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# THE DATABASE ASAS AND THE PERIODS OF SEVERAL EARLY-TYPE BINARIES

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The database ASAS (Pojmański 2002) is quite important for studies of eclipsing binaries (Otero 2003). It allows to obtain minima of southern objects (as a matter of fact, by $+30^\circ$ declination) – such measurements have been quite rare last years. Here the database is used for six early-type binaries. The calculated times of minima are collected in Table 1.

**EM Car** is a well known O 8 type eclipsing binary with orbit of small eccentricity (Andersen & Clausen 1989, hereafter AC; Stickland et al. 1995). New times of minima should help to precise the period of apside line rotation. All known times of minima are displayed in Fig. 1. A minimum measured by the writer at La Silla during another project is included too (the first row of Table 1; observing details see Mayer et al., 1998). $O-C$ were calculated using the ephemeris by AC:

$$\text{Prim.Min.} = \text{HJD } 2445038.8001 + 3\overset{\text{d}}{.}4142765 \times E.$$

The best fit of minimum times gives the formula

$$O-C = 0\overset{\text{d}}{.}0132 - 0\overset{\text{d}}{.}0000016 \times E \pm 0\overset{\text{d}}{.}0132 \sin[2\pi * (E-1250)/4600];$$

$+$ sign is valid for primary, $-$ for secondary minima. Terms with $E$ of power $\geq 2$ are smaller than $0\overset{\text{d}}{.}0001$ and are not considered. Apparently the sidereal period is a little shorter ($3\overset{\text{d}}{.}4142749$) than given by AC; the apside line rotation period is 43 years, time of periastron passage JD 2449306, and eccentricity is unchanged: $e = 0.0120$. However, the errors of the new minimum times are rather large and the differences against values given by AC are not strongly constrained.

**SV Cen** is a binary with the largest rate of change of period among all binaries, see e.g. Drechsel & Lorenz (1995; hereafter DL). Since it might not be unambiguous to calculate the number of epochs even in an interval only a decade long (the interval between DL measurement and ASAS), we divided the ASAS data to two parts and calculated the period valid for the interval from the year 2000 to 2003, with the resulting value of the period $1\overset{\text{d}}{.}65764$. According to DL, the period in February 1993 was $1\overset{\text{d}}{.}65811$; calculating the epoch number with the period equaling the mean of these two values ($1\overset{\text{d}}{.}65788$), we got the numbers in Table; the corresponding $O-C$ are displayed in Fig. 2. The average period in the interval from 1993 to 2001 was then $1\overset{\text{d}}{.}65770$. The shortening of the period was considerable sometime around the year 1993.

Table 1: The times of minima

| Name | HJD−2400000 (error) | Epoch | $O-C$ days | Source |
|---|---|---|---|---|
| EM Car | 48686.9690(20) | 1068.5 | 0.0145 | see text |
| | 52278.7712(12) | 2120.5 | -0.0022 | ASAS |
| | 52280.5022(26) | 2121 | 0.0216 | ASAS |
| SV Cen | 51918.7470(17) | 5178 | 2.1984 | ASAS |
| | 52634.8504(14) | 5610 | 2.1754 | ASAS |
| AQ Cir | 28656.350 | −21099 | 0.000 | Hoffmeister |
| | 49012.098 | −3332 | 0.009 | Mayer et al. (1998) |
| | 51981.760 | −740 | 0.004 | ASAS |
| | 52829.578 | 0 | 0.000 | ASAS |
| TU Mus | 48500.3080 | 0 | 0.0014 | Hipparcos |
| | 52402.7436 | 2813 | 0.0000 | Terrell et al. |
| | 52492.9188 | 2878 | 0.0016 | ASAS |
| V431 Pup | 52944.8168(30) | 474 | | ASAS |
| V701 Sco | 52081.5401(22) | 7720.5 | 0.0161 | ASAS |
| | 52081.9210(15) | 7721 | 0.0161 | ASAS |
| | 52729.1292(14) | 8570.5 | 0.0134 | ASAS |
| | 52729.5081(6) | 8571 | 0.0113 | ASAS |

