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PHOTOELECTRIC MINIMA OF ECLIPSING BINARIES

We present new photoelectric times of minimum of five eclipsing binaries. Their periods lie between 1 and 3 days and the primary or both components are of relatively early spectral type. Our photoelectric observations were carried out with a 35 cm Cassegrain reflector at the R. Szafraniec Observatory in Metzerlen, Switzerland, during the period from August to October 1991. A single-channel photoelectric STARLIGHT-1 photometer, furnished with an unrefrigerated EMI 9924A tube and standard Johnson B filter, was used. The 13 new times of primary and secondary minima and their errors were determined using the Kwee - van Woerden (1956) method.

TV Cas

The period changes of this well-known eclipsing binary have been discussed frequently (Frieboes-Conde & Herzeg 1973, Tremko & Bakos 1977). Two new epochs of primary minimum are listed in Table 1, where N means the number of points used for the time determination. Fig. 1 shows the O-C diagram for all photoelectric times of minimum found in the literature (De Landtsheer 1983, and references therein). From this figure it is very difficult to determine the nature of the period change.

If we assume that the dominant period variation is caused by the presence of a third body and that all observed times of minimum cover approximately one period of the circular third-body orbit, we find new linear light elements:

Pri. Min. = HJD 2444602.4474 + 1.81260217·E,

and we can derive the following light-time effect parameters:

P ≅ 20 460 days ≅ 56 years,
semi-amplitude = 0.017 days.

These elements and all others given in this paper were computed using the least squares method. The theoretical curve is plotted as a dashed line in Fig. 1. The mass function amounts to $f(m_3) = 1.39\ M_\odot$ (Tremko & Bakos, 1977), the minimum mass of the third body is $m_3 = 0.6\ M_\odot$.

More timings of high accuracy are needed for this interesting object.

ZZ Cep

No discussion or comment on the change of period of the eclipsing binary ZZ Cep was found in the literature covering the last 25 years. Kandpal and Srivastava (1967) presented photoelectric observations (in V) and derived photoelectric elements and absolute dimensions of this system. Four newly observed times of minimum are presented in Table 1.

Using only the photoelectric timings published in the literature and one normal point derived by Kwiek (1936), we obtain the following light elements

Pri. Min. = HJD 2427928. 4519 + 2.14179954·E,

which are practically identical to those published by Herbig (1947).

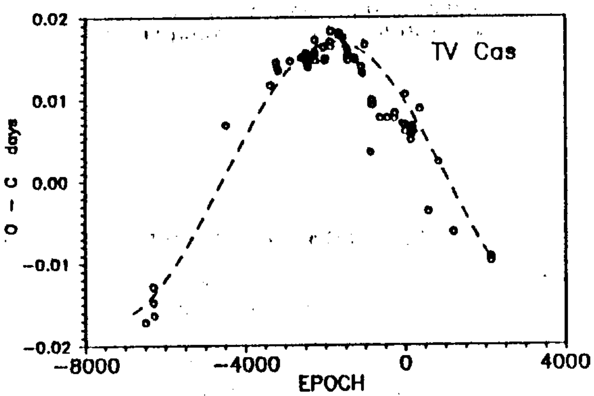

Fig. 1: O–C diagram for photoelectric times of minimum of TV Cas. The dashed curve is computed according to the light-time effect parameters.

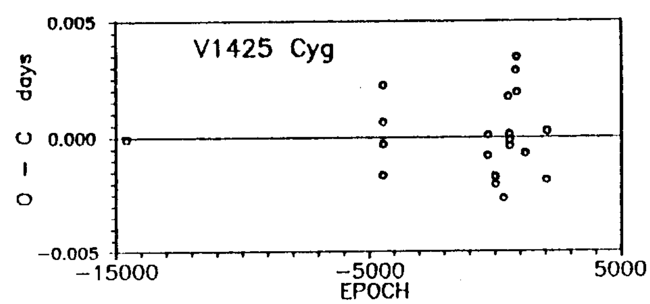

Fig. 2: O–C diagram for photoelectric time of minimum of V1425 Cyg. The small square denotes the mean of photographic observations obtained by Strohmeier at HJD 2427714.2597.

