

## EIGHT STARS WHOSE RADIAL VELOCITIES VARY.

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OUR current observations of stars of the *Orion* type indicate that the following eight stars vary in their velocity in the line of sight. The variation of three of these was suspected<sup>1</sup> from the examination of the plates taken last season with a dispersion of three prisms; but the diffuse character of the lines rendered the measurements with high dispersion very difficult, and with a dispersion of only one prism the determinations are by no means easy or precise.

These measurements, and all others that we have published for stars of the *Orion* type, are to be regarded as merely provisional, since the wave-lengths of certain of the stellar lines (particularly those of silicon) have as yet been only approximately determined in the laboratory, and certain other lines (especially those of hydrogen at  $\lambda 4542$  and  $\lambda 4686$ ) have not been seen in the laboratory. We expect to be able to publish later fairly accurate wave-lengths of these hydrogen lines, as determined from the stars, since we always measure them when sufficiently sharp to be set upon in a stellar spectrum. When we are able to utilize these measures, which we have not yet done, the accuracy of the radial velocities will be appreciably increased.

We defer until a later communication the measures of the velocities of  $\theta^1$  and  $\theta^2$  *Orionis*, of which we are obtaining as many plates as possible, as the stars promise to be of especial interest. We have been able to secure measurable plates of the other brighter stars of the trapezium besides  $\theta^1$ , which at the same time yield values of the radial velocity of the *Orion* nebula.

The magnitudes given are from the Revised *Harvard Photometry*.

<sup>1</sup> ASTROPHYSICAL JOURNAL, 17, 246, 1903.

*g Persei* ( $\alpha = 1^{\text{h}} 56^{\text{m}}$ ;  $\delta = +54^{\circ} 0'$ ; Mag. = 5.0).

Plate	Date	G. M. T.	Taken by	Velocity		No. of Lines		Velocity Mean
				F.	A.	F.	A.	
				km	km			km
IB 176	1903, Nov. 7	15 <sup>h</sup> 41 <sup>m</sup>	F.	-21	-27	3	3	-24
191	Nov. 17	12 56	A.	-19	-21	3	3	-20
200	Dec. 1	13 43	F. A.	-13	-10	3	4	-12
260	1904, Jan. 23	14 45	A.	+8	+12	3	5	+10

The hydrogen lines  $\gamma$  and  $\beta$  and  $Mg \lambda 4481$  are quite sharp in the spectrum of this star, and are well adapted for measurement. The helium lines are not conspicuous. The hydrogen lines at  $\lambda 4542$  and  $\lambda 4686$  are present, but faint.

*$\epsilon$  Persei* ( $\alpha = 3^{\text{h}} 51^{\text{m}}$ ;  $\delta = +39^{\circ} 43'$ ; Mag. = 3.0).

Plate	Date	G. M. T.	Taken by	Velocity		No. of Lines		Velocity Mean
				F.	A.	F.	A.	
				km	km			km
IB 180	1903, Nov. 7	19 <sup>h</sup> 38 <sup>m</sup>	F.	-3	-5	4	4	-4
192	Nov. 17	13 36	A.	-26	-30	3	5	-28
202	Dec. 1	15 20	F. A.	-29	-19	4	3	-24
228	Dec. 26	19 3	F.	+15	-3	3	4	....
261	1904, Jan. 23	15 23	A.	-18	-2	3	5	....

In this spectrum the hydrogen and helium lines are broad and diffuse, and the two plates taken in 1901 with three prisms offered little hope of successful measurement. There is a considerable difference in the appearance of the same lines on the different plates of series IB, and it is quite likely that the lines are complex. This gives the effect of maxima of intensity within the broad lines, and in some cases the two observers have evidently not set upon the same point in a line, whence the resulting radial velocities for the two observers are quite widely discrepant. The combination of the results into a single mean would in such a case evidently be incorrect, as the lines dealt with are not the same for the two observers. Accordingly, where instances of this sort are encountered, as in IB.228 and 261 of the table above, we have left blank spaces in the mean velocity column. We consider, however, that the range shown

by the other plates of the star is sufficient to establish the variation, quite apart from the evidence in the same direction afforded by the complexity and changes in the lines themselves.

$\theta^1$  *Orionis* ( $\alpha = 5^h 30^m$ ;  $\delta = -5^\circ 27'$ ; Mag. = 4.8).

The measurement of the hydrogen lines in the spectrum of this star is complicated by the superposition of the bright nebular lines. A similar effect is apparent at the helium line  $\lambda 4472$ , where at least one bright line is present, and there is some evidence of further complexity, although in this case the bright line may belong to the star and not to the nebula. We shall discuss this matter, as well as other interesting features of the spectrum of this star and other stars in the trapezium, in a later paper.

The range in velocity which we have so far found for this star amounts to over 60 km.

$\theta^2$  *Orionis* ( $\alpha = 5^h 30^m$ ;  $\delta = -5^\circ 29'$ ; Mag. = 5.3).