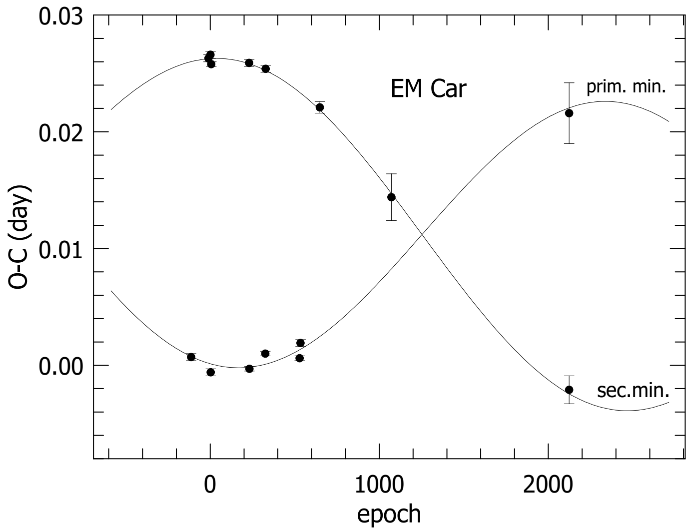


**Figure 1.** $O-C$ graph of EM Car. The curves correspond to the formula given in the text.

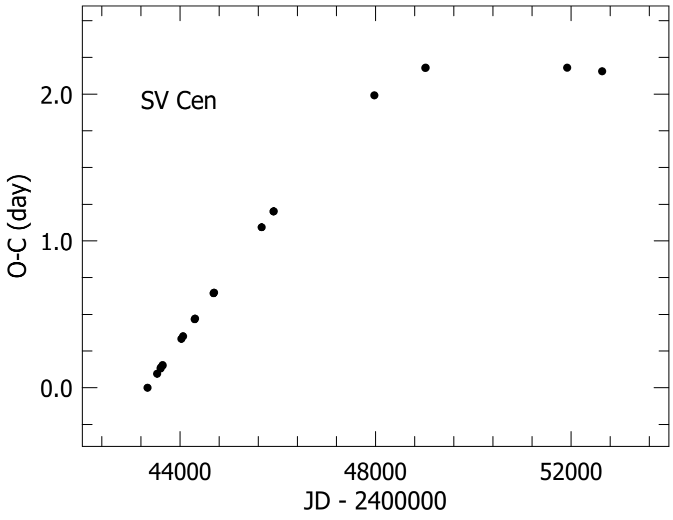


**Figure 2.** $O-C$ graph of SV Cen calculated with ephemeris Prim. min.= HJD 2443332.978 + $1\overset{d}{.}65770 \times E$

**AQ Cir** was classified by Lyngå (1964) as $OB^-$. Dividing the ASAS data into two time intervals, we got times of minima listed in Table 1, and fitting the La Silla measurement (made in $B$; Mayer et al. 1998) to the ASAS light curve (in $V$; therefore not too precise process, due to unknown $B-V$), another time of minimum was obtained. Then the accuracy of the period allowed to use also the original minimum time by Hoffmeister (1943). The resulting ephemeris is

$$\text{Prim.Min.} = \text{HJD } 2452829.5780(7) + 1\overset{d}{.}14570492(7) \times E.$$

**TU Mus** is one of several contact systems of early spectral type; a similar system is V382 Cyg. In Fig. 3, $O-C$ diagram for this star is plotted. The new minimum fits the ephemeris given by Terrell et al. (2003) quite well ($O-C = +0\overset{d}{.}0016$; the epoch of the time of a minimum marked "Terrell et al." in Table 1 has been estimated as the middle of the interval of Terrell's et al. observations). Terrell et al. concluded,that in the time interval covered by observations, the period was constant. But they did not consider the older times of minima by Oosterhoff (1928, 1930) and by Knipe (1971), see Fig. 3. These older minima support a conclusion that TU Mus period lengthens, albeit not regularly – similar behaviour is known for V382 Cyg (Mayer 1980).

