NEW EPHEMERIS FOR W UMA

Summary: visual observations of W UMa, an EW type eclipsing binary, revealed that period of light variation is decreased compared with previous ones given by several observers. Hence, a new ephemeris is given according to results.

Introduction

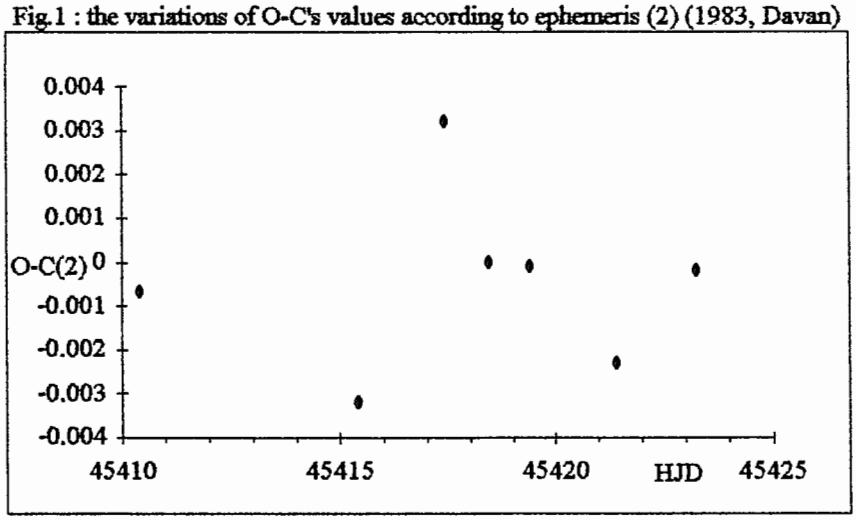
W UMa is an EW-type eclipsing binary, characterized by a light variation between 7.75 and 8.48 magnitude and a secondary minimum almost deep than primary one. Several astronomers observed W UMa proposing different ephemerides:

$$\text{Min.I (Rocznik)} = 41004.39769 + 0.33363696 * E^{(1)} \quad (1)$$
$$\text{Min.I (GCVS 85)} = 44986.3624 + 0.33363808 * E^{(2)} \quad (2)$$
$$\text{Min.I (IBVS 2083)} = 45765.7385 + 0.33363749 * E^{(3)} \quad (3)$$

As we see, light variation periods are slightly different.

Many observers of this variable star think the binary system has a strong activity which causes some distortions in light curve and evident O-C's changes. The hypothesis that O-C's changes can show a cyclic behaviour was first proposed in 1980 by Tümer et al.[4] and in 1982 by Hamzaoglu et al.[3] after a photoelectric observations' analysis. Anyway, no value of an hypothetical O-C's variation period was found. In 1983 Davan[5] observed W UMa by a photomultiplier attached to a reflector telescope, and using two different H-α filters. The results showed light curve amplitude and O-C's values oscillating in a range of about $\pm$ 0.003 day. According to author, O-C and light amplitude changes may be due to mass ejections and/or magnetic activity for the presence of sunspots in binary system. Furthermore, the similarity of the light amplitude changes in both H-α and infrared observations also indicates the sources of activities may have periodic appearance, so confirming Tümer's and Hamzaoglu's hypotheses. The variations of O-C's values versus heliocentric julian days are following presented, observed by Davan:

Fig.1 : the variations of O-C's values according to ephemeris (2) (1983, Davan)



Results and discussion

Between 1990 and 1995,I carried out about 700 visual estimates of W UMa using GEOS finding chart C83. From these data I calculated by SOP[6] program 18 heliocentric times of primary minimum which are collected in the next table with the relative date in julian days, and the O-Cs according to the previous 3 ephemerides:

