for the study of bright line (nebular) spectra. But I can see *no good reason* why they should be preferred to the prism train in stellar spectroscopic work, with the compound spectroscope or spectrograph, for the chief arguments for their use in the case of the objective spectroscope (*i. e.*, the avoidance of loss of light by absorption in the large object-glass, and the possibility of making absolute wave-length measurements with them without the aid of a comparison spectrum) no longer hold in this class of work. It seems to me that in this case the prism train is much to be preferred, partly on the score of greater stability, but much more because it concentrates all the light in one spectrum. We lose a great deal of light by the absorption and diffusion of the large object-glass;[1] we lose still more at the jaws of the slit by reason of the constant shifting and blurring of the image by atmospheric disturbances, and there is not so much left, even when the largest telescope and the brightest stars are at our disposal, that we can afford (as we can in the case of the Sun) to waste it recklessly in the multiplication of useless and extraneous spectra.

F. L. O. WADSWORTH.

YERKES OBSERVATORY,
January 1898.

VARIABLE STAR CLUSTERS.[1]

SINCE the announcement made in *Circular* Nos. 2 and 18, of variables discovered in clusters, a further examination of the clusters ω Centauri, Messier 3, Messier 5, and *N. G. C.* 7078 has been made by Professor Bailey. As a result, the numbers of known variables in these clusters have been increased by 62, 19, 22, and 24 respectively, making the total numbers 122, 132, 85, and 51, or 390 in all four clusters. Adding to these the 47 already announced in other clusters, makes the total number 437.

NEW VARIABLE STARS.

When a new variable star is discovered at this Observatory it is the custom to collect all the photographs of the region containing it and to derive its photographic magnitude from each of them as described in the *H. C. O. Annals*, **26**, 250. We can thus determine its bright-

[1] Much more, probably, than we subsequently lose in the prism train if the material and refracting angle (see this JOURNAL, **2**, 264, November 1895) of the elements of the latter be properly chosen.

[1] *Harvard College Observatory Circular* No. 24.

ness on from twenty to a hundred or more nights distributed over the last ten years. The approximate dates of maxima, the corresponding magnitudes, the period and the form of light curve are also determined so far as possible. Examples of such results have already been published, but every year, owing to the increasing amount of material, the work becomes more laborious although at the same time more complete and exact. Many of these stars vary irregularly so that their elements cannot be determined precisely. When the object is not a catalogue star its position, and that of each of the fainter comparison stars must also be determined from measures of their rectangular coördinates. An attempt is then made to photograph each of these variables once a month, and, if possible, to obtain corresponding observations of their visual magnitudes. As the total number of variable stars discovered here is now more than a hundred, not including those found in clusters, the labor involved in this work is very great. Accordingly, it is difficult to deduce all the required data for one star before another is found. The accompanying table gives the material that has been so far collected for the variables recently discovered here from the Draper Memorial photographs.

Constellation	Designation	R.A. 1900	Dec. 1900	Type	No. Plates	Mag.		Discoverer
						Br.	Ft.	
		h *m*						
Eridanus	−16° 771	3 59.8	−16° 0′	III	35	8.3	9.4	M. Fleming
Eridanus	−25° 1766	4 7.3	−25 24	III	65	8.1	<12.5	M. Fleming
Monoceros....	− 8° 1641	6 52.5	− 8 56	III	43	8.1	10.3	M. Fleming
Puppis.....	−38° 4049	8 1.7	−38 29	IV	..	...	....	L. D. Wells
Puppis.....	−22° 2160	8 3.1	−22 38	IV	..	...	....	L. D. Wells
Hydra	− 5° 2550	8 24.7	− 5 59	III	..	...	....	M. Fleming
Carina	R	10 40.9	−58 54	...	149	9.6	10.7	L. D. Wells
Virgo.....	− 5° 3424	12 2.1	− 6 12	III	..	...	....	M. Fleming
Centaurus	.....	13 15.1	−61 3	III	..	...	....	M. Fleming
Apus.....	*A.G.C.* 19014	13 55.6	−76 19	III	..	...	....	———
Boötes	+14° 2700	14 1.7	+13 59	III?	..	...	....	L. D. Wells
Libra	−17° 4122	14 30.3	−17 36	II ?	38	8.3	9.6	E. F. Leland
Triang. Aust..	*A.G.C.* 20554	15 4.8	−69 42	IV	85	9.1	9.8	———
Serpens	+10° 2956	16 2.5	+10 12	III	41	9.0	<11.9	M. Fleming
Ara.....	*A.G.C.* 23005	16 54.3	−54 55	IV	..	...	....	L. D. Wells
Pavo.....	*A.G.C.* 23935	17 34.7	−57 40	IV	..	...	....	L. D. Wells
Pavo.....	.....	17 41.1	−62 23	III	65	9.1	<12.8	M. Fleming
Ara.....	.....	17 45.7	−51 40	III	..	...	....	M. Fleming
Cygnus	+32° 3522	19 37.1	+32 23	IV	..	...	....	L. D. Wells
Pavo.....	*A.G.C.* 27560	20 3.3	−60 14	III	..	...	....	M. Fleming
Capricornus ..	*A.G.C.* 27776	20 11.3	−21 38	IV	55	8.6	10.3	———
Microscopium.	−40° 13888	20 22.6	−40 45	III	70	8.5	<12.5	M. Fleming
Capricornus ..	−17° 6181	21 1.7	−16 49	III	79	8.1	9.3	M. Fleming
Aquarius	−14° 5960	21 7.3	−14 48	III	78	8.4	9.3	M. Fleming
Indus.....	*A.G.C.* 29232	21 13.6	−45 27	IV	..	...	....	L. D. Wells
Andromeda...	+47° 4318	23 50.3	+48 5	III	48	9.3	9.8	M. Fleming
Cassiopeia ...	.....	23 58.2	+55 7	III	101	9.8	<13.4	M. Fleming

