	2	275824	$2p\ {}^2P_1 - 3s\ {}^2S_1$
361.54	3	276595	$2p\ {}^2P_2 - 3s\ {}^2S_1$
356.79	2*d*	280277	$2p\ {}^2P_2 - 3d\ {}^2D_{32}$
353.01	1*d*	283278	$2p\ {}^2P_2 - 4s\ {}^2P'_{21}$

L. Bloch, E. Bloch and G. Dejardin (*Jour. de Phys.*, **7,** 129, 1926) list 336 lines of Ne II, including some doubtful lines, in the near visible region. With the aid of information given by these new ultra-violet lines and the pioneer work of de Bruin who classified 34 lines in 5 multiplets of the quartet system, we have succeeded in classifying 203 lines in 59 multiplets, thus accounting for all the stronger lines given by Bloch and Dejardin. Table 2 gives the term values of all the states of Ne II thus far identified. The assignment of these levels appears to be assured except those attributed to the $4f$ electron, in which case the reality of the levels is undoubted but their designation is only provisional. X_3 is a fragment of some other multiple level of the sort. All terms have ${}^3P'$ limits (Ne III) except $3s\,{}^2D_{3,2}$ and $3s\,{}^2S_2$ associated with ${}^1D$ and ${}^1S$ terms in Ne III. The ${}^2D$ term is apparently an extremely close pair, the corresponding pair in O II differing by only 1 frequency unit.

TABLE 2

TERM VALUES IN NE II

(Terms marked * were discovered by de Bruin)

	QUARTETS			DIFF.	DOUBLETS			DIFF.
					$2p$	${}^2P_2$	330429	782
						${}^2P_1$	329647	
					sp^6	${}^2S_1$	113376	
*	$3s$	${}^4P'_3$	111300.0	518.0	$3s$	${}^2P'_2$	106343.7	612.2
*		${}^4P'_2$	110782.0	299.0		${}^2P'_1$	105731.5	
*		${}^4P'_1$	110483.0					

TABLE 2 (*Concluded*)

			QUARTETS	DIFF.			DOUBLETS	DIFF.
					3s	$^2D_{32}$	84050	
					3s	$^2S_1$	53828.5	
	4s	$^4P'_3$	48432.6	376.9	4s	$^2P'_2$	47108.4	571.9
		$^4P'_2$	48055.7	305.1		$^2P'_1$	46536.5	
		$^4P'_1$	47750.6					
*	3p	$^4S'_2$	77477.5		3p	$^2S'_1$	77532.6	
*	3p	$^4P_3$	84238.2	222.8	3p	$^2P_2$	76266.0	127.0
*		$^4P_2$	84015.4	182.5		$^2P_1$	76139.0	
*		$^4P_1$	83832.9					
*	3p	$^4D'_4$	81322.6	337.6	3p	$^2D'_3$	79419.4	511.0
*		$^4D'_3$	80985.0	249.7		$^2D'_2$	78908.4	
*		$^4D'_2$	80735.3	144.0				
*		$^4D'_1$	80591.3					
	3d	$^4P'_3$	49259.5	−181.8	3d	$^2P'_2$	49098.6	−859.0
		$^4P'_2$	49441.3	−221.5		$^2P'_1$	49957.6	
		$^4P'_1$	49662.8					
*	3d	$^4D_4$	51293.5	81.0	3d	$^2D_3$	50161.9	756.8
*		$^4D_3$	51212.5	106.5		$^2D_2$	49405.1	
*		$^4D_2$	51106.0	98.2				
*		$^4D_1$	51007.8					
	3d	$^4F'_5$	50258.4	528.1				
		$^4F'_4$	49730.3	97.6				
		$^4F'_3$	49633.7	149.4				
		$^4F'_2$	49484.3					
	4f	$^4D_4$	27602.0	15.0				
		$^4D_3$	27587.0	58.9				
		$^4D_2$	27528.1	86.7				
		$^4D_1$	27441.4					
	4f	$^4F'_5$	27526.7	624.4				
		$^4F'_4$	26902.3	296.0				
		$^4F'_3$	26606.3	−315.4				
		$^4F'_2$	26921.7					
	4f	X_3	26830.5					

The term values here given are referred to the $^3P'$ limit in Ne II and are derived from the two series involving the 3s and 4s electrons.

