COMMISSIONS 27 AND 42 OF THE IAU
INFORMATION BULLETIN ON VARIABLE STARS
Number 4835

Konkoly Observatory
Budapest
28 January 2000
HU ISSN 0374 – 0676

THE VARIABLE LIGHT CURVE OF 56 ARIETIS

ŽIŽŇOVSKÝ, J.; SCHWARTZ, P.; ZVERKO, J.

Astronomical Institute, Slovak Academy of Sciences, 059 60 Tatranská Lomnica, Slovak Republic
e-mail: ziga@ta3.sk, weki@ta3.sk, zve@ta3.sk

56 Ari (SX Ari, HD 19832, HR 954) is a well studied CP star with a relatively short period of rotation ($P \approx 0.728$ days). Shore & Adelman (1976) mentioned the possibility of a free-body precession of 56 Ari. Their suspicion was based on spectroscopic study of silicon spots on the surface of the star in different epochs. The explanation of observed variations was based on a nonspherical shape of the star caused by its strong magnetic field. The period of precession was predicted to ≈ 3 years. Photometric investigation of 56 Ari, as well as other short period Ap stars was suggested to prove the hypothesis of long term free-body precession. Adelman & Fried (1993) published their UBV photometry of 56 Ari from the Braeside Observatory covering two observational seasons in 1990 and 1991. Comparing their light curves with those of Hardie & Schroeder (1963) and Blanco & Catalano (1970) they concluded that the light curves of 56 Ari undertook significant changes.

Our observations of 56 Ari were performed with the 60-cm Cassegrain reflector at the Skalnaté Pleso Observatory equipped with an OPTEC SSP-5A photometer with a Hamamatsu R4457 photomultiplier and standard UBV filters. U, B and V light curves were obtained during three seasons: 1996/1997, 1997/1998 and 1998/1999. HR 945 (HD 19600) was used as a comparison star. The same one was used by Hardie & Schroeder (1963), and Adelman & Fried (1993). In the first two seasons the sequence C—V—C—V... was used, where C means two 10 seconds integrations of HR 945 and V four 10 seconds integrations of 56 Ari in each filter. In the season 1998/1999 C was measured once and V twice, using 20 seconds integrations. In the first season 284, in the second one 330 and in the third season 218 measurements of 56 Ari in each filter were secured. Full phase coverage of the curves took 160, 154 and 91 days in the three seasons. The observations were reduced with the REDUCT software package (Komžík 1996).

In Fig. 1 the U light curves of 56 Ari in the first and the third seasons are presented, as these two light curves differ most from each other. We have found differences in the shapes and in the amplitudes of light curves in all three filters. The mean brightness of 56 Ari in the B and V colours is the same as in the years 1990 and 1991 (Adelman & Fried 1993), but it is fainter by ≈ 0.05 magnitudes in U. This difference is probably caused by the red leak of the U filter, as our photomultiplier is sensitive in the red region (up to ≈ 8300 Å). The $B - V$ colour indices of the stars are -0.108 for 56 Ari and $+0.008$ for the comparison star (Mermilliod 1981).

