THE ORBIT OF THE SPECTROSCOPIC BINARY η *ORIONIS.*

By Walter S. Adams.

The variation in the radial velocity of η *Orionis* was discovered at the Yerkes Observatory in December of 1901, and announced at the Washington meeting of the Astronomical and Astrophysical Society during that month. The star has been on the regular observing list since that time, and sufficient material has been secured to make an accurate determination of its orbit possible.

The star belongs to the class of binaries in which one component is relatively dark, as no certain evidence of superposed spectra has been found on any of the photographs. The spectrum is that of the *Orion* type, but contains, in addition to the regular helium and hydrogen lines, three silicon lines, and a number of lines due to oxygen and nitrogen which have proved of great value in determining the star's velocity. In general the lines may be said to be slightly better for purposes of measurement than in the case of the average star of this type, though still rather ill-defined and diffuse. At some points in the star's orbit the change in its radial velocity is so rapid as to amount to several kilometers in the course of the exposure required to photograph the spectrum, and this, no doubt, influences to a considerable degree the character of the lines upon the plates taken at such times.

The number of lines measured upon the different plates varies considerably, but in the great majority of cases is from eight to ten. A careful examination of the cases in which more or less lines have been measured has led to the conclusion that any attempt to make a distinction in the weight given to a plate according to the number of its lines would be fully as liable to introduce error as to eliminate it, and accordingly unit weight has been assigned in each case. So far as the individual lines are concerned, however, the method has been adopted of assigning a weight to each line at the time of measurement, representing in the judgment of the observer the accuracy with which the line is measured. As the weights are assigned previous to any knowledge of the velocity values given by the different lines, this procedure is free from any tendency to be influenced by these values in giving the weights.

To illustrate the amount of range shown by the different lines, the results of the measures of two of the plates are given in full below. These plates are taken at random, one from among the earlier observations, and one from among the observations of the past few months, and are of an average quality.

B 269 1902, January 9, G. M. T. 13^h 38^m			B 448 1902, November 6, G. M. T. 18^h 28^m		
Line	Velocity	Weight	Line	Velocity	Weight
4340.634	+188.9km	2	4345.677	−50.7km	2
4349.541	187.8	1	4367.012	45.5	2
4388.100	199.3	2	4415.076	57.4	3
4415.076	190.0	2	4417.121	52.0	3
4417.121	191.4	2	4471.676	54.2	3
4471.676	195.1	2	4481.400	55.6	2
4552.750	198.4	3	4552.750	57.6	2
4574.900	191.6	1	4567.950	49.0	2
4591.066	192.2	1	4574.900	52.2	2
4649.250	188.8	2	4591.066	56.6	2
4713.308	189.3	3	4596.291	55.3	2
Weighted Mean	+192.4		Weighted Mean	−53.4	
Reduction to Sun	−13.4		Reduction to Sun	+15.3	
Radial Velocity	+179.0km		Radial Velocity	−38.1km	

The following table contains the series numbers, dates, and results of measurement of the twenty-eight plates which have been obtained, and which are used in the determination of the orbit. The range of velocity is very great, amounting to over 285 kilometers, and is the largest which has hitherto been found among binaries of this class.

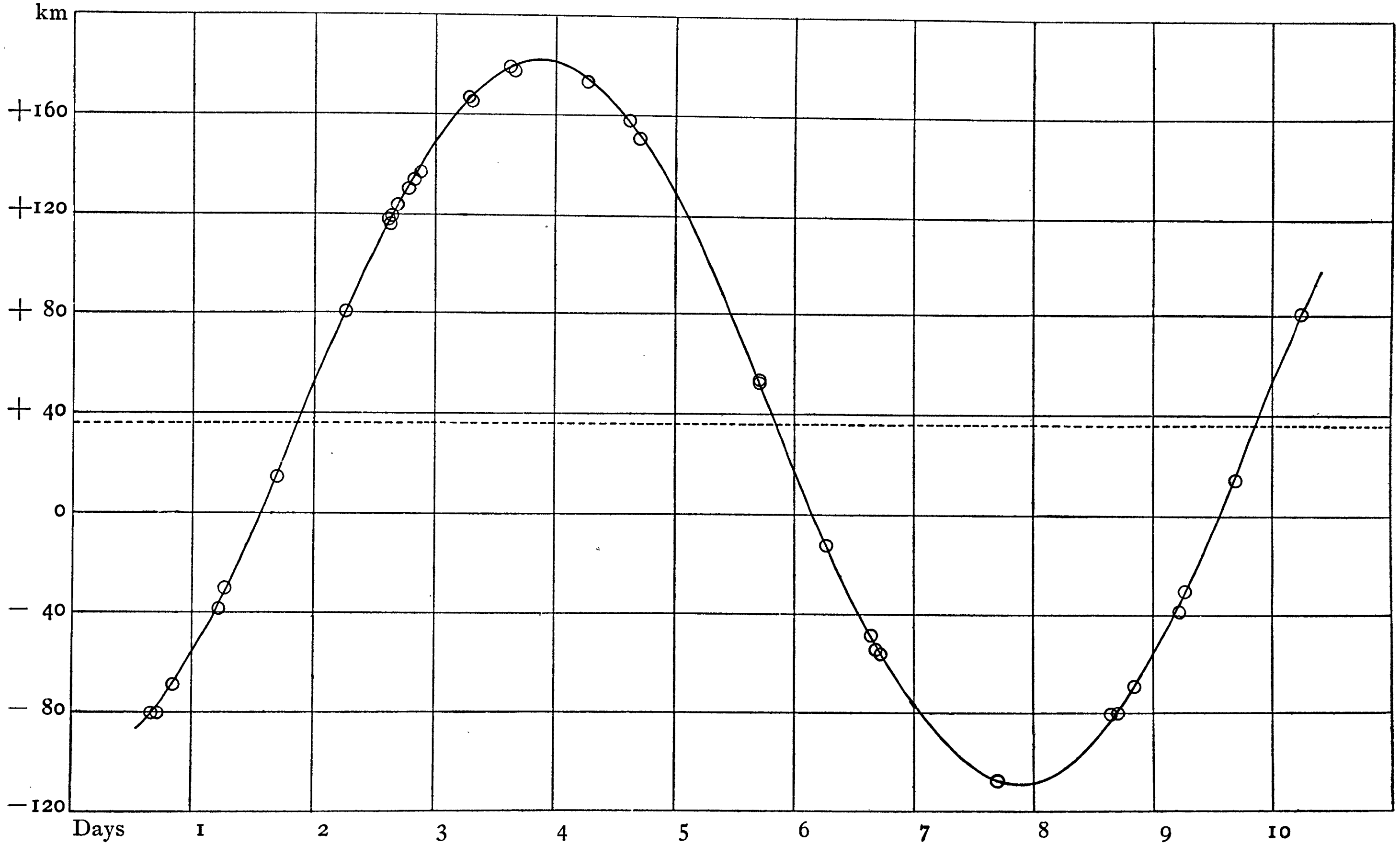
The spectrograms were all taken by the writer, with the exception of the first two and one of the last, which were obtained by Professor Frost.

