21 35.7 Discovered visually during observations of *SS Cygni.*

23 49.4 This star is ρ *Cassiopeiæ*. 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	*Circular* 24
2 37.4	−23 2	68	7.7	8.6	Table II	17 34.7	−57 40	43	8.3	9.8	*Circular* 24
6 28.1	− 8 48	54	9.0	10.1	*Circular* 32	17 45.7	−51 40	56	8.9	12.4	*Circular* 24
8 1.7	−38 29	47	0.3	10.2	*Circular* 24	17 47.3	−48 17	134	9.7	<12.3	Table I
8 3.1	−22 38	23	9.4	11.6	*Circular* 24	18 13.6	−15 39	...	8.5	9.1	Table II
8 24.7	− 5 59	48	8.0	9.6	*Circular* 24	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	*Circular* 32	19 10.5	−50 38	113	9.2	10.6	Table I
10 8.3	+60 31	76	7.0	8.3	*Circular* 32	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	*Circular* 24
11 59.6	− 5 13	77	7.2	8.8	*Circular* 32	20 3.3	−60 14	75	9.0	10.2	*Circular* 24
12 2.1	− 6 12	80	7.1	8.3	*Circular* 24	20 11.2	−52 56	91	10.5	12.9	Table I
13 15.1	−61 3	55	10.5	11.3	*Circular* 24	20 12.9	−51 1	124	8.1	9.7	Table I
14 1.7	+13 59	30	10.0	13.0	*Circular* 24	21 13.6	−45 27	83	7.2	8.9	*Circular* 24
16 17.7	−51 42	102	11.0	<12.3	Table I	23 19.2	−17 52	73	8.3	< 9.4	Table II

EDWARD C. PICKERING.

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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.

lished in full in a later volume of the *Annals*. Following the notation proposed by Vogel for the ordinary series of hydrogen lines, the new series may be designated, $H\alpha'$, $H\beta'$, $H\gamma'$, etc. The great difficulty in determining the wave-length of $H\beta'$ which is approximately 5414, is that no known lines of greater wave-length have been found in the spectrum of ζ *Puppis*. Accordingly, extrapolation, which is always uncertain, must be employed. The star, δ *Orionis*, besides the line $H\beta'$, contains also the known line D_3, wave-length 5876, which thus permits the wave-length of $H\beta'$ to be determined by interpolation. These lines also occur in ϵ *Orionis*, and probably in other stars of the so-called *Orion* type. It is greatly to be desired that the spectra of these stars should be photographed with a slit spectroscope attached to a large telescope, as the wave-lengths of these lines could then be determined with far greater accuracy by the help of a comparison spectrum. A comparison of the mean of the wave-lengths given in *Circular* No. 16, with those recently determined, and with two computed values, is given in the following table. The first of these is given in *Circular* No. 16, and is a slight modification of Balmer's formula. It is $3646.1 \frac{n^2}{n^2 - 16}$, in which n is an even number for the ordinary series of hydrogen lines, and an odd number for the additional series. The second formula is $\frac{1}{\lambda} = A + B\frac{1}{m^2} + C\frac{1}{m^4}$. This form was proposed by Kayser, immediately after the announcement of the discovery of this series of lines. If we accept this formula, it would appear to be the true law connecting their wave-lengths, and would render them comparable with those of other elements. The designation of the lines is given in the first column of the following table, the mean of the observed wave-lengths given in *Circular* No. 16 is contained in the second column, and the wave-lengths derived by Mr. King in the third column. The next four columns give the value of n, taken from the sixth column of the table in *Circular* No. 16, and computed wave-lengths taken from the seventh column of the same table, and the residuals found by subtracting the computed values from the observed values given in the second and third columns. A similar comparison with the formula $\frac{1}{\lambda} = 27461 - 121790 \frac{1}{m^2} - 352010 \frac{1}{m^4}$, is contained in the last four columns of the table.

Des.	Cir. 16	Obs.	n	Comp.	O–C	O–C	m	Comp.	O–C	O–C
$H\alpha'$	......	......	5	10128.1	.....	.....	3	10435.2	.....	.....
$H\beta'$	......	5413.6	7	5413.9	.....	−0.3	4	5413.0	.....	+0.6
$H\gamma'$	......	4542.4	9	4543.6	.....	−1.2	5	4540.1	.....	+2.3
$H\delta'$	4200.6	4200.7	11	4201.7	−1.1	−1.0	6	4200.6	0.0	+0.1
$H\epsilon'$	4026.3	4026.0	13	4027.4	−1.1	−1.4	7	4027.5	−1.2	−1.5
$H\zeta'$	3924.8	3924.0	15	3925.2	−0.4	−1.2	8	3925.8	−1.0	−1.8
$H\eta'$	3858.6	3860.8	17	3859.8	−1.2	+1.0	9	3860.6	−2.0	+0.2
$H\theta'$	3816.0	3815.7	19	3815.2	+0.8	+0.5	10	3815.4	+0.6	+0.3
$H\iota'$	3783.4	......	21	3783.4	0.0	.....	11	3782.1	+1.3	.....
	......	......	∞	3646.1	.....	.....	∞	3641.5	.....	.....

It will be noticed that the two computed values do not differ very greatly for any of the observed lines. The difference is greatest for $H\gamma'$, and here the observed value is nearly midway between the two computed values. On the whole, the observed values agree more nearly with the first formula, than with the second. This is remarkable, if it does not represent the true law, since this formula contains no arbitrary constants. There is only one constant, and that is determined with great accuracy from the ordinary series of hydrogen lines. The second formula contains three arbitrary constants which are selected so as to represent the observed values as nearly as possible. A least square determination was not considered necessary, since the outstanding differences from observation were evidently systematic, and not accidental. The wave-length when m or n is infinite, could be accurately measured, but unfortunately these lines, like those of the ordinary series, do not appear to be present in the stars. The wave-length of the line $H\alpha'$ differs greatly according to the two formulæ, but no means as yet exist for determining radiations of such great wave-length in a star.

EDWARD C. PICKERING.

CAMBRIDGE, U. S.
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NOVA PERSEI, NO. 2.[1]

THE early observations made here, of the new star in *Perseus*, are described in *Circular* No. 56. This star may be designated *Nova Persei*, No. 2, to distinguish it from the star in R. A. $1^h\,55^m\!.1$, Dec. $+56°\,15'$, which appeared in this constellation in 1887. A photograph

[1] *Harvard College Observatory Circular* No. 57.