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U OPHIUCHI: AN ECLIPSING BINARY WITH RAPID APSIDAL MOTION

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U Ophiuchi is a detached system, with well-determined masses and absolute dimensions. The period variations are an intriguing characteristic of the variable, and an explanation in terms of light-time effect in a possible triple system was put forward already by Parenago (1949). A truly periodic representation, however, still remains somewhat unconvincing (Herczeg, 1980). Difficulties are also manifest in diverging values of the parameters for the light-time orbit given by different authors (e.g., Koch and Koegler, 1977, Panchatsaram, 1981).

A clue to these problems might be sought in the observed times of Min II, that follow roughly the trend of the primary minima, but with systematic deviations. As already noticed by Koch and Koegler, shorter - term fluctuations on a time scale of ≅ 20 yr are apparent in the phase of secondary eclipse relative to mid-primary. Yet the authors ruled out an explanation based on apsidal motion. The reason was that the variations seemed to lack rigorous periodicity; besides, there seemed to be "a clear preference for secondary eclipse to occur before the half-period moment".

A thorough period study of the available photoelectric minima times (including a reanalysis of the early photoelectric observations by Huffer (Huffer and Kopal 1951) and Magalashvili (1949)) has convinced us, however, that their conclusions were based on scanty and incomplete data. In Fig.1 we present interpolated values of the quantity $(t_{II} - t_{I} - P/2)$ for the observed secondary minima. A cosine fit to these data gives an entirely satisfactory approximation. Straightforward interpretation in terms of a rotating eccentric close orbit yields the preliminary values of

$$e = 0.0032 \pm 0.0002 , \qquad U = 20.7 \pm 0.3 \text{ yr}$$

for orbital eccentricity and period of apsidal revolution, respectively.

After subtraction of the phase shifts due to apsidal motion, the O-C plot

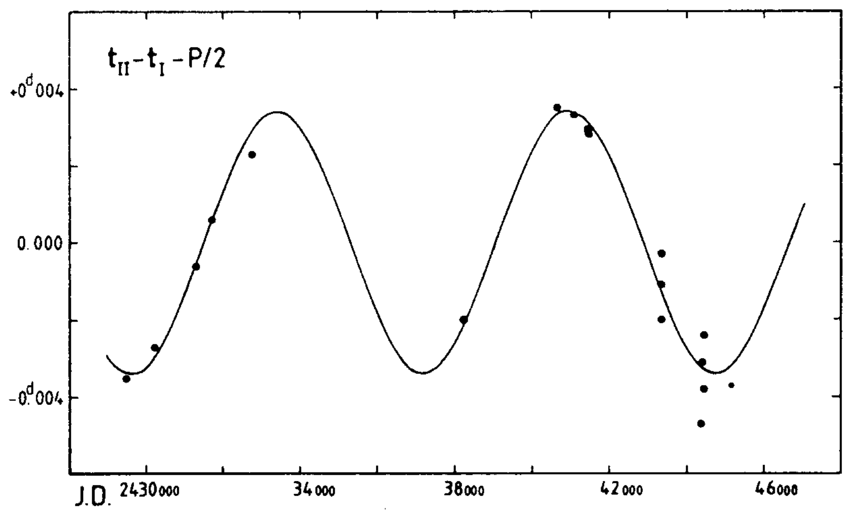


Figure 1: Time variation of the displacement of secondary minimum of U Oph relative to mid-primary. The continuous curve is the function $0^{d}.0034 \cos (337^{\circ} + 17^{\circ}.38 (t - 1969.72))$.

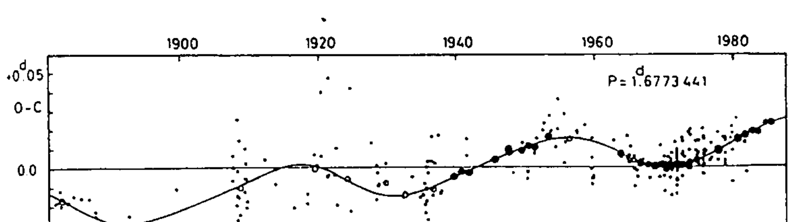


Figure 2: (O-C) diagram of the observed times of primary minimum 1881 - 1985. Modified after Frieboes-Conde and Herczeg (1973), Fig. 19. The continuous curve is the predicted O-C curve for Min I according to our final elements for light-time orbit and apsidal motion.

was compared with a grid of standard light-time curves. Apsidal motion parameters and light-time orbit were adjusted by means of a differential corrections procedure. The final set of elements so obtained satisfies the photoelectric data as well as the large number of visual minima times accumulated during the last hundred years.

Although U Oph is not neglected by photoelectric observers, we wish to emphasize that more minima times of secondary eclipse are needed — not only to improve on light-time orbit, eccentricity and apsidal motion parameters, but also to ensure that random variations from other causes do not introduce systematic errors in their determination. The importance of observing apsidal motion in eclipsing binaries with reliable absolute dimensions as a test for theoretical models of stellar structure and stellar evolution theory is well-known.

The full details and implications of this period study, including a discussion of the evolutionary status of U Ophiuchi, will be presented elsewhere (Kämper, 1985).

I would like to thank W.Braune, Berlin, for pointing out this system, and D.Lichtenknecker, Hasselt, for his help in searching the literature.

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Note: Two phe times of minimum given by Popovici 1971 (IBVS No. 508) must certainly be attributed to U Peg, not to U Oph.