Plate No.	Date G. M. T.	Velocity	O.–C.
		km.	km.
B 251	1901, November 27.846	− 68.9	−0.6
A 294	December 6.691	+ 14.6	−1.8
B 256	December 18.703	+ 54.4	+1.9
A 296	December 19.676	− 53.7	−0.5
B 260	December 31.585	+115.9	−1.0
B 265	December 31.835	+136.6	−2.4
A 299	1902, January 4.691	− 55.1	+1.2
A 305	January 8.722	+130.0	0.0
B 269	January 9.568	+179.0	+0.1
B 274	January 16.547	+117.6	+2.2
B 279	January 16.762	+133.1	−1.6
A 309	January 22.590	− 80.5	+0.6
B 283	January 24.569	+119.8	+1.3
A 310	February 10.565	+177.8	−1.9
A 315	February 11.525	+158.5	+0.1
A 316	February 12.629	+ 53.1	+1.1
A 321	February 19.598	+151.0	−2.0
A 326	February 21.549	− 47.9	+1.3
B 296	March 13.564	+123.9	+0.2
A 339	March 27.563	− 80.0	−2.6
B 309	April 3.542	−106.5	0.0
B 405	September 3.908	− 29.5	+0.4
A 372	September 4.892	+ 80.5	+1.6
B 411	September 13.901	+166.6	+0.8
B 416	October 8.860	+173.6	−1.9
B 426	October 15.888	+165.0	−2.2
B 448	November 6.769	− 38.1	−2.6
B 460	November 19.822	− 11.8	0.0

All of the above measures were made by Adams with the exception of those of B 269 and B 309, which are the means of measures by Frost and Adams. Plate B 279 was measured twice, and the value given is the mean of the two determinations.

The method used in the derivation of the orbit was that of Lehmann-Filhés, although the very low value of the eccentricity would' no doubt, have made some of the methods using developments in power series equally applicable. The observations were plotted on millimeter paper with a period of $U = 7.9896$ days, and a smooth curve was drawn through them subject to the condition that, after an abscissa had been constructed, making the areas above and below it equal, the adjacent areas included between the maximum and minimum ordinates, the abscissa, and the curve should be equal. The areas in question were adjusted by means of a planimeter, and the following quan-

PLATE III.



Light Curve of η *Orionis.*

tities were obtained as a basis for the computation of the elements:

Velocity of system $V = +35.5$ km.
$A = 146.5$ km; $B = 143.0$ km; $z_1 = +1.35$; $z_2 = -1.38$.

The unit in the cases of z_1 and z_2 is arbitrary, as their ratio alone is required. The notation is that of Lehmann-Filhés.

The elements derived from these quantities are as follows:

$$u_1 = 90^\circ\ 41'.6$$
$$\omega = 42^\circ\ 16'$$
$$e = 0.016$$

$$\log \mu = 9.89566 \text{ or,}$$
$$\mu = 45^\circ.059$$
$$T = 1901, \text{ December } 1.821$$
$$a \sin i = 15{,}901{,}000 \text{ km.}$$

Owing to the very low value of the eccentricity, ω and T are the most uncertain of these elements, but even in these cases the errors should not be large.

An ephemeris was computed with these elements, and the differences between the observed and the computed velocities are given in the column O. – C. of the table above. In view of the character of the spectrum measured, these residuals are entirely satisfactory. A least squares solution might reduce them slightly, but as no significance is to be attached to fractions of a kilometer in measures of stars having this type of spectrum, it has not seemed desirable to undertake it. The accompanying diagram shows the curve derived from the set of elements, and the positions of the observed velocities in reference to it. Owing to the high velocities involved, the scale is necessarily small, but the general agreement of the values is well shown.

In conclusion attention may be called to the fact that η *Orionis* is also a visual double star with components of the fourth and sixth magnitudes. It is, of course, with the brighter of these that we are dealing here.

YERKES OBSERVATORY,
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