Tab.1 : W UMa's minima in 1990/1995

DATE	U.T.	HJD	O-C(1)	O-C(2)	O-C(3)
10 Feb 90	21.00	47933.375 ± 0.008	0.005	-0.013	-0.006
14 Feb 90	20.57	47937.373 ± 0.026	-0.001	-0.018	-0.012
17 Feb 90	21.03	47940.377 ± 0.020	0.001	-0.017	-0.011
22 Feb 90	21.11	47945.383 ± 0.014	0.002	-0.016	-0.009
13 Apr 90	22.10	47995.424 ± 0.014	-0.003	-0.020	-0.014
21 Apr 90	22.22	48003.432 ± 0.021	-0.002	-0.020	-0.013
30 Apr 90	22.35	48012.441 ± 0.023	-0.001	-0.019	-0.012
23 Mar 91	21.39	48339.402 ± 0.027	-0.004	-0.023	-0.016
30 Mar 91	21.46	48346.407 ± 0.028	-0.005	-0.024	-0.016
31 Mar 91	21.52	48347.411 ± 0.009	-0.003	-0.021	-0.014
6 Apr 91	21.56	48353.414 ± 0.015	-0.004	-0.023	-0.016
26 Dec 94	19.39	49713.319 ± 0.006	-0.004	-0.028	-0.018
9 Jan 95	19.58	49727.332 ± 0.011	-0.003	-0.027	-0.017
20 Jan 95	20.16	49738.345 ± 0.022	-0.001	-0.025	-0.015
29 Jan 95	20.15	49747.344 ± 0.017	-0.010	-0.034	-0.024
1 Feb 95	20.24	49750.350 ± 0.007	-0.007	-0.031	-0.021
20 Feb 95	20.41	49769.362 ± 0.015	-0.012	-0.036	-0.026
20 Mar 95	21.32	49797.397 ± 0.002	-0.003	-0.027	-0.017

We see ephemerides (2) and (3) are last in foreseeing times of light minimum, while ephemeris (1) shows a mean difference equal to:

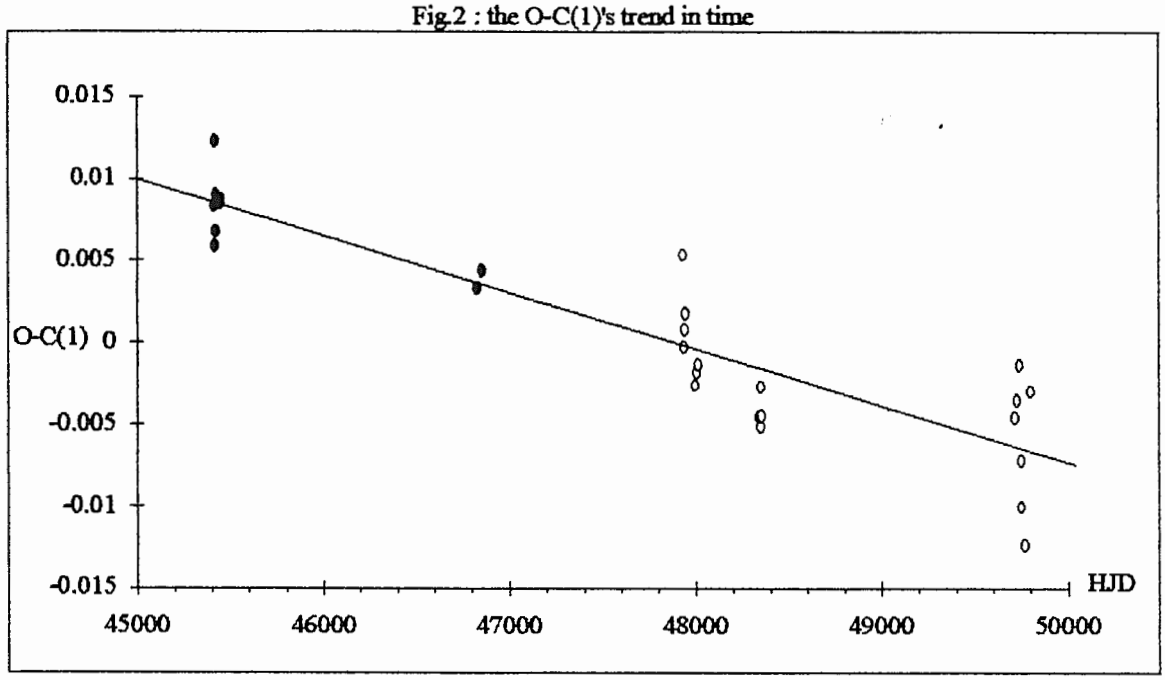
$$O\text{-}C(1)_{mean} = -0.003 \pm 0.015 \text{ day}$$

which seems to confirm the validity of ephemeris (1) given by Rocznik.
However a more careful analysis reveals the period of ephemeris (1) is not valid anymore and we must search a new ephemeris.