This star is Bond 685, and follows the trapezium about  $6^s$ , south  $100''$ . The hydrogen and helium lines are broad and diffuse, and hard to set upon, though not complicated by nebular lines. A range of about 140 km in the radial velocity is indicated on the first four plates. The details of the measurements will be communicated later.

$\sigma$  *Orionis* ( $\alpha = 5^h 34^m$ ;  $\delta = -2^\circ 39'$ ; Mag. = 3.8).

Plate	Date	G. M. T.	Taken by	Velocity		No. of Lines		Velocity Mean
				F.	A.	F.	A.	
				km	km			km
IB 210	1903, Dec. 1	20 <sup>h</sup> 55 <sup>m</sup>	F. A.	+17	+20	3	4	+18
222	Dec. 25	20 28	A.	+31	+38	3	3	+35
250	1904, Jan. 2	18 14	A.	+16	+11	5	4	+14

Two plates of this star taken early in 1903 with a dispersion of three prisms led to a suspicion of variability in its velocity. The plates, however, were not well adapted to measurement, and no attempt was made to measure them in other than an approximate way. In the list given above all of the plates are noted as good. The spectrum is characterized mainly by the strength of

its helium lines, which are, in most cases, fairly well defined. There appear on one or two plates to be evidences of complexity in the spectrum, but these are scarcely sufficient to justify conclusions on the subject.

$\xi$  Orionis ( $\alpha = 6^h 6^m$ ;  $\delta = +14^\circ 14'$ ; Mag. = 4.4).

Plate	Date	G. M. T.	Taken by	Velocity		No. of Lines		Velocity Mean
				F.	A.	F.	A.	
				km	km			km
IB 184	1903, Nov. 7	22 <sup>h</sup> 53 <sup>m</sup>	F.	+13	-8	3	4	....
264	1904, Jan. 23	17 47	F. A.	+46	+34	3	5	+40
275	Jan. 29	15 8	A.	+18	+18	4	4	+18

In the case of this star also the first evidences of variability were furnished by two plates taken early in 1893 with a dispersion of three prisms. Under high dispersion, however, the lines in the spectrum are so excessively diffuse and vague as to render measurement practically impossible. The plates taken with one prism which are entered in the list above show a very great improvement in this respect; yet, in spite of this, accurate measurement is extremely difficult, and the results given are subject to considerable uncertainty.

$S$  Monocerotis ( $\alpha = 6^h 36^m$ ;  $\delta = +9^\circ 59'$ ; Mean Mag. 4.6).

Plate	Date	G. M. T.	Taken by	Velocity		No. of Lines		Velocity Mean
				F.	A.	F.	A.	
				km	km			km
A 307	1902, Jan. 8	20 <sup>h</sup> 15 <sup>m</sup>	A.	+35	+32	3	3	+33
B 276	Jan. 16	15 41	A.	+25	+34	3	3	+28
A 437	1903, April 16	15 7	F. A.	+31	+41	2	4	+36
IB 189	Nov. 14	23 23	A.	+22	+17	3	3	+19
236	Dec. 27	15 34	A.	+8	+14	3	3	+11

The investigation of the spectrum of this well-known variable star was begun by us about two years ago, but the variation in its velocity was not established with certainty until quite recently. The spectrum is characterized by broad, strong helium lines, traces of a few oxygen and nitrogen lines, and by the prominence of the two lines of hydrogen at  $\lambda 4542$  and  $\lambda 4686$ . The last two

lines have been measured upon all of the plates, and when we have more accurate values of their wave-lengths their use will assist materially in increasing the accuracy of the velocity determinations. The results given above may, accordingly, be modified sensibly when these lines come to be included. We are not as yet in possession of sufficient data to draw any conclusions as to the relation between the period of the light variation and that of the velocity variation.

$\eta$  *Hydrae* ( $\alpha = 8^h 38^m$ ;  $\delta = +3^\circ 46'$ ; Mag. = 4.3).

Plate	Date	G. M. T.	Taken by	Velocity		No. of Lines		Velocity Mean
				F.	A.	F.	A.	
B 490	1903, Feb. 4	16 <sup>h</sup> 56 <sup>m</sup>	F.	km	km			km
IB 214	Dec. 1	23 20	F. A.	+ 5	+ 2	3	3	+ 4
225	Dec. 25	23 22	A.	+10	+ 1	5	5	+ 6
				+26	+26	6	6	+26

We expressed, in March 1903, our suspicion of a variation in the velocity of this star. This has been confirmed by our recent plates. Among the early plates, three, which were obtained under very unfavorable conditions, were too weak for more than rough measurement, and are not included in the list above. The spectrum is difficult of measurement, and there appear to be evidences of the presence of maxima in some of the lines.

The plates measured by Frost in this paper were reduced by Miss Emily E. Dobbin.

YERKES OBSERVATORY,  
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