THE ORBITS OF THE SPECTROSCOPIC COMPONENTS OF A PERSEI

By W. E. Harper

I have thought that a brief summary of an investigation concerning the binary nature of this star might be of interest to readers of the Journal. Its visual magnitude is 5.47 and spectral type F5 and its co-ordinates of position for 1900 are R.A.=3h $49^m.2$, Dec. $= +50° 24'$. It was announced as a spectroscopic binary showing double lines by the Lick Observatory in 1922 and since then 37 spectrograms have been obtained at this observatory.

Considerable difficulty was experienced in obtaining the period in which the components revolved the one about the other. Only a small percentage of the spectra showed double lines, which seemed to indicate that the orbit was quite eccentric with the orbital velocities large enough only around periastron for the lines to be resolved on our single prism dispersion. Eventually a period of 30.43 days was found to harmonize all the observations, and it was seen that on only three out of the thirty days would it be possible to obtain the component lines separate. As the determination of the orbital elements would depend greatly upon the portion of the curve where the component spectra were resolved an effort was made to secure as many observations as possible around that particular phase. Cloudy weather during the past eight months at the critical time has, however, militated against complete success in this regard.

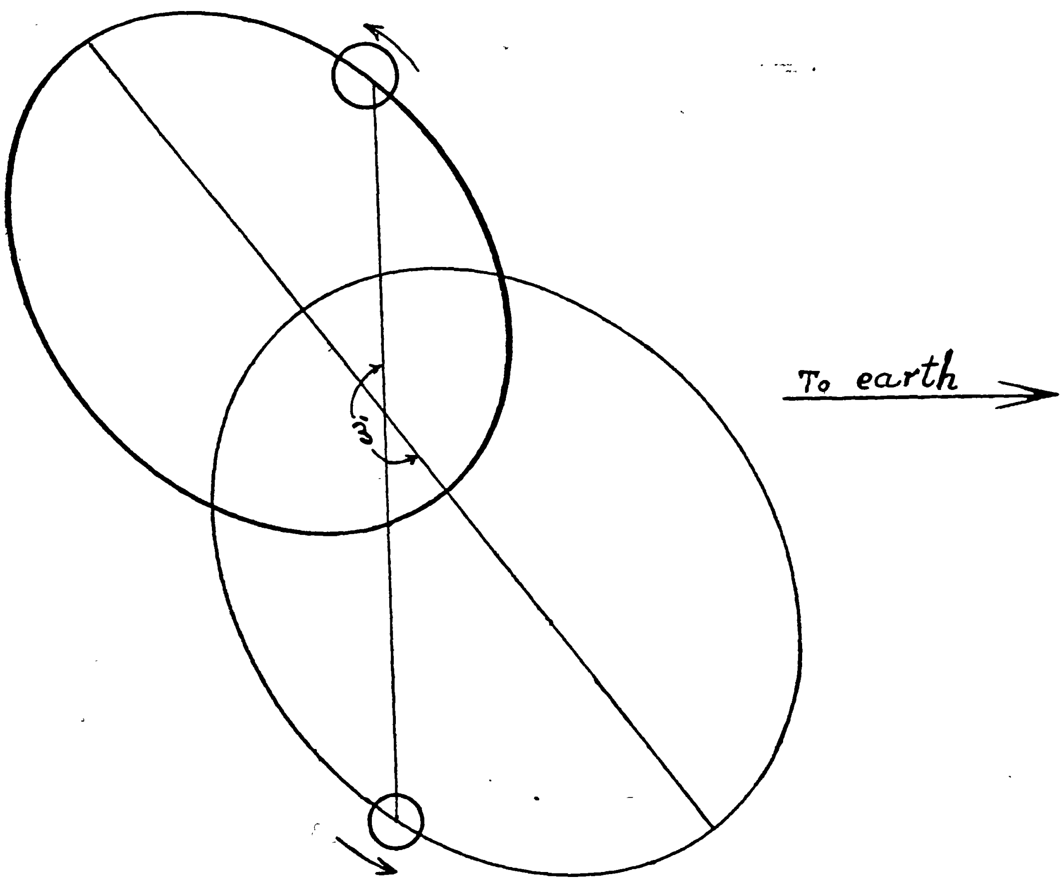
Through the kindness of the Lick observers the velocities of their three plates were obtained, and as two of them showed the lines as double, it was decided to incorporate them with our own. Their three prism dispersion resolved the lines on the branch of the curve where our single prism of course would not, and, as these two observations happened to fall on that particular branch of the curve, it was all the more desirable to include them.

Without going into the details of the work it may be said that preliminary values of the elements were obtained in the ordinary graphical way and then improved values were obtained by the method of least squares. Thirty-two observation equations, with seven unknowns, when solved yielded the following values of the elements, to which the corresponding probable errors are attached.

