PERIOD CHANGE IN THE CONTACT SYSTEM AW UMA

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ABSTRACT. Nine new minima were determined from the UBV photelectric observations obtained in 1992 and 1995-6. They were used to derive the new ephemeris of AW UMa. The mid-eclipse brightening best visible in U colour was detected. Possible reasons of the observed orbital period decrease are discussed.

Key words: Stars: eclipsing binaries, AW UMa

Introduction

AW UMa is a bright (V_{max}=6.84^m) F0-F2 A-type W UMa system (orbital period P = 0.43873 days) discovered and classified by Paczynski (1964). It has the lowest known mass ratio ($\approx$ 0.075) among W UMa binaries. Changes of the form of the light curve were found by Kalish (1965), Dworak and Kurpinska (1975), Woodward et al. (1980), Istomin et al. (1981), Hrivnak (1982), Derman et al. (1990) and Bakos et al. (1991). During 1989-90 observing seasons unusually strong light and colour variations as large as 0.15^m were observed by Derman et al. (1990) in a few days time interval. The orbital period change was found by Woodward et al. (1980) and Istomin et al. (1981). Hrivnak (1982) considered either sudden or continuous decrease of the period. Demircan et al. (1992) discussed following mechanisms for the period decrease: (i) a mass transfer from the more massive to the less massive component, (ii) an interaction with a disk or a shell around the system. Very slow mass transfer from the less massive to the more massive component slows the period decrease.

The last spectroscopic study of AW UMa was made by Rucinski (1992). He assumed the inclination angle i = 80^o and the mass ratio q = 0.075 from the light curve solutions. Two sets of spectroscopic data obtained in 1988 (I) and 1989 (II) lead to the masses of the components as follows: $M_1^I = 1.28 \pm 0.14$ M$_\odot$, $M_2^I = 0.096 \pm 0.012$ M$_\odot$ and $M_1^{II} = 1.79 \pm 0.28$ M$_\odot$, $M_2^{II} = 0.134 \pm 0.023$ M$_\odot$.

Light curves, times of minimum and period study of AW UMa

Our UBV photoelectric observations of AW UMa were obtained at the Skalnaté Pleso and Stará Lesná observatories in 1992 and 1995-6, respectively. In both cases a single-channel pulse-counting photoelectric photometer installed in the Cassegrain focus of the 0.6m reflector was used. Integration time of one measurement was 6-10 seconds. BD +31^{o}2270 served as the comparison star.

