

Of the 225 lines measured in the ultra-violet region of the spectrum only 29 remain unidentified.

The hydrogen spectrum.—Twenty-eight hydrogen lines are shown in spectrum No. 3. The wave-lengths obtained are compared in Table III with the theoretical values derived from Balmer's formula. With the exception of $H\delta$, which seems to be unaccountably displaced towards the red, the wave-lengths of the ultra-violet lines are found to agree closely with the formula. A slight deviation occurs in the most refrangible lines, the positions of which seem to be distinctly more refrangible than those assigned by theory.

The continuous spectrum given by the prominences in the ultra-violet, beginning at the end of the hydrogen series, seems analogous to a feature noticed by Sir William Huggins in the absorption spectra of first type stars, and is possibly due to hydrogen.

Hydrogen and helium in the lower chromosphere.—From the character of some of the helium lines it is inferred that this element is probably absent from the lowest strata, whilst parhelium appears to be separated from helium, and to exist at a lower level.

Unlike helium, hydrogen gives very intense lines in the flash layer. These lines are well defined and narrow, even in the very lowest strata.

Reasons are given to show that the absence of hydrogen absorption in the ultra-violet, and of helium absorption in the visible spectrum, may be due to insufficient quantity of these elements above the photosphere, not to equality of temperature between the radiating gas and photospheric background.

The corona spectrum.—The wave-length of the green line deduced from measures of No. 3 and No. 7 spectra confirms the value obtained by Sir Norman Lockyer at the same eclipse. The only other lines shown on these photographs are at λ 3388 and near H.

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SIXTY-FOUR NEW VARIABLE STARS.¹

THE photographs of the Henry Draper Memorial continue to furnish great numbers of new variable stars. A large part of those enumerated below were found from the presence of bright hydrogen

¹Harvard College Observatory Circular No. 54.

lines in their spectra. Many stars whose spectra are of the fourth type also prove to be variable. These variables have been divided into two classes. First, those in which the variation is so great that it is obvious to the most inexperienced observer. Secondly, those in which the variation so far detected is small, about half a magnitude to a magnitude. In each of these cases, two or more experienced observers, who are accustomed to accurate measures of photographic brightness, are satisfied that the change is real. We have here a case like the confirmation visually by a second observer, since so many plates of each variable are examined, generally a dozen or more, that on several the star is bright, and on several, faint. There seems to be no way in which these changes can be rendered more evident, and owing to the redness of many of the stars it is doubtful if visual observations would be more conclusive. Perhaps photometric measures, which appear to be less influenced by color, or photographs taken with a reflector might be employed to advantage. Owing to the accidental errors, additional measures add but little to the certainty of variation, which is best shown by comparing two plates, on one of which the variable is bright, on the other, faint. It seems best therefore to publish the positions of these stars, hoping that by further observations the laws governing their changes may be learned. In both tables, the name of the constellation is given in the first column. For northern stars, the boundary of the constellations is taken from the *Atlas Cælestis Novus* of Heis, and for southern stars from the *Uranometria Argentina*. The catalogue designation, if any, is given in the second column. The approximate right ascension and declination for 1900 are given in the third and fourth columns. The class of spectrum is given in the fifth column. Following the notation of the *Draper Catalogue*, Mc is used to denote a spectrum of the third type like that of α *Ceti* at minimum. Md denotes a similar spectrum in which, however, the hydrogen lines are bright as in α *Ceti* at maximum. Intermediate spectra are indicated by Mc 5 d. N denotes a spectrum of the fourth type, and Pec. that the spectrum is peculiar. The name of the discoverer is given in the sixth column. A few remarks on individual stars follow Table II. Each is preceded by the right ascension for 1900.

TABLE I.
VARIABLES HAVING LARGE RANGE.