The mean quantum defects of the various states are given in table 3, where they are compared with those of O II which should, according to

TABLE 3

MEAN QUANTUM DEFECTS OF NE II

	QUARTETS	DOUBLETS	BOTH	VALUES FOR O II
2p		0.847	(0.847)	0.724
3p	0.672	0.624	0.648	0.548
3s	1.015	0.969	0.992	0.867
4s	0.991	0.948	0.965	0.857
3d	0.045	0.024	0.035	0.030
4f	0.010		(0.010)	−0.025

Hund, run closely parallel. Not only are the quantum defects very similar in the two cases, but the term separations are also similar, but usually nearly three times as great for Ne II as for O II.

From the value for $2p^2P_2$, the ionization potential is 40.89 volts. To alter this by 1000 units (0.12 volt) would change the quantum defect for $3d$ by 0.029 and for $4f$ by 0.070 which are well beyond the bounds of probability. The I. P. may, therefore, be taken as *40.9 ± 0.05 volt.* The most accurate estimate of this quantity hitherto available was 38.5 volts, based on extrapolation and assumed parallelism of Moseley curves recently given by Millikan and Bowen (*Phil. Mag.*, **4**, p. 561, 1927).

Note Added to Proof. De Bruin (*Zs. f. Physik*, **46**, 856, 1928) gives additional terms which are fewer than those here tabulated. His arrangement in multiplets differ from ours. We believe our assignment to be more nearly correct—March 7, 1928.

ON HIERARCHICAL CORRELATION SYSTEMS

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The correlation system consisting of the $k(k-1)/2$ coefficients r_{ab} existing between $k > 3$ sets $a, b, \ldots$ of n variables $x, y, \ldots$ is said to be hierarchical if the $k(k-1)(k-2)(k-3)/4$ tetrad equations

$$r_{ab}r_{cd} - r_{ac}r_{ad} = 0 \qquad (a, b, c, d, \text{ all different}) \qquad (1)$$

hold.[1] The ordinary way of representing a correlation system graphically is by a scatter diagram of the n points $x_a, x_b, \ldots; y_a, y_b, \ldots; \ldots$ in a space of k dimensions of which one axis is assigned to each of the k sets $a, b, \ldots$. For the present purposes it is more convenient to use a space of n dimensions, one axis for each individual $x, y, \ldots$ and to plot therein k points $a_x, a_y, \ldots; b_x, b_y, \ldots; \ldots$ which represent the values for the individuals for each variable $a, b, \ldots$. These k points may be treated as k vectors $\mathbf{a}, \mathbf{b}, \ldots$ from the origin to the points. If the values are referred to their means as is usual, the k vectors determine a k-space perpendicular to the line $\mathbf{u}$ equally inclined to the n axes (direction cosines all $1/\sqrt{n}$). The length of the vectors may be taken as unity by so choosing the scales of measurement that the standard deviations of all sets are equal to $1/\sqrt{n}$, and the correlation coefficients r_{ab} become the inner products $\mathbf{a}.\mathbf{b}$. The correlation system thus comes to be represented by k points on a unit sphere, the cosines of the $k(k-1)/2$ edges are the coefficients, the tetrad relations become

$$\mathbf{a}.\mathbf{b}\ \mathbf{c}.\mathbf{d} - \mathbf{a}.\mathbf{c}\ \mathbf{b}.\mathbf{d} = \mathbf{a} \times \mathbf{b}.\mathbf{c} \times \mathbf{d} = 0 \qquad (2)$$