COMMISSIONS 27 AND 42 OF THE IAU
INFORMATION BULLETIN ON VARIABLE STARS

Number 3704

Konkoly Observatory
Budapest
16 March 1992

HU ISSN 0374 - 0676

A MAJOR PERIOD CHANGE OF VW CEPHEI

VW Cep is one of the most extensively observed W UMa type binaries. The light curve shows two almost equal eclipses of about $0^m.4$ in V but the minima are sometimes asymmetric and the shape of the light curve is slightly different at different epochs. Yamasaki (1982) and Linnell (1980) have attempted to explain the variations in terms of starspots, not unlike the RS CVn variables, and Van't Veer (1991) has continued with this theme by exploring the role of magnetic effects on period changes. The changes in the light curve have also been attributed to mass transfer (Karimie 1983). The spectroscopic and photometric evidence suggests that the components of the binary are in marginal contact, with the secondary being slightly hotter than the primary (Hill, 1989). VW Cep is typical of the W-type W UMa systems (Hilditch *et al.* 1988). According to the models (*cf.* Robertson & Eggleton 1977, Lucy & Wilson 1979) these systems oscillate between contact and semi-detached states on a thermal timescale ($\sim 10^7 yrs$) spending most of the time as contact systems. During the contact state mass is expected to be transferred from the secondary to the primary and the period, assuming conservative mass exchange, is expected to increase. The period of VW Cep is known to vary but the problem is complicated by a faint third companion which was discovered astrometrically (Hershey 1975). The orbit of VW Cep about the common centre of gravity causes a change in the light travel time from the variable which introduces a distortion into the O-C diagram.

New photoelectric observations of VW Cep have been made during 1991 from Hadlow, Kent and Catsfield, East Sussex in southern England (see Table 1). Observations marked JW were made from Catsfield with a 25-cm Newtonian equipped with a prototype JEAP photon counting photometer using an EMI9924B PMT (Walker 1986, 1991) with computer controlled data acquisition. Integration times were 30 seconds through a 1 arc minute aperture. Observations marked RDP were made from Hadlow with a 40-cm Newtonian equipped with an EMI6526B PMT feeding a J-FET DC amplifier. The signal was passed to a voltage to frequency converter and read off a digital meter. Integration times were 10 seconds through a 2 arc minute aperture. The comparison star used throughout was BD +75° 753

(HD 197750 = BAA VSS Comp B) and the check star was BD +74° 877 (HD 197617 = BAA VSS Comp C). All observations were made through Johnson V filters. The observed times of minimum were determined by fitting low order polynomials to the observations and the errors are estimated to be < 0.005 days.

To construct the O-C diagram the new timings have been combined with other times of minimum taken from the compilation of Karimie (1983), BAA VSS Circulars and from recent IBVS's. Before any investigation of the period change can be made it is necessary to correct the O-C residuals for the light travel time and for this the elements given by Hershey (1975) have been used. The figure shows the light time corrected O-C diagram and the light time correction itself. The O-C diagram is characterised by a general shortening of the period which takes place through a number of discrete period changes. Major changes in period at JD $\sim$ 2431000 (1943) and 2437100 (1960) have been recognised before but a new major change at JD $\sim$ 2444600 (1980) seems to have passed largely unnoticed.

It can be seen that the only significant departures from straight line segments occur near the time when the light time correction is changing most quickly. While this feature has in the past been attributed to small period changes it seems more likely that it is an artifact caused by a small error in the light time correction, which could be removed by a small change to P or ω. If this is the case then the behaviour of VW Cep may be accounted for by three approximately equal discrete reductions in the period at $\sim$ 20 year intervals (see Table 2). Karimie also supports the notion of discrete period changes.

The widely used ephemerides now give gross errors so a new one is necessary. A linear fit to the uncorrected data from 1984 to the present yields a new *observed* ephemeris for primary minimum of:

$$JD_{min1} = \underset{\pm 3}{2446822.5233} + \underset{\pm 1}{0.2783099} \cdot E$$

This ephemeris will slowly drift off because it takes no account of the light time correction but if the period remains constant the error could reach at most -0.01 days in five years. On past behaviour the period might be expected to change again around the turn of the century.

VW Cep poses some interesting problems because the general trend of the period change, which is well represented by $\dot{P}/P = -7.4 \times 10^{-7} yr^{-1}$, is similar to the value expected for "broken-contact" W UMa systems (Lucy &

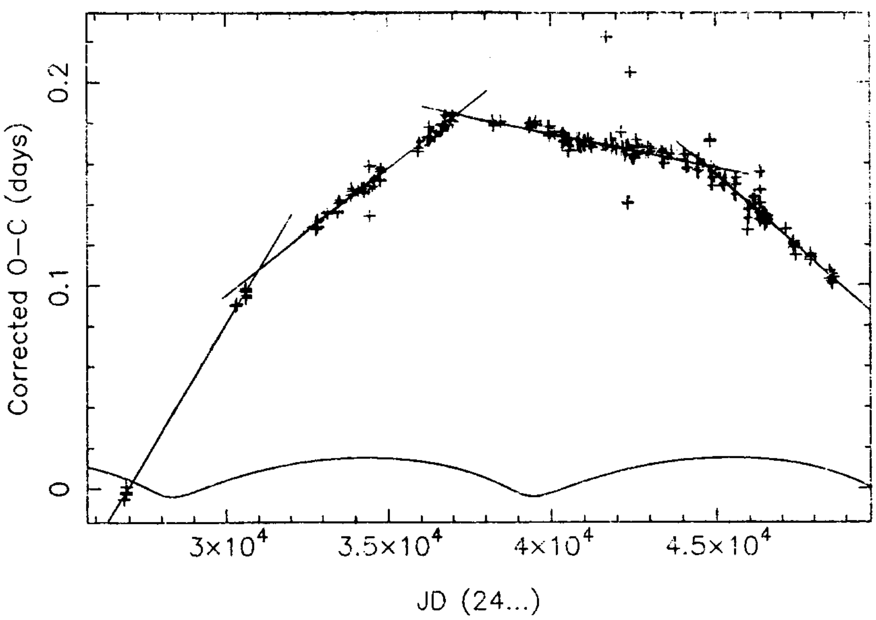

Figure 1: Light-time corrected O-C diagram showing the four constant period sections. The curve shows the light-time correction that was applied.

Table 1: New times of minima

HJD	min	observer
2448506.4398	2	RDP
2448506.5751	1	RDP
2448566.4134	1	JW
2448570.5864	1	JW
2448597.3037	1	JW
2448600.5034	2	RDP
2448604.2601	1	JW
2448619.2883	1	RDP

Table 2: Values of discrete period changes

Year	1943	1960	1980
$\Delta P/P$	-1.4×10^{-5}	-1.6×10^{-5}	-1.1×10^{-5}

Wilson, 1979) and not the W-type like VW Cep. Also, because the period changes are abrupt it suggests that the contact between the two stars is episodic and very brief, which implies a more complex relationship between the components than current theory suggests.

C. Lloyd
Astrophysics Division
Rutherford Appleton Laboratory
Chilton, Didcot
OXON OX11 0QX
UK

J. Watson
Iddons
Henley's Down
Catsfield, Battle
East Sussex TN33 9BN

R.D. Pickard
Crayford Manor House AS
The Manor House
Mayplace Road East
Crayford
Kent DA1 4HB

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