Constellation	Designation	R. A. 1900	Dec. 1900	Class	Discoverer
<i>Chamaleon</i>	Z. C. 8 ^h 2054	8 ^h 24. ^m 1	-76° 2'	Md	W. P. Fleming
<i>Carina</i>	.....	9 18.2	-68 20	Md	W. P. Fleming
<i>Vela</i>	A. G. C. 13539	9 51.3	-41 7	N	L. D. Wells
<i>Antlia</i>	A. G. C. 14440	10 30.8	-39 3	N	L. D. Wells
<i>Carina</i>	.....	10 33.2	-61 48	....	E. C. Pickering
<i>Centaurus</i>	Z. C. 11 ^h 129	11 2.9	-54 35	N	L. D. Wells
<i>Virgo</i>	-18° 3660	13 36.3	-18 38	....	L. D. Wells
<i>Lupus</i>	Z. C. 14 ^h 3225	14 52.6	-53 0	N	W. P. Fleming
<i>Lupus</i>	.....	15 8.5	-50 25	....	E. C. Pickering
<i>Circinius</i>	.....	15 20.0	-57 22	Md ?	W. P. Fleming
<i>Norma</i>	Z. C. 16 ^h 59	16 2.6	-48 58	Md ?	W. P. Fleming
<i>Norma</i>	A. G. C. 21999	16 9.0	-52 21	Md ?	W. P. Fleming
<i>Norma</i>	-51° 10147	16 17.7	-51 42	N	W. P. Fleming
<i>Triang. Austr.</i>	Gilliss 12037	16 39.8	-67 36	N	W. P. Fleming
<i>Scorpius</i>	-43° 11672	17 18.1	-43 44	Md	W. P. Fleming
<i>Scorpius</i>	-35° 11923	17 40.8	-35 40	N	W. P. Fleming
<i>Ophiuchus</i>	-6° 4661	17 44.8	-6 40	....	W. P. Fleming
<i>Ara</i>	-48° 12145	17 47.3	-48 17	Md	W. P. Fleming
<i>Ara</i>	-49° 11810	17 49.2	-49 46	Mc	W. P. Fleming
<i>Corona Austr.</i>	-39° 12196	17 58.2	-39 20	N	W. P. Fleming
<i>Corona Austr.</i>	.....	18 2.6	-45 26	Mc	W. P. Fleming
<i>Corona Austr.</i>	.....	18 7.2	-42 53	Md	W. P. Fleming
<i>Telescopium</i>	.....	18 19.0	-49 42	Md	W. P. Fleming
<i>Sagittarius</i>	-16° 4904	18 24.6	-16 59	N	W. P. Fleming
<i>Scutum</i>	-8° 4726	18 44.9	-8 1	N	L. D. Wells
<i>Scutum</i>	-8° 4764	18 50.0	-8 19	N	W. P. Fleming
<i>Sagittarius</i>	.....	18 55.9	-12 54	Md	W. P. Fleming
<i>Sagittarius</i>	-22° 4958	18 57.7	-22 51	Mc	W. P. Fleming
<i>Telescopium</i>	.....	19 0.5	-49 4	Md	W. P. Fleming
<i>Telescopium</i>	C. P. D. -50° 11027	19 10.5	-50 38	Md ?	W. P. Fleming
<i>Lyra</i>	+42° 3338	19 22.2	+42 36	....	W. P. Fleming
<i>Telescopium</i>	.....	19 43.1	-50 15	Md	W. P. Fleming
<i>Telescopium</i>	.....	20 11.2	-52 56	Md	W. P. Fleming
<i>Telescopium</i>	-51° 12487	20 12.9	-51 1	Mc 5 d	W. P. Fleming
<i>Cygnus</i>	.....	21 35.7	+42 45	....	H. R. Colson
<i>Aquarius</i>	-22° 5901	22 17.7	-22 35	Md ?	W. P. Fleming
<i>Piscis Austr.</i>	A. G. C. 30605	22 20.5	-29 35	...	W. P. Fleming
<i>Andromeda</i>	+48° 4093	23 28.8	+48 16	Md ?	W. P. Fleming
<i>Pegasus</i>	+25° 5054	23 55.0	+25 21	Md ?	W. P. Fleming

TABLE II.
VARIABLES HAVING SMALL RANGE.

