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PHOTOELECTRIC OBSERVATIONS OF u HERCULIS AND A REMARK ON ITS PERIOD

The early type eclipsing binary u Herculis may represent a very interesting case of close binary evolution and studies of its period can, in principle, contribute significantly to our understanding the system. This may justify the belated publication of a set of photoelectric observations secured at the Hoher List station of the Bonn Observatory in August-September 1959 and March-May 1961. The measurements define six epochs of minimum brightness.

The series comprises 194 observations obtained with the 34-cm reflector, 97 in each of the colors b and r of the instrumental system; the latter has an isophotic wavelength near 6000 Å. Comparison star was d Herculis, check star e Herculis and the magnitude differences (d-e) indicate for the mean error of a single observation ± 0.009 mag. in the blue, ± 0.008 mag. in the red region. Only measurements close to the light minima were taken and they allow the derivation of the following minimum epochs.

Min. I (hel) :	JD 2436831.304	O-C= $-0^{d}.002$	
	37366.6240	+0.0002	
	37422.5059	-0.0059	(n)
Min.II (hel) :	JD 2436793.3500	O-C= -0.0117	(n)
	36832.3279	-0.0033	(n)
	37365.596	-0.002	(n)

The symbol (n) indicates that the epoch is based on two sets of observations separated by two, in one case six nights. The 0-C values correspond to the elements:

$$\text{Min.I} = \text{JD } 2405830.0326 + 2^{d}.0510270 \text{ E} \qquad \text{(Catalano 1967)}$$

Due to the relatively few observations, the average error of a minimum epoch is $\pm\ 0^{d}.002$. Where the timing is given to the third decimal of the day only, the observations either barely bracket the minimum brightness (JD 2436831) or the time of minimum was calculated from two short runs of observation, one on each branch of the eclipse. (The minimum JD 2436793 depends appreciably on the extinction correction, as the observations on August 18, 1959 were carried out up to $z = 56^{\circ}$.)

Timings of primary minimum go back more than a century for u Herculis; photoelectric observations are not too frequent but they are fairly evenly distributed over nearly 60 years. The period was studied, among others, by Martin (1938) and Catalano (1967). No definite changes of the period have been found; in particular, early reports of an apsidal rotation are discounted now. The following tabulation of later photoelectric minima - not necessarily complete - can be considered as continuation of Martin's table (loc.cit.p.270); the 0-C values are calculated using Catalano's formula again.

RUIZ	1955.6	p	2435317.6460	0-C=	-0.0018	(Ruiz 1957)
		s	35318.6734		+0.0001	
HERCZEG	1959.6/7 1961.2/4		See p.1 of this paper			
ENGELKEIMER	1961.5	p	2437448.6619	0-C=	-0.0029	(private comm.)
CATALANO	1964.6	p	38605.4445		+0.0004	(Catalano 1967)
		p	38607.4955		+0.0004	
BATTISTINI et al.	1968.5	p	40053.4646		-0.0045	(Battistini et al. 1973)
	1971.6	s	41176.402	0-C=	-0.004	

D.Engelkeimer's result was kindly communicated to me by the Data Center for Eclipsing Binaries maintained at the University of Florida, Gainesville; information from the files of the Data Center is gratefully appreciated.

Among the more recent photometric elements, those of Catalano's give the best representation of the minima. Elements by Ruiz (1957) are almost equally good while the formula given by Miczaika and Keutmann (1936) gives slightly higher negative residuals for all later determinations.

Although the epochs for secondary minimum are, as a rule, less accurate and in a few cases show unexpectedly large residuals (notably those observed in 1913, 1934 and 1959) the lack of apsidal motion with any detectable amplitude - say, above $0\overset{d}{.}01$ - is rather obvious. It has been pointed out, on the other hand, that reasonable values of the orbital elements and apsidal motion coefficients would require a relatively rapid rotation of the major axis; its period may be of the order of 40-80 years. Thus the orbit must be very nearly circular, rendering the case of u Herculis favorable for studying spectroscopic effects of gas streaming and circumstellar matter; this point was emphasized by Kovachev and Seggewiss (1975). Nevertheless, the lack of secular period changes during the last 100 years may not mean that the period is strictly constant. Differences between the time residuals given by Catalano for 1964 and the predominantly negative O-C values found in the years preceeding as well as following that date, are probably real. This can be the consequence of small, irregular, short term changes of the period or perhaps temporarydistortions of the eclipsing light curve. It is worth noting, that a number of qualified visual determinations (BAV, SAG) yield for 1972 a normal epoch with 0-C= $-0\overset{d}{.}007 \pm 0\overset{d}{.}010$.

This particular question of random period changes deserves further studies, preferably by more frequent and more regular photoelectric observations.

I should like to thank Mrs. Helga Hagen for her assistance in the reduction of the measurements and Mr. J. Ruiz for kindly sending me the unpublished details of his observations. Tables of the individual measurements obtained at the Observatorium Hoher List are available on request.

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