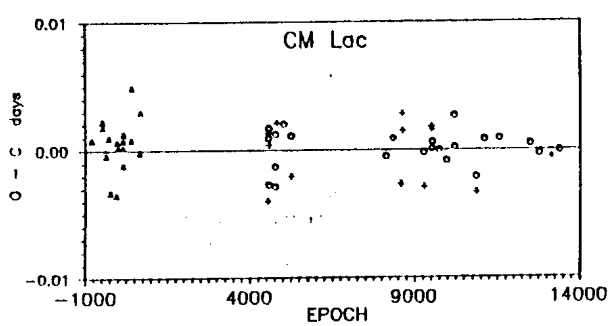

Fig. 3: O–C diagram for CM Lac. The circles and plus sign are the photoelectric times for primary and secondary minimum. The triangles denote the older photographic results published by Wachmann (1935, 1936).

Table 1

star	JD Hel. – 2400000	error [10^{-4} d]	min type	N	filter
TV Cas	48481.4069	1	I	37	B
	48490.4693	1	I	29	B
ZZ Cep	48485.4433	1	I	25	B
	48500.4348	1	I	29	B
	48532.560	12	I	8	B
	48545.4120	8	I	14	B
V1425 Cyg	48506.3960	2	I	22	B
	48533.3245	1	II	28	B
CM Lac	42276.5021	6	II	35	V
	42276.5020	6	II	32	B
	42280.5123	2	I	37	V
	42280.5123	3	I	43	B
	42284.5258	3	II	30	V
	42284.524	27	II	20	B
	42309.3972	3	I	44	V
	42309.3973	2	I	45	B
	48093.5063 ⋆	19	II	10	B
	48495.4820	2	I	20	B
	48503.5054	1	I	24	B
EE Peg	48486.4656	3	I	15	B
	48507.4929	1	I	27	B

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V1425 Cyg

A photometric study of the early-type Algol variable V1425 Cyg (= BV 346) was presented by Lee (1989). In this system the hot component is also the more massive one and it is therefore called a "reverse Algol" system. One new primary and secondary minimum is presented in Table 1.

Using only the photoelectric timings published in the literature (Lee 1989) and one point as the mean of 14 photographic observations provided by Strohmeier (Tate 1970), we derived the following improved light elements:

Pri. Min. = HJD 2445969.0607 + 1.25238755·E,

which are in a good agreement with the elements computed by Lee (1989). The corresponding O–C diagram is plotted in Fig.2.

CM Lac

In Table 1 we list the times of minimum computed from the original photoelectric measurements published by Murnikova & Makarchikova (1981). For the primary minima, using Kwee–van Woerden's (1956) method, we obtained slightly different results, and four times of secondary minimum were not found in the literature. In this table we also present our three newly determined times.

Using only the photoelectric timings published (Alexander 1958, Caton et al. 1991), one can derive the following light elements:

$$\text{Pri. Min.} = \text{HJD } 2427026.3158 + 1.60469140 \cdot E,$$

which are practically identical to Alexander's (1958) results. This means that the system CM Lac demonstrates very good constancy of its period over an interval of about 60 years. The O–C diagram is plotted in Fig. 3.

EE Peg

A very comprehensive study of the eclipsing binary EE Peg was published by Lacy & Popper (1984). In their paper, the presence of a third star was inferred from its effect on the radial velocities of the eclipsing pair. The period of the third body orbit was found spectroscopically to be 1464 days. The newly observed times of primary minimum are presented in Table 1.

Using only the photoelectric timings published, we derive the following current light elements:

$$\text{Pri. Min.} = \text{HJD } 2440286.4363 + 2.6282159 \cdot E.$$

This period is slightly longer than the one used by Lacy & Popper ($2^{d}62821423$). Unfortunately, the period of the third body orbit given above cannot be confirmed photoelectrically. The Fourier analysis of the O–C residuals employing the photoelectric results favor a shorter period of either 235 or 658 days.

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