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PERIOD CHANGES IN V839 OPHIUCHI

The eclipsing binary V839 Oph (BD +09°3584 = HD 166231 = GSC 1009.264, α_{2000} = $18^h9^m21\overset{s}{.}4$, $\delta_{2000} = 9°9'4\overset{''}{.}3$, Sp. F8V, $V_{max} = 8.7$ mag) is a relatively well-known W UMa type binary system with a period of 0.4090 day. This bright variable star belongs to the nearest binaries and therefore it was also included into the Hipparcos program of parallax measurement from space (Dworak & Oblak 1987, 1989). It was discovered to be a variable star by Rigollet (1947), the first photoelectric measurements were presented by Binnendijk (1960). Later on, photometric measurements were obtained by Wilson & O'Toole (1965), Lafta & Grainger (1985) and Niarchos (1988, 1989). The recent photoelectric times of minima were published by Hanžl (1990, 1991), Demircan et al. (1994) and Agerer & Hübscher (1995).

Our new CCD photometric observations of V839 Oph were carried out during August and October 1995 at Ondřejov Observatory, Czech Republic, using a 65cm reflecting telescope with a CCD-camera (SBIG ST-6) at the primary focus. The measurements were done using the standard Johnson V filter with 20 s exposure time. One additional time of primary minimum was obtained in October 1995 at the R. Szafraniec Observatory, Metzerlen, Switzerland, using a 35cm Cassegrain telescope with the same CCD-camera and without any filter.

The star GSC 1009.464 = BD +09°3578 (V = 9.04 mag) – used also by Binnendijk (1960) and other observers – on the same frame as V839 Oph served as a comparison star. All CCD data were reduced using a software developed at Ondřejov Observatory by P. Pravec and M. Velen (Pravec et al. 1994). The times of primary minima and their error were determined as mean values the Kwee–van Woerden (1956) method and the parabolic fit into the data file. They are presented in Table 1. In this table N stands for the number of measurements used for the determination of minimum time. The epochs were calculated using the linear light elements given in GCVS (Kholopov et al. 1985):

$$\text{Pri. Min.} = \text{HJD}\,24\ 40448.4129 + 0.40899532 \times \text{E}.$$

The period changes of V839 Oph were studied by means of O−C diagram analysis. We took into consideration all photoelectric times of minima found in the literature as well as the first visual minimum obtained by the discoverer ($E = -21664.5$). The other numerous visual estimations were not included due to the large scatter of the data.

Table 1. New precise times of primary minima of V839 Oph

JD Hel.– 24 00000	Error (10^{-4}d)	N	Epoch	Observatory
49954.3939	0.0001	45	23242.0	Ondřejov
49995.2942	0.0001	82	23342.0	Ondřejov
50013.2907	0.0003	31	23386.0	Metzerlen

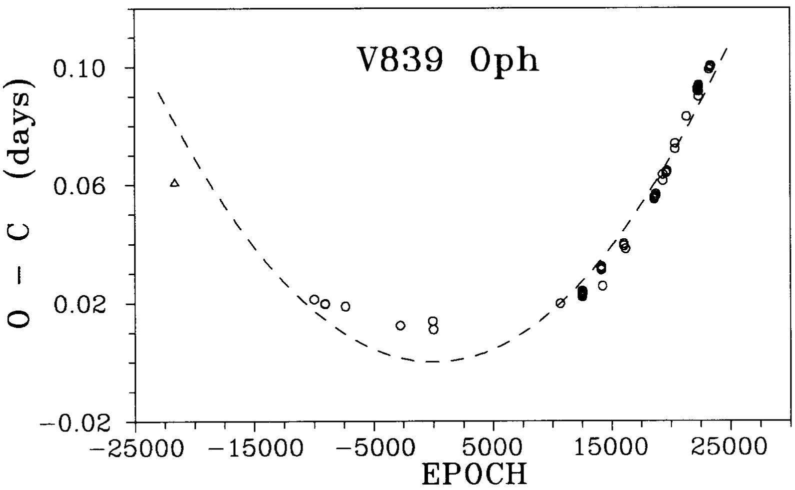

Figure 1. O–C residuals for the times of minima of V839 Oph with respect to the linear light elements. The dashed curve represents the parabolic approximation. The individual primary and secondary photoelectric times are denoted by circles, the first visual estimation by triangle.

A total 52 times of minimum light were incorporated in our analysis, with 23 secondary eclipses among them. We derived new quadratic light elements by the least squares method:

$$\text{Pri. Min.} = \text{HJD } 24\ 40448.4019 + 0.40899634 \times \text{E} + 1.73 \times 10^{-10} \times \text{E}^2.$$

$$\pm 8 \qquad \pm 23 \qquad \pm 0.12$$

It indicates, that the period of V839 Oph is increasing. From these elements we obtained $\frac{\Delta P}{P} = 8.46 \cdot 10^{-10}$. The O–C residuals for all times of minimum with respect to the linear ephemeris are shown in Figure 1. The non-linear fit, corresponding to the calculated elements is plotted as a dashed curve.