**V431 Pup** is a variable found by the satellite HIPPARCOS. It is a rare member of a group of evolved binaries with eccentric orbits. Mayer et al. (2002) gave its period as $9\overset{d}{.}3434$; it depended on the estimation of the number of epochs between the HIPPARCOS minimum and radial velocities measured in thirties. According to the ASAS minimum it appears now that this number of epochs was underestimated by one. It is possible to identify the time of the ASAS minimum with the time of the deepest measurement, as HJD 2452944.8168; this, with the HIPPARCOS time, gives the period as $9\overset{d}{.}35928$.

**V701 Sco** was recently announced as a binary with a possible light time effect (Mayer & Wolf 2002). The ASAS material could be divided into two parts, and times of primary and secondary minima were obtained. These times not only confirm the time of a minimum published by Mayer & Wolf, they also confirm the trend of the period, i.e., its cyclic

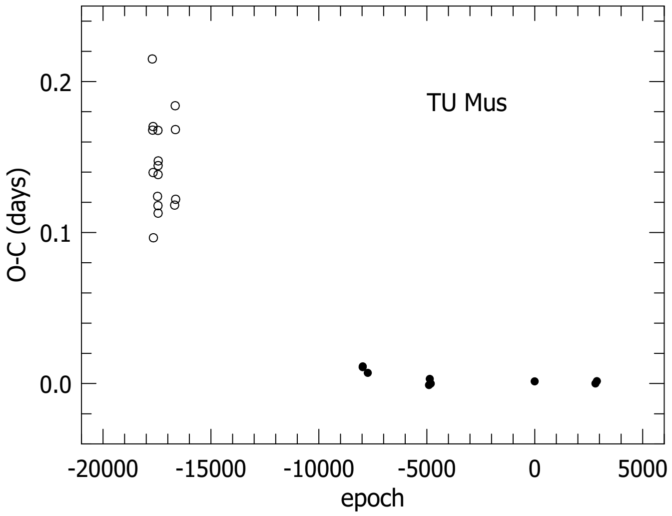


**Figure 3.** $O - C$ graph of TU Mus. Filled circles present the photoelectric minima, open circles the photographic ones. Ephemeris by Terrell et al. is used: Prim. Min. = HJD 2448500.3066 + $1\overset{d}{.}38728653 \times E$.

change. In Table 1, the ephemeris

$$\text{Prim.Min.} = \text{HJD } 2446199.4850 + 0\overset{d}{.}7618728 \times E.$$

is used.

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References:

Andersen, J., & Clausen, A., 1989, *A&A*, **213**, 183
Drechsel, H., & Lorenz, R., 1995, *IBVS*, 3868
ESA, 1997, *The Hipparcos and Tycho Catalogue*, ESA SP-1200, Noordwijk
Hoffmeister, C., 1943, *Kleine Veröf. Berlin-Babelsberg*, **27**
Knipe, G. F. G., 1971, *Republ. Obs. Johannesb. Circ.*, **8**, 8
Lyngå, G., 1964, *Medd. Lund Ser. II*, **No. 141**
Mayer, P., 1980, *BAC*, **31**, 292
Mayer, P., Niarchos, P. G., Lorenz, R., Wolf, M., & Christie, G., 1998, *A&AS*, **130**, 311
Mayer, P., Lorenz, R., & Drechsel, H., 2002, *A&A*, **388**, 268
Mayer, P., & Wolf, M., 2002, *IBVS*, 5293
Oosterhoff, P.Th., 1928, *BAN*, **4**, 188
Oosterhoff, P.Th., 1930, *BAN*, **5**, 156
Otero, S.A., 2003, *IBVS*, 5480
Pojmański, G., 2002, *Acta Astron.*, **52**, 397
Stickland, D. J., Lloyd, C., Koch, R. H., & Pachoulakis, I., 1995, *Observatory*, **115**, 317
Terrell, D., Munari, U., Zwitter, T., & Nelson, R.H., 2003, *AJ*, **126**, 2988