Constellation	Designation	R. A. 1900	Dec. 1900	Class	Discoverer
<i>Hydrus</i>	.....	2 ^h 10 ^m .4	-71° 57'	Mc 5 d	W. P. Fleming
<i>Hydrus</i>	<i>A. G. C.</i> 2634	2 26.3	-69 58	Mc 5 d	W. P. Fleming
<i>Cetus</i>	<i>A. G. C.</i> 2859	2 37.4	-23 2	Mc 5 d	W. P. Fleming
<i>Horologium</i>	<i>Z. C.</i> 2 ^h 1104	2 41.2	-54 44	Mc	W. P. Fleming
<i>Eridanus</i>	-1° 546	3 46.4	- 1 41	Mc 5 d	W. P. Fleming
<i>Puppis</i>	<i>A. G. C.</i> 8954	7 1.7	-35 47	Mc 5 d	W. P. Fleming
<i>Canis Major</i>	-11° 1805	7 3.4	-11 46	N	W. P. Fleming
<i>Lynx</i>	+46° 1271	7 20.9	+46 10	Mc	W. P. Fleming
<i>Hydra</i>	- 8° 2343	8 19.6	- 8 11	Mc 5 d	W. P. Fleming
<i>Hydra</i>	- 9° 2612	8 34.9	- 9 14	Mc 5 d	W. P. Fleming
<i>Virgo</i>	- 8° 3329	12 15.2	- 8 27	Md?	W. P. Fleming
<i>Centaurus</i>	<i>A. G. C.</i> 17944	13 6.3	-56 28	....	L. D. Wells
<i>Virgo</i>	- 2° 3653	13 8.9	- 2 16	Mc 5 d	W. P. Fleming
<i>Chamaeleon</i>	<i>A. G. C.</i> 18352	13 24.6	-77 3	....	W. P. Fleming
<i>Lupus</i>	<i>Z. C.</i> 14 ^h 970	14 16.9	-47 4	N	W. P. Fleming
<i>Norma</i>	-50° 10442	16 14.6	-50 14	Md	W. F. Fleming
<i>Serpens</i>	-15° 4923	18 13.6	-15 39	N	W. P. Fleming
<i>Corona Austr.</i>	.....	18 23.7	-45 2	Md	W. P. Fleming
<i>Telescopium</i>	-48° 12910	19 0.1	-48 44	Mc	W. P. Fleming
<i>Sagittarius</i>	-16° 5360	19 28.6	-16 35	N	L. D. Wells
<i>Sagittarius</i>	<i>C. P. D.</i> -41° 9189	19 40.6	-41 26	Mc 5 d	W. P. Fleming
<i>Sagittarius</i>	<i>A. G. C.</i> 27520	20 0.8	-27 31	Mc 5 d	W. P. Fleming
<i>Octans</i>	<i>Gilliss</i> 15580	22 5.7	-85 10	Mc 5 d	W. P. Fleming
<i>Aquarius</i>	-18° 6299	23 19.2	-17 52	Pec.	W. P. Fleming
<i>Cassiopeia</i>	+56° 3111	23 49.4	+56 56	Pec.	L. D. Wells

- 7^h 20^m.9 The variation, although small, has been confirmed by two other observers, and is indicated by observations with the meridian photometer.
- 10 33.2 Found by superposing an original negative on a contact print from another negative taken on a different date.
- 15 8.5 Found by superposing an original negative on a contact print from another negative taken on a different date.
- 7 40.8 This star is *C. P. D.* -35°7243. Innes has announced the variability of -35°7270, which follows 51^s.9, south 0'.1. *A. J.*, 20, 59, 95.
- 18 44.9 "Probably a variable of the *19 Piscium* type" in Espin's Catalogue of Red Stars, *Cunningham Memoirs*, No. V, 75. Discovered also independently by Mrs. Fleming.
- 19 22.2 Found by inspection of a photograph taken as described in *Circular* No. 29. Thirteen exposures of 29^m 40^s each were made on July 13, 1899, stopping the clock automatically for 20^s after each exposure. This variable is mentioned in the Fifty-fourth Annual Report. Photometric measures show that its maxima are represented by the formula, *J. D.* 2,414,856^d.500 + 0^d.5668 *E.* Range 0.83 magnitudes.