Subtracting the parabolic term in light elements, which could be caused by a mass transfer or mass loss from the system, the $O - C_2$ diagram can be plotted. Significant quasi-sinusoidal variation of these residuals are easily seen in Figure 2. This additional phenomenon can be caused by the presence of a third body in this system (light-time effect) or by magnetic activity of the components, which was described recently by Applegate (1992). The preliminary period of a third body orbit or a magnetic cycle could be $P_3 \simeq 11000$ days = 30 years.

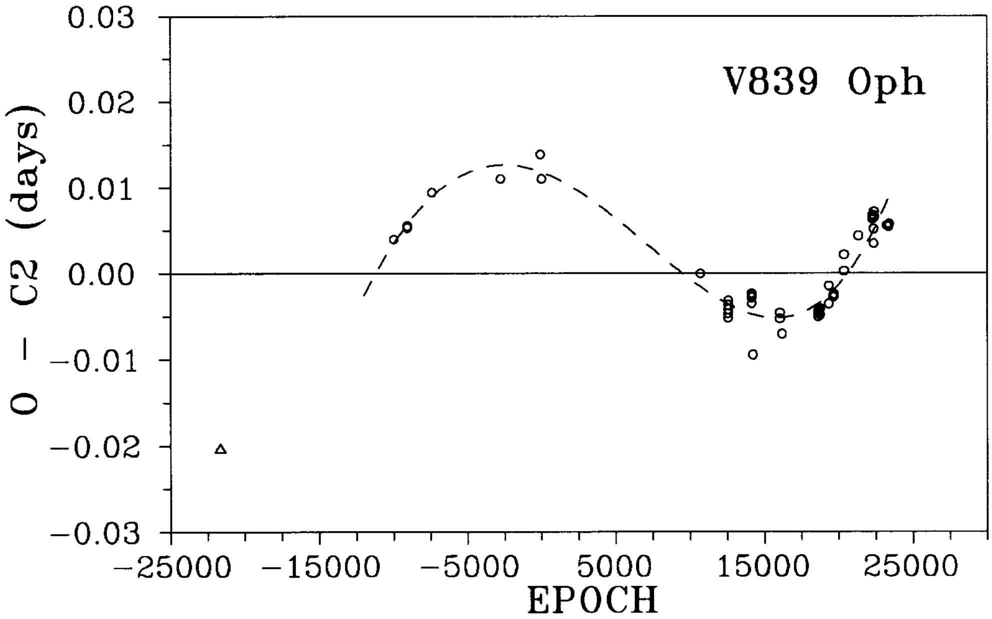

Figure 2. O−C_2 residuals for the times of minimum of V839 Oph after subtracting the parabolic term in light elements. The quasi-sinusoidal profile with the period of about 30 years is remarkable.

No firm solution of the present $O - C_2$ diagram could be given because the predicted period is not covered sufficiently by precise photoelectric measurements. More high accuracy timings of this eclipsing binary are necessary in the future to expand the time span for better analysis of both of these phenomena.

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References:

Agerer, F., Hübscher, J., 1995, *Inf. Bull. Var. Stars*, No. 4222

Applegate, J.H., 1992, *Astrophys. J.*, **385**, 621

Binnendijk, L., 1960, *Astron. J.*, **65**, 79

Demircan, O., Tanriver, M., Devlen, A. et al., 1994, *Inf. Bull. Var. Stars*, No. 4126

Dworak, T.Z., Oblak, E., 1987, *Inf. Bull. Var. Stars*, No. 2991

Dworak, T.Z., Oblak, E., 1989, *Inf. Bull. Var. Stars*, No. 3399

Hanžl, D., 1990, *Inf. Bull. Var. Stars*, No. 3423

Hanžl, D., 1991, *Inf. Bull. Var. Stars*, No. 3615

Kholopov, P.N. et al., 1985, *General Catalogue of Variable Stars*, Vol. II, Nauka, Moscow

Kwee, K.K., Van Woerden, H., 1956, *Bull. Astron. Inst. Neth.*, **12**, 327

Lafta, S.J., Grainger, J.F., 1985, *Astrophys. Space Sci.*, **114**, 23

Niarchos, P.G., 1988, *Inf. Bull. Var. Stars*, No. 3156

Niarchos, P.G., 1989, *Astrophys. Space Sci.*, **153**, 143

Pravec, P., Tichý, M., Tichá, J., Moravec, Z., Vávrová, Z., Velen M., 1994, *Planet. Space Sci.*, **42**, 345

Rigollet, R., 1947, *l'Astronomie*, **61**, 54

Wilson, R.E, O'Toole, W., 1965, *Publ. Astron. Soc. Pacific*, **77**, 58