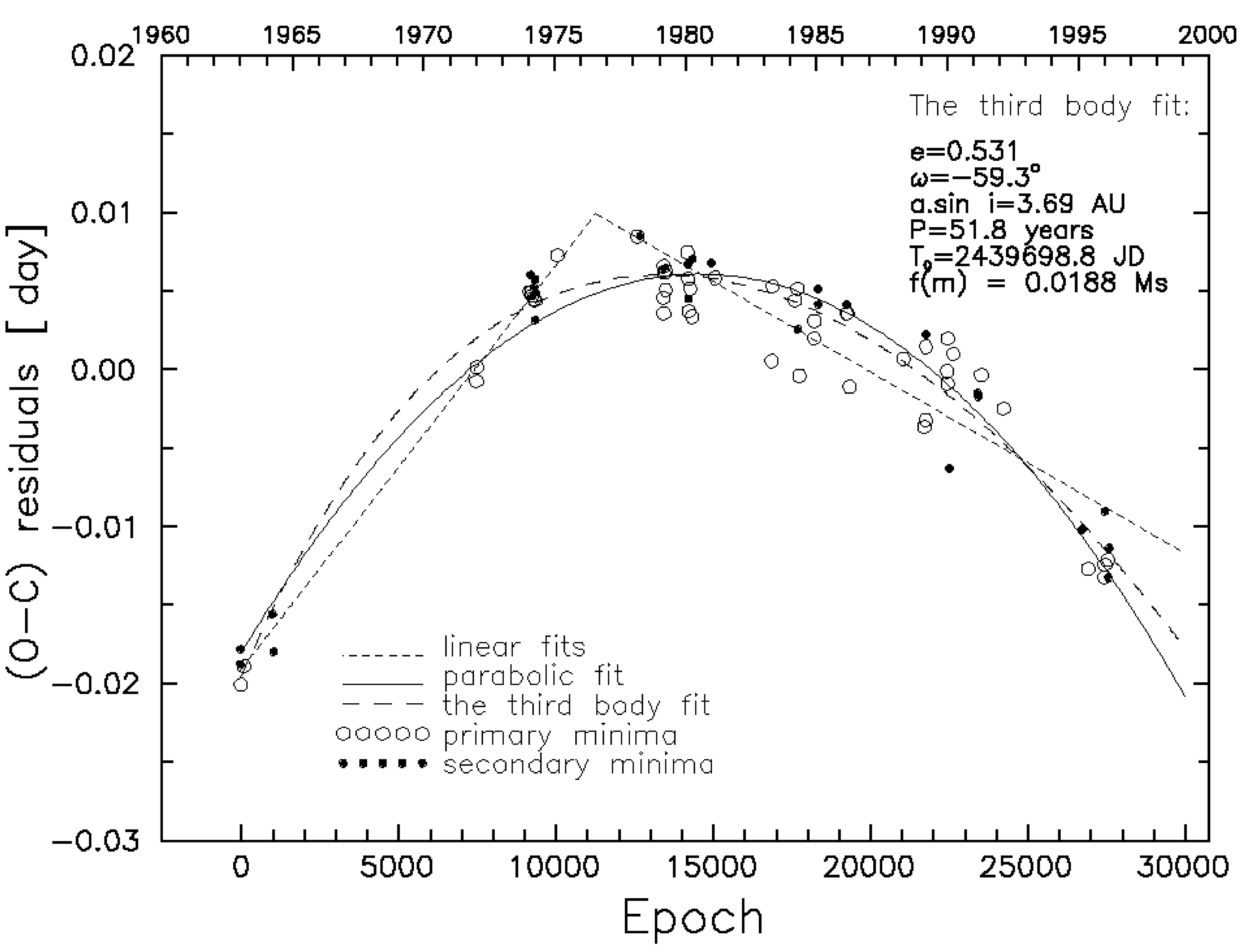

Figure 1: The (O-C) diagram for the times of the primary and secondary minima calculated using the ephemeris (1).

Our U,B,V light curves of AW UMa are plotted in Fig. 2. The light curves seems to be without complications described by Derman et al. (1990) and Bakos et al. (1991), suggesting the decrease of activity in the system. In the secondary minimum (when the smaller component was totally eclipsed) a mid-eclipse brightening, best visible in U colour, was registered.

Nine heliocentric times of minima determined from our UBV observations are listed in Table 1. They were used together with published photoelectric times of minima (see Bakos et al., 1991 and Demircan et al., 1992) to study period change.

The (O-C) residuals (Fig. 1) were calculated using the HJD ephemeris:

$$Min\,I = 2\,438\,044.8004 + 0.43872974 \times E. \qquad (1)$$

The period change given in Fig. 1 may represent either 1) a sudden period change from one constant period to another constant period or 2) a continuously changing period (real or apparent). The first explanation implies that the period changed in 1976. The ephemerides be-