- 21 35.7 Discovered visually during observations of *SS Cygni*.
 23 49.4 This star is ρ *Cassiopeia*. The variation, although small has been confirmed by four other observers. The spectrum closely resembles that of the second type.

Measures have been made of a number of the stars in the above tables and also of those announced without magnitudes in previous circulars. The right ascension and declination for 1900, the number of plates examined, and the brightest and faintest photographic magnitudes, are given in the successive columns of Table III. The last column gives the authority for the variability.

TABLE III.
PHOTOGRAPHIC MAGNITUDES.

R. A.	Dec.	No.	Br.	Ft.	Authority	R. A.	Dec.	No.	Br.	Ft.	Authority
2 ^h 10. ^m 4	-71° 57'	75	9.6	10.5	Table II	16 ^h 54. ^m 3	-54° 55'	50	9.9	11.0	<i>Circular 24</i>
2 37.4	-23 2	68	7.7	8.6	Table II	17 34.7	-57 40	43	8.3	9.8	<i>Circular 24</i>
6 28.1	- 8 48	54	9.0	10.1	<i>Circular 32</i>	17 45.7	-51 40	56	8.9	12.4	<i>Circular 24</i>
8 1.7	-38 29	47	0.3	10.2	<i>Circular 24</i>	17 47.3	-48 17	134	9.7	< 12.3	Table I
8 3.1	-22 38	23	9.4	11.6	<i>Circular 24</i>	18 13.6	-15 39	...	8.5	9.1	Table II
8 24.7	- 5 59	48	8.0	9.6	<i>Circular 24</i>	18 19.0	-49 42	129	11.3	< 12.7	Table I
8 34.9	- 9 14	70	7.7	9.0	Table II	18 23.7	-45 2	107	11.9	12.6	Table II
9 13.5	-65 49	116	10.9	12.1	<i>Circular 32</i>	19 10.5	-50 38	113	9.2	10.6	Table I
10 8.3	+60 31	76	7.0	8.3	<i>Circular 32</i>	19 22.2	+42 36	191	7.2	8.1	Table I
10 33.2	-61 48	210	10.1	< 12.5	Table I	19 37.1	+32 23	58	8.7	10.3	<i>Circular 24</i>
11 59.6	- 5 13	77	7.2	8.8	<i>Circular 32</i>	20 3.3	-60 14	75	9.0	10.2	<i>Circular 24</i>
12 2.1	- 6 12	80	7.1	8.3	<i>Circular 24</i>	20 11.2	-52 56	91	10.5	12.9	Table I
13 15.1	-61 3	55	10.5	11.3	<i>Circular 24</i>	20 12.9	-51 1	124	8.1	9.7	Table I
14 1.7	+13 59	30	10.0	13.0	<i>Circular 24</i>	21 13.6	-45 27	83	7.2	8.9	<i>Circular 24</i>
16 17.7	-51 42	102	11.0	< 12.3	Table I	23 19.2	-17 52	73	8.3	< 9.4	Table II

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THE SPECTRUM OF ζ PUPPIS.¹

THE presence of a second series of hydrogen lines, in addition to the ordinary series, in the spectrum of ζ *Puppis*, was announced in *Circulars* Nos. 12, 16, and 18. Accurate wave-lengths could not then be determined for the less refrangible lines. Since then, measures have been made of six photographs of spectra of ζ *Puppis*, and two of spectra of δ *Orionis*. The measurements have been made by Miss F. Cushman, and the conversion into wave-lengths, by Mr. Edward S. King, with the assistance of Miss Cannon. This work will be pub-

¹ *Harvard College Observatory Circular* No. 55.