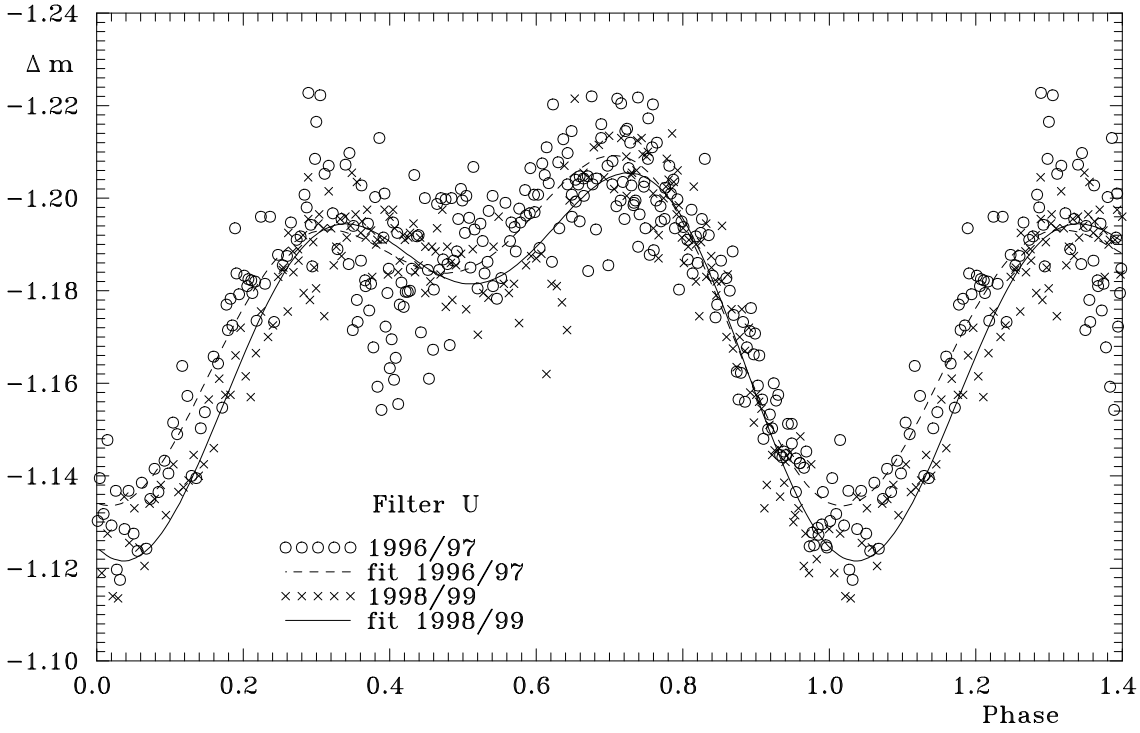

Figure 1. *U* light curves of 56 Ari in two different seasons.

To demonstrate the observed variability of light curves, we present in Fig. 2 only their least-squares fits. The observations were fitted by a sine wave and its first harmonic (Mathys & Manfroid 1985, Heck et al. 1987)

$$\Delta m = a + b\sin(x + \varphi_1) + c\sin(2x + \varphi_2)$$

(where x is the Julian date of observations) with a fixed period. Parameters of the fits: a, b, c, φ_1 and φ_2 are listed in Table 1. S_o is the probable error in magnitudes computed by fit. The ephemeris of Blanco & Catalano (1970)

$$\mathrm{JD_{min}} = 2439797.586 + 0.727902 \times E$$

was used, with the value of period P slightly improved by Adelman & Fried (1993).

Table 1: Parameters of fits of light curves

Season	Filter	a	b	c	φ_1	φ_2	S_o
1996/97	U	−1.178	0.027	0.019	1.220	1.520	0.011
1997/98	U	−1.174	0.027	0.014	1.187	1.226	0.010
1998/99	U	−1.173	0.031	0.021	1.200	1.216	0.008
1996/97	B	−0.769	0.020	0.015	−1.234	−1.540	0.008
1997/98	B	−0.767	0.020	0.014	−1.378	1.404	0.009
1998/99	B	−0.766	0.024	0.018	−1.421	1.235	0.008
1996/97	V	−0.638	0.012	0.011	−1.529	−1.532	0.007
1997/98	V	−0.638	0.012	0.009	−1.531	1.454	0.007
1998/99	V	−0.637	0.017	0.013	−1.568	1.350	0.009