R. A. $3^h\ 59^m.8$. Bright hydrogen lines suspected.

R. A. $4^h\ 7^m.3$. Hydrogen lines bright.

R. A. $6^h\ 52^m.5$. Hydrogen lines bright.

R. A. $8^h\ 1^m.7$. Found to be fourth type by Mrs. Fleming.

R. A. $8^h\ 24^m.7$. Bright hydrogen lines suspected.

R. A. $10^h\ 40^m.9$. This star is No. 119 on page 627 of the *Argentine General Catalogue.*

R. A. $12^h\ 2^m.1$. Bright hydrogen lines suspected.

R. A. $13^h\ 15^m.1$. Hydrogen lines bright. The position of this star for 1875 is R.A.$=13^h\ 13^m\ 31^s$, Dec.$=-60^\circ\ 55'$.

R. A. $13^h\ 55^m.6$. Bright hydrogen lines suspected. In the *Uranometria Argentina*, page 243, this star, which is θ Apodis, is stated to be variable. Discovered independently by Mrs. Fleming by means of its spectrum. The photographs show a variation of about one magnitude.

R. A. $15^h\ 4^m.8$. In *Argentine General Catalogue* "var.?" Discovered independently from photographic charts by Miss L. D. Wells.

R. A. $16^h\ 2^m.5$. Hydrogen lines bright.

R. A. $17^h\ 41^m.1$. Hydrogen lines bright. The position of this star for 1875 is R.A.$=17^h\ 38^m\ 45^s$, Dec.$=-62^\circ\ 21'.6$.

R. A. $17^h\ 45^m.7$. Hydrogen lines bright. The position of this star for 1875 is R.A.$=17^h\ 43^m\ 42^s$, Dec.$=-51^\circ\ 39'.2$.

R. A. $20^h\ 3^m.3$. Bright hydrogen lines suspected.

R. A. $20^h\ 11^m.3$. Suspected of variability by Secchi and others. Found independently from the photographs by Miss L. D. Wells.

R. A. $20^h\ 22^m.6$. Hydrogen lines bright. Maxima represented by formula, $2410860 + 325\ E$.

R. A. $23^h\ 50^m.3$. Bright hydrogen lines suspected.

R. A. $23^h\ 58^m.2$. Hydrogen lines bright. The position of this star for 1855 is R.A.$=23^h\ 55^m\ 53^s$, Dec.$=+54^\circ\ 52'.3$.

In *Circular* No. 10 the variability of $-27^\circ\ 15202$ (erroneously printed 15203) suspected by Thome was confirmed by Miss E. F. Leland. Measures of 35 photographs give the maximum brightness 8.9, minimum <12.3.

In *Circular* No. 17 the variability of a star in R.A.$=0^h\ 25^m.6$, Dec. $=-46^\circ\ 58'$ (1900) is announced. Measures of 26 photographs give the maximum brightness 9.0, minimum <12.2.

In *Circular* No. 17 the variability of a star in R.A. $=13^h\ 31^m.1$, Dec. $=-55^\circ\ 58'$ (1900) is announced. Measures of 42 photographs give the maximum brightness 9.0, minimum <12.6.

In *Circular* No. 17 the variability of a star in R.A. = $20^h\ 8^m.5$, Dec. = $-44^\circ\ 43'$ (1900) is announced. Measures of 114 plates give the maximum brightness 9.0, minimum <11.4.

In *Circular* No. 19 the variability of a star in R.A. = $5^h\ 18^m.9$, Dec. = $-69^\circ\ 21'$ (1900) is announced. Measures of 51 photographs give the maximum brightness 8.2, minimum 9.4.

EDWARD C. PICKERING.

January 31, 1898.

POLARIZING PHOTOMETERS.[1]

NEARLY all of the photometric measurements obtained at the Harvard College Observatory during the last twenty years have been made with modifications of three forms of photometers which are identical in principal. The first of these is described in the *Annals*, Vol. XI, Part I, and was used for the observations contained in that publication. The second, the meridian photometer, furnished the observations contained in the *Annals*, Vols. XIV, XXIII, XXIV, and XXXIV. The third photometer is described in the ASTROPHYSICAL JOURNAL, **2**, 89. In all of these instruments the star to be measured is compared directly with another star by means of a double image prism and Nicol. In the first instrument, the images of two adjacent stars are brought together by a double image prism ; in the second, images of two stars, however distant, are brought together by reflecting them by prisms or mirrors into two object-glasses ; in the third photometer, images formed by a large telescope, of two stars not more than half a degree apart, are brought together by achromatic prisms.

An objection to the first form of photometer is that the emergent pencils of the images compared do not coincide. Small errors may therefore be introduced by irregularities in the cornea of the eye of the observer, or if he holds his eye in such a position that a portion of one image will be cut off by the edge of the pupil. This difficulty has recently been remedied by placing a second double image prism in the focal plane of the telescope, so that it does not affect the position of the two images but makes the emergent pencils coincide. A surprising degree of accuracy may then be obtained in the measures. Comparisons of the star o Ceti with the adjacent star $-3^\circ 355$, which follows it about 10^s, have been made by Mr. O. C. Wendell with the

[1] *Harvard College Observatory Circular* No. 25.