The decrease of O-Cs and the new ephemeris for W UMa

Collecting all heliocentric times of minimum in my possession we can plot a graph which shows the O-C(1)'s drift. Used minima were: 7 of Davan[5], 1 of Hanzl[7], 1 of Keskin et al.[8], 4 of Kelemen[9], all photoelectric (filled circles) and at last, the 18 visual times of light minimum (blank circles) included in this work. The graph is showed in fig.2:

Fig.2 : the O-C(1)'s trend in time



As we see, the period of light variation of W UMa seems to be less than 0.33363696 day. The application of the least squares method supplies a correction and we obtain a period of:

$$P = 0.3336358 \pm 0.0000001 \text{ day}$$

So I propose a new ephemeris for W UMa:

$$\text{Min.I} = 48864.2137 + 0.3336358 * E \qquad (4)$$

Light curves

Visual light curves of W UMa often show light increase or decrease. This phenomenon could be caused by mass ejection and/or sunspots on the stars' surface. Following some light curves are reported:

Fig.5 : light curve of 14 Feb 90

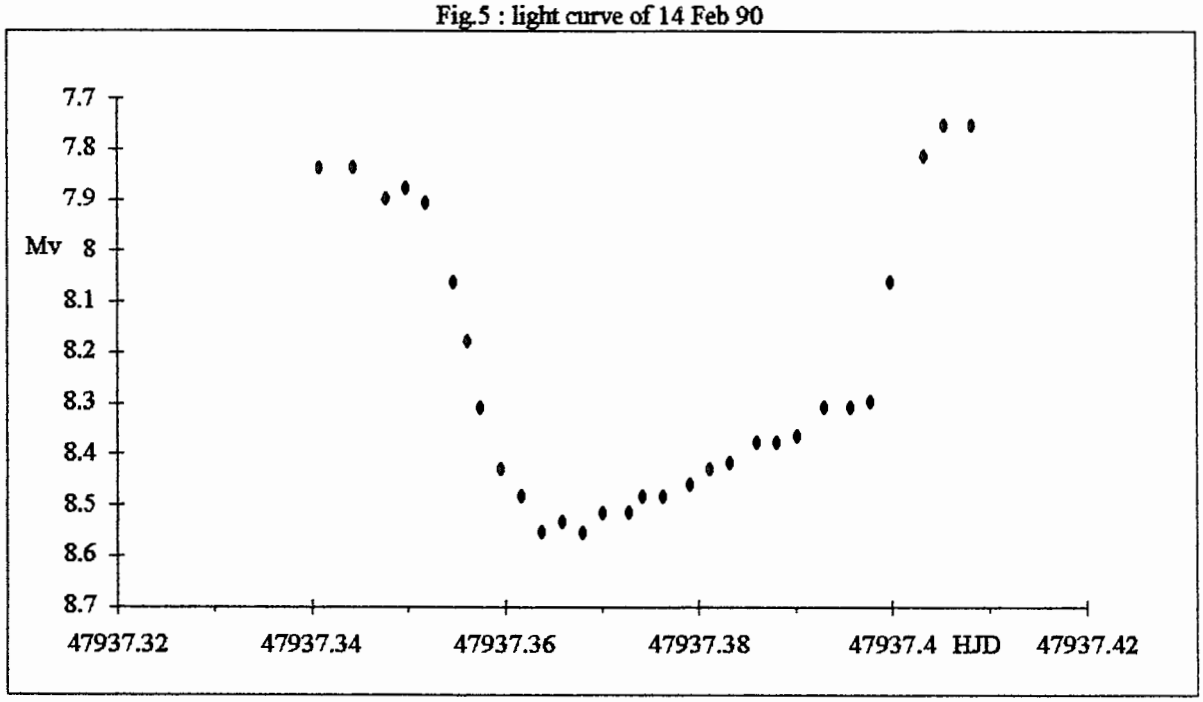


Fig.6 : light curve of 30 Apr 90

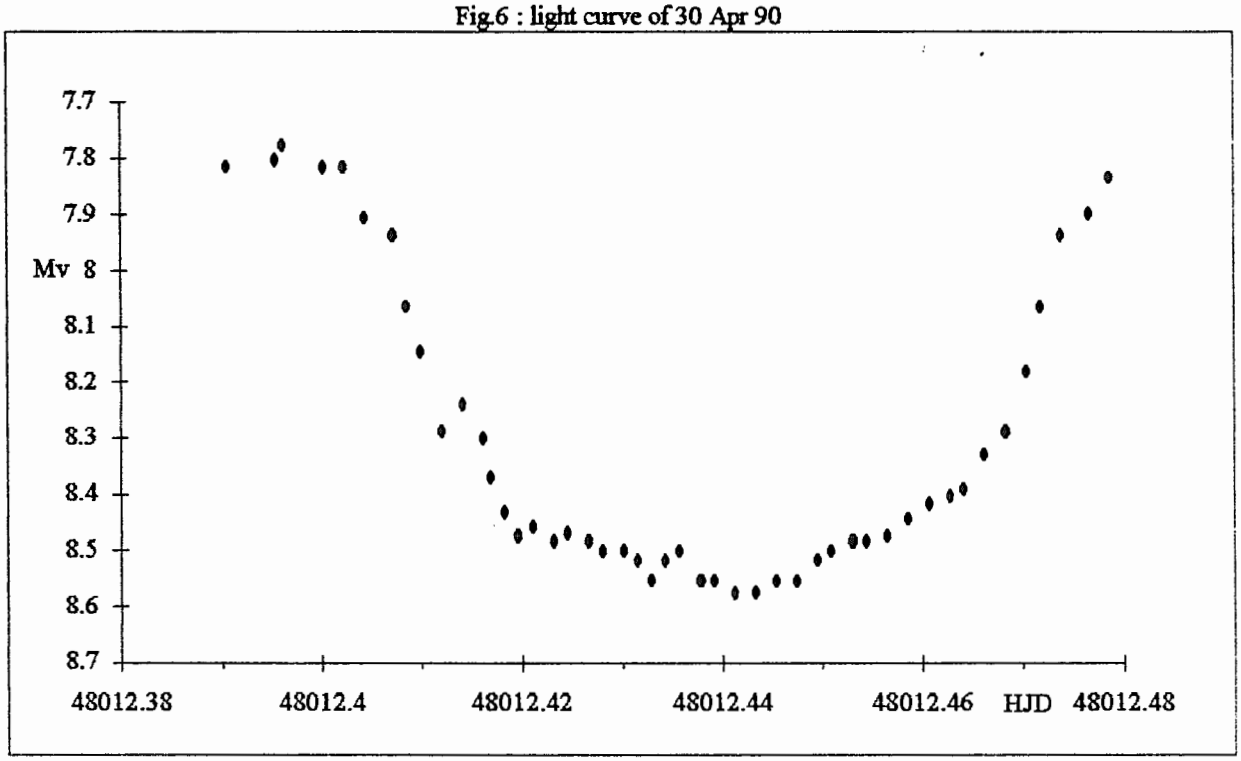
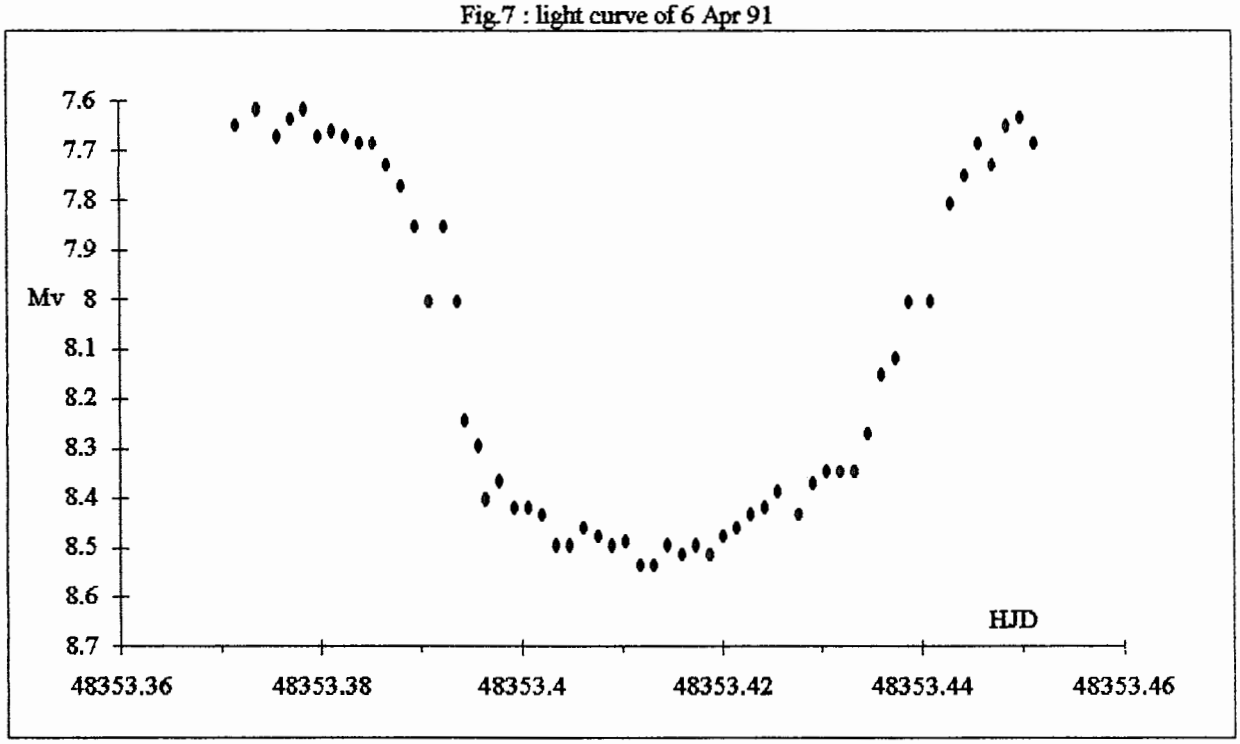


