nent maxima or minima encountered during the march of the reflector in y, be taken, a circle is to be drawn with a center at R and a radius RP. In case of the first minimum at $y = 40$ cm., the image is I at $z = 40$, $y = 80$. Hence $IC = 27$ cm. is the path difference from the minimum at $y = 40$ cm. which is placed a little too high. The following data so measured, may be given as examples.

Minimum	$y =$ 40 cm.,	$\lambda/2 =$ 27cm.	$y =$	110 cm.,	$7\lambda/2 =$ 179 cm.
	70 cm.,	$3\lambda/2 =$ 82			$9\lambda/2 =$ 220
	93 cm.,	$5\lambda/2 =$ 126			
Maxima	$y =$ 53 cm.,	$1\lambda =$ 50 cm.	$y =$	130 cm.,	$4\lambda =$ 198 cm.
	83 cm.,	$2\lambda =$ 105		155 cm.,	$5\lambda =$ 248
	103 cm.,	$3\lambda =$ 148		25 cm.,	$0\lambda =$ 4

These results in their entirety are convincing, being quite as accurate as the location of maxima and minima admits. The minima of figure 2 treated by the same method give, for instance,

Minimum	$y =$ 25 cm.,	$\lambda/2 =$ 24 cm.	$y =$	103 cm.,	$7\lambda/2 =$ 170 cm.
	50 cm.,	$3\lambda/2 =$ 68		126 cm.,	$9\lambda/2 =$ 215
	80 cm.,	$5\lambda/2 =$ 125		etc.	

with similar data for the maxima.

* Advance note from a report to the Carnegie Institution, Washington, D. C.

NOTE ON THE PROBLEM OF GREAT STELLAR DISTANCES

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Through a study of the faint variable stars in the Small Magellanic Cloud it has been possible to check the photometric methods of measuring the parallaxes of globular clusters.

The great distances now ascribed to the globular systems require that the cluster type variables, with periods less than one day, be of high luminosity. The high absolute brightness of typical Cepheids, with periods longer than one day, is commonly accepted; but the faintness of the galactic variables of the cluster type, and their peculiarly large radial velocities, suggest that studies of their proper motions and trigonometric parallaxes will contribute little in the near future to the problem of their average absolute magnitude. It is now found, however, that the faintest variables in the Small Magellanic Cloud are Cepheids of the cluster type, and they are but one magnitude fainter than the typical Cepheids with periods of three days.

In 1904 and 1905 Miss Leavitt discovered nearly a thousand variable stars in the Small Magellanic Cloud from photographs made at Harvard's observing station at Arequipa, Peru. In addition, she found more than eight hundred variables in the Large Magellanic Cloud. Miss Leavitt

undertook an investigation of the periods and light curves of these stars, but for various reasons had not progressed far at the time of her death, beyond the work reported in *Harvard Circular* 173, 1912. In that paper she gives the periods of twenty-five stars, notes that they are all of the Cepheid type, and calls attention to a remarkable relation connecting the brightness of the variables and the length of their periods. The logarithm of the period was found to increase about 0.48 for each increase of one magnitude in brightness. The longest period she found was 127 days for one of the brightest stars in the Cloud; the shortest period was 1.25 days for a variable nearly four magnitudes fainter.

In the globular clusters are found large numbers of Cepheid variable stars with periods shorter than one day, and only a few with longer periods. In my work on cluster distances I used the relation given by Miss Leavitt, first putting it on an absolute luminosity basis (following Hertzsprung), and then extending it to these cluster type Cepheids. It soon appeared that the linear formula given by Miss Leavitt did not hold, and an empirical curve was derived and used for obtaining distances of Cepheids in the clusters and throughout the galactic system in general.

Some objections have been raised to my extension of the period-luminosity curve, which identifies cluster type variables as giants rather than dwarfs. The proper motions of two of these variables are large, and many of them are in high galactic latitude. Both properties are usually, but not always, associated with low absolute magnitude.

The adopted high luminosity is strongly supported, however, by the comparable brightness in clusters of the short period Cepheids and the B type stars, as well as by the direct comparison with the few long period Cepheids in Messier 5, Omega Centauri, and other globular clusters. Spectrophotometric analyses of the cluster stars afford additional support. A direct extension of the observed period-luminosity curve to cluster type variables in the Small Magellanic Cloud itself would appear to be especially decisive.

Most of the known variable stars in the Cloud have median magnitudes corresponding to periods between two and five days. A few are fainter. About twenty-five of these faint variables have been investigated during the past year on a special series of long-exposure photographs made for

Variable	Period *d.*	Median	Variable	Period *d.*	Median
1408	0.715	16.0	1823	0.795	16.0
1420	0.67*	16.4	1928	0.608	15.8
1634	0.81	15.6	1943	0.81*	16.2
1655	0.444:	16.2	1964	0.687*	16.1
1731	0.65	16.2	2002	0.702	16.4
1739	0.63*	16.4	3610	0.6	16.2
1741	0.400:	16.2			

the purpose at Arequipa. Further observation is necessary before definitive results can be given, but for the preceding variables provisional periods and median magnitudes have been obtained.

The numbers, except the last, are those published by Miss Leavitt. Colons indicate periods not well determined. For stars marked with an asterisk a multiple of the period given above satisfies the observations nearly or quite as well.

The light curves are in all cases of the typical cluster form. From the plates now available, the elements of variation could not be determined for some of the other faint stars, but for none do the observations demand a long period.

The median magnitudes are derived from published values of maximum and minimum, except that for No. 1741 which is a revised unpublished value derived by Miss Leavitt, and that for No. 3610—a hitherto unannounced variable. The medians are based on a provisional and apparently homogeneous system of magnitudes for the comparison stars. The standardization of these magnitudes is under way and will permit a new evaluation of the medians for the variable stars and a redetermination of the distance of the Small Magellanic Cloud.

The mean of the thirteen periods is 15.4 hours. The mean of the thirteen median magnitudes is 16.13 ± 0.05, in close agreement with the median magnitude, 16.2, predicted from the extended period-luminosity curve for variables of this period. We are led to the conclusion, even after making ample allowance for the provisional nature of the magnitude scale and for the uncertainties that affect some of the periods, that cluster type variables are giant stars in the Small Magellanic Cloud, as previously found for certain globular clusters. Naturally we infer that they are giants stars wherever they occur.

THE VITAL INDEX OF THE POPULATION OF ENGLAND AND WALES, 1838–1920[1]

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The senior author[2] has suggested the term "vital index" as a convenient designation of the function

$$V = \frac{100\ Births}{Deaths}$$

which measures more effectively than any other demographic function yet devised the essential biological fitness of a population, in the sense of organic evolution. For a population V is the direct measure of survival