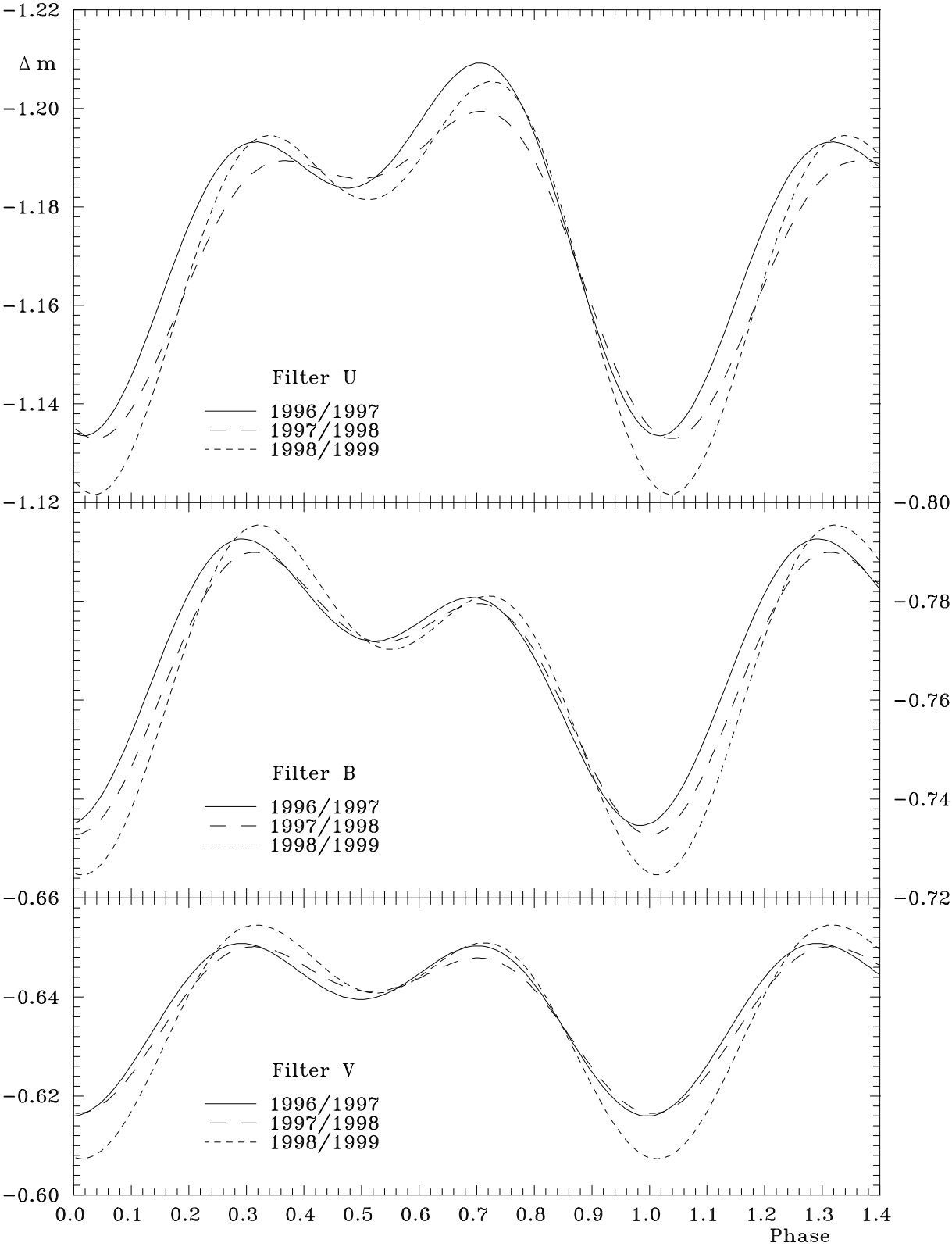

Figure 2. The fits of the three light curves in three different seasons.

The general shape of our light curves is similar to that of Adelman & Fried (1993). The B and V light curves have their primary maxima near phase 0.3, while the U light curve reaches its maximum near phase 0.7. As follows from Fig. 2, the largest differences are between the U light curves. Contrary to this, according to Adelman & Fried (1993) their U light curves of 56 Ari in 1990 and 1991 are more similar than those of B and V. The shape of the B and V light curves of Blanco & Catalano (1970) obtained in 1967 is the same as in this paper. Their U light curve, however, reaches the maximum near phase 0.3, or at least, both the maxima at phases 0.3 and 0.7 are of the same brightness.

There are differences in the positions of primary minima in all the three colours. While the primary minima for U light curves were almost exactly at phase 0.0, the primary minima of the B and V light curves were shifted to phase ≈ 0.95 in the years 1990 and 1991 (Adelman & Fried 1993). In our data sets the V light curves of the first two seasons have their primary minima at phase 0.0 but they are shifted to ≈ 0.02 in the third season. Our B and U light curves show a gradual shift of the minima towards phase 0.02 in the B and 0.04 in the U filter. Such a behaviour of the positions of minima in a phase diagram could be attributed to the increase of the rotational period. Musielok (1988) found an increase of the period by 4 seconds per 100 years for this star, caused by magnetic braking. This value is too small to be recognized in our light curves, as the observations cover an interval of 846 days only. Similar shifts of the primary maxima of the B and V light curves and of both the primary and the secondary maxima of the U light curve are indicated by our fits. The falling branch of our light curves (phases 0.8–0.9) remains unchanged in all the three seasons.

The observed shifts of primary minima, as well as changes in the shapes of light curves are most probably caused by a free-body precession of 56 Ari.

This work was supported by VEGA grant No. 4175/97.

References:

Adelman, S.J., Fried, R., 1993, *Astron. J.*, **105**, 1103
Blanco, C., Catalano, F.A., 1970, *Astron. J.*, **75**, 53
Hardie, R.H., Schroeder, N.H., 1963, *Astrophys. J.*, **138**, 350
Heck, A., Mathys, G., Manfroid, J., 1987, *Astron. Astrophys. Suppl. Ser.*, **70**, 33
Komžík, R., 1996, *Private comm.*
Mathys, G., Manfroid, J., 1985, *Astron. Astrophys. Suppl. Ser.*, **60**, 17
Mermilliod, J.-C., 1981, *NASA ADC CD-ROM, Selected Astron. Cat.*, Vol. 1
Musielok, B., 1988, *IBVS*, No. 3257
Shore, S.N., Adelman, S.J., 1976, *Astrophys. J.*, **209**, 816