Fig.7 : light curve of 6 Apr 91



The 14 Feb 90's light curve shows a gradual light increase at minimum of about 0.1-0.2 magnitude, while 30 Apr 90's light curve has a greater width than the others.
The comparison with light curve of fig.7 shows these deviations from the "normal" light curve of 6 Apr 91.

Conclusions

Visual observations in years 1990/1995 and previous photoelectric measures by other astronomers indicated a new ephemeris for W UMa, with a period shorter than all previously provided. By visual observations too, light increase or decrease can be seen in light curves, confirming the binary system shows activity with features which could be periodical. Demonstrating this phenomenon doesn't seem to be beyond visual observations, so I ask all GEOS members to direct their telescopes at the W UMa system at least 2 or 3 times in the year and to send me their visual estimates for reaching a more concrete result.

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References:

(1) AA.VV. - *Rocznik Astronomiczny Obserwatorium Kraskowiego*
(2) AA.VV. - *General Catalogue of Variable Star* (1985)
(3) E.HAMZAOGLU et al. - *Information Bullettin on Variable Stars*, **2083**(1982)
(4) O.TÜMER et al. - *Information Bullettin on Variable Stars*, **1783**(1980)
(5) B.M.DAVAN - *Information Bullettin on Variable Stars*, **3021**(1987)
(6) A.GASPANI - *Stochastic Optimization Program*, **5**
(7) D.HANZL - *Information Bullettin on Variable Stars*, **3423**(1990)
(8) V.KESKIN et al. - *Information Bullettin on Variable Stars*, **3355**(1989)
(9) J.KELEMEN - *Information Bullettin on Variable Stars*, **2745**(1985)