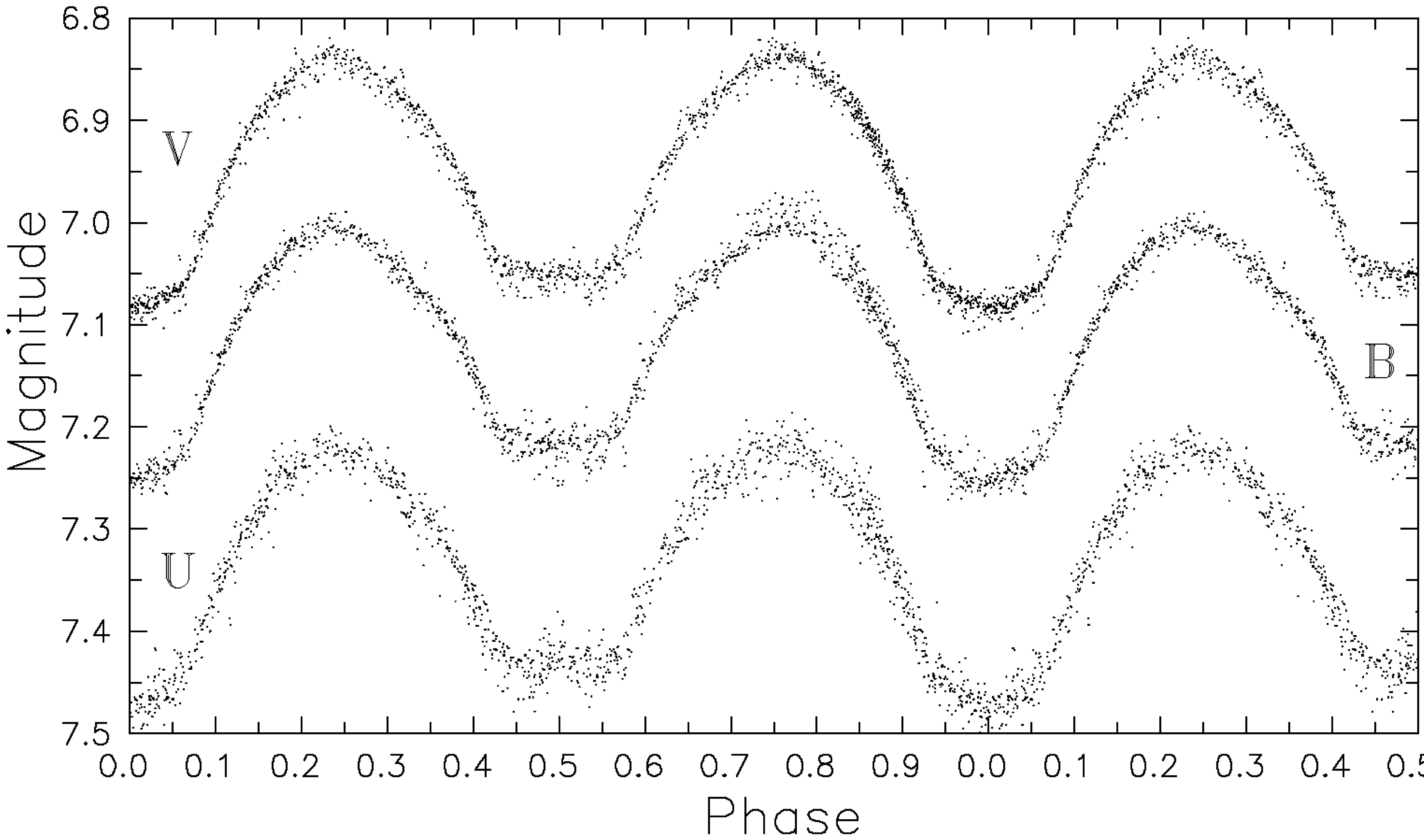

Figure 2: U,B,V light curves of AW UMa. Phases were calculated using the ephemeris (4).

Table 1: New times of minima for AW UMa

Epoch	JD Hel.	Error	Observatory
24249	48683.5554	0.0005	S. Pleso
26744.5	49778.39774	0.0002	S. Lesná
26936	49862.4120	0.0008	S. Lesná
27469.5	50096.478	0.001	S. Lesná
27472	50097.5706	0.00004	S. Lesná
27474	50098.44886	0.00002	S. Lesná
27567	50139.4693	0.0002	S. Lesná
27572	50141.4447	0.0004	S. Lesná
27617	50161.4076	0.0004	S. Lesná

fore (E< 11 286) and after this change are as follows:

$$Min\,I = 2\,438\,044.7813 + 0.43873231 \times E. \quad (2)$$

$$Min\,I = 2\,438\,044.8234 + 0.43872858 \times E. \quad (3)$$

The ephemerides indicate a period jump $\Delta P/P = -8.5\,10^{-6}$, caused by the sudden mass transfer burst from the more to less massive component.

The ephemeris for the real continuously changing period was found by fitting the residuals with a quadratic fit as follows:

$$Min\,I = 2\,438\,044.7824 + 0.438733046 \times E - 1.132\,10^{-10} \times E^2. \quad (4)$$

The times of future minima can be estimated using this ephemeris. Real continuous decrease of the period ($\Delta\ P/P\ = -2.26\,10^{-10}$) is caused by the continuous mass transfer between the components and/or interaction with the circumstellar disk or shell.

Apparent change of the period is caused by a light time effect due to the presence of the third body in the system. The third body fit and corresponding spectroscopic elements found by the simplex method are given in Fig. 1. The derived elements are very uncertain, because only the part of possible 51.8 years light time curve is covered. Using the mass function f(m) = 0.0188 $M_\odot$ and the total mass of the binary (Rucinski, 1992), one can easily find the mass of the third body (in the case of coplanar orbits) as 0.40 $M_\odot$ (M_{1+2} = 1.376 $M_\odot$) or 0.49 $M_\odot$ (M_{1+2} = 1.924 $M_\odot$). The sum of squares of residuals for the third body fit (2.61 $10^{-4}d^2$) is better than that for the quadratic fit (3.22 $10^{-4}d^2$) or two linear fits (3.86 $10^{-4}d^2$). Therefore the sudden period change is the least probable.

Acknowledgements. The research has been supported through the Slovak Academy of Sciences grant No. 1282/1996.

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