FINAL ELEMENTS

$$P = 30.4338 \pm .0009 \text{ days}$$
$$e = .612 \pm .013$$
$$\omega_2 = 214^\circ.36 \pm 6^\circ.63$$
$$\omega_1 = 34^\circ.36 \pm 6^\circ.63$$
$$\gamma = +25.66 \pm 0.49 \text{ km.}$$
$$K_1 = 49.38 \pm 2.11 \text{ km.}$$
$$K_2 = 57.10 \pm 2.21 \text{ km.}$$
$$T = \text{J.D. } 2423797.270 \pm .181 \text{ days}$$

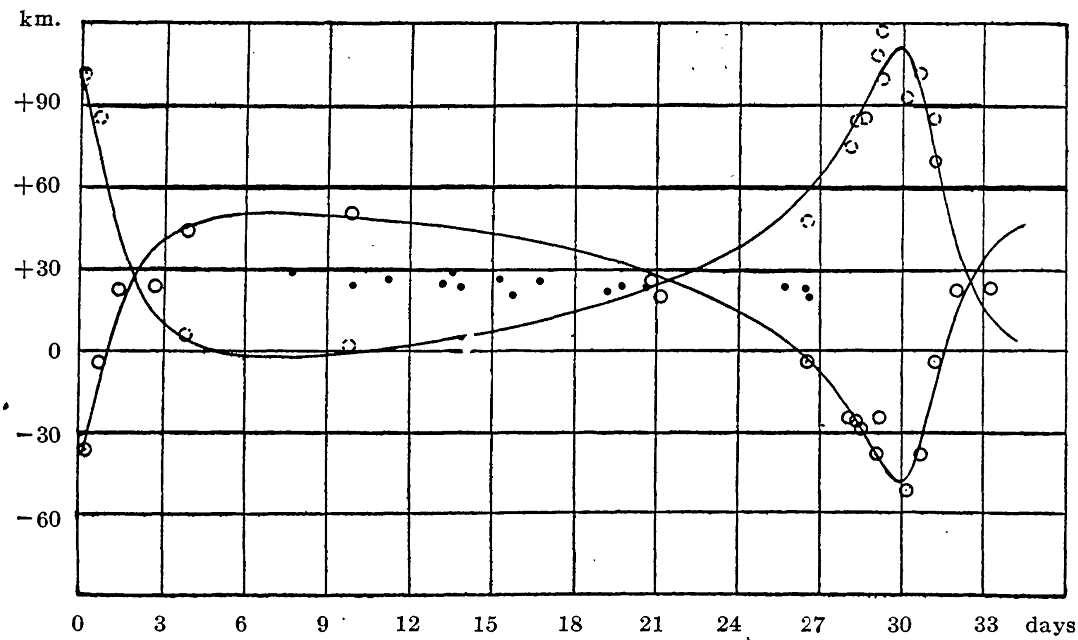
$$a_1 \sin i = 16\ 343\ 000 \text{ km.}$$
$$a_2 \sin i = 18\ 898\ 000 \text{ km.}$$
$$m_1 \sin^3 i = 1.012 \odot$$
$$m_2 \sin^3 i = 0.875 \odot$$



Projected orbit of A Persei

There seems to be a tendency for the observed velocities to become increasingly more positive year by year as if this system were revolving about another in a much greater period of time. Future observations are necessary to determine whether this peculiar trend of the residuals has a real physical significance or not.

As mentioned above and as may be noted from the radial velocity curves and from the graph of the orbits, the eccentricity is exceptionally high. There is only one other F-type with higher eccentricity if we except the visual binaries. In fact with such



Velocity Curves of A Persei, showing individual observations

exception there are only nine between types A_5 to G_5 where the eccentricity exceeds 0.49.

The masses of each component are comparable to that of the sun. There is always present the uncertainty in the angle of inclination (i) of the orbit. Here, however, we can make a pretty fair guess at it by making use of Eddington's mass-luminosity relation. The absolute magnitude of the star has been determined by Young and the author as +3.25. On Eddington's curve this corresponds to a mass for an F_5 star of 1.49 times the sun. Our derived elements show an average mass for the components, multiplied by $\sin^3 i$, to be 0.944 times the sun. Hence $1.49 \sin^3 i = 0.944$ whence $i = 59°.2$.

The theory of probability calls for the average value of a great number of orbits to be 57°.3, but practical considerations suggest that the average will be slightly greater than this. Reversing the process it may be looked upon as one more observed point on Eddington's curve for assuming $\sin^3 i = 0.65$ as is usually done the resulting mass of one component is 1.45 times the sun in good agreement with the curve value of 1.49.

On the radial velocity curve shown individual observations are plotted, the broken circles referring to component II. The small filled circles represent observations unused in the solution.

Dominion Astrophysical Observatory,
April, 1928.