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DOES THE PERIOD OF BE LYNCIS REALLY VARY?

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The first period variation analyses (Liu et al., 1991, Tang et al., 1992, Liu & Jiang., 1994) of the HADS star BE Lyncis ($m_V \approx 8.8$ mag, $P = 0^d.09586954$) indicated a parabolic fit of the $O - C$. Kiss & Szatmáry (1995) suggested the presence of period variations possibly due to a companion. Derekas et al. (2003, D03) re-analysed the available data, and disproved the light-time hypothesis. They also noted that the scatter of the points in the $O - C$ diagram was slightly higher than the accuracy of individual data points, which might refer to microvariability. However, both Rodríguez et al. (1996) and D03 failed to detect additional frequency components. Later, Fu & Yiang (2005) revived the binary hypothesis again. The purpose of this paper is to test whether there is cyclic phase modulation in the light curve of BE Lyn that may refer to a light-time effect. We present 6 times of maxima from the period between 2003–2006, and re-analyse the available light curve data with phase shift analysis (e.g. Jurcsik et al., 2001) using template curve fitting.

Table 1: The log of new observations

Date	HJD (first point)	length (hour)	number of points	instrument	filter
2003.12.08	2452981.51	4.03	174	1.0 RCC	V
2004.04.22	2453119.47	2.98	281	1.0 RCC	V
2006.10.18	2454027.47	4.97	567	0.4 N	V
2006.10.19	2454028.42	5.90	668	0.4 N	V
2006.10.27	2454036.44	5.74	568	0.4 N	V
2006.10.30	2454039.42	6.47	833	0.4 N	V

We took new CCD observations of BE Lyn from two different sites. First, we used the the 1-meter RCC telescope of Konkoly Observatory, located at the Piszkéstető Mountain Station (1.0 RCC). The typical integration time was 8 s for Johnson V filter. In October, 2006 further observations were made with the 40 cm Newton telescope (0.4 N) of the University of Szeged, Dept. of Experimental Physics and Astronomical Observatory. Instrumental magnitudes were taken with Johnson V filter and with typically 10 seconds exposures. The log of observations is listed in Table 1, the light curves are shown in Fig. 1. The light curves are published electronically on the IBVS site (as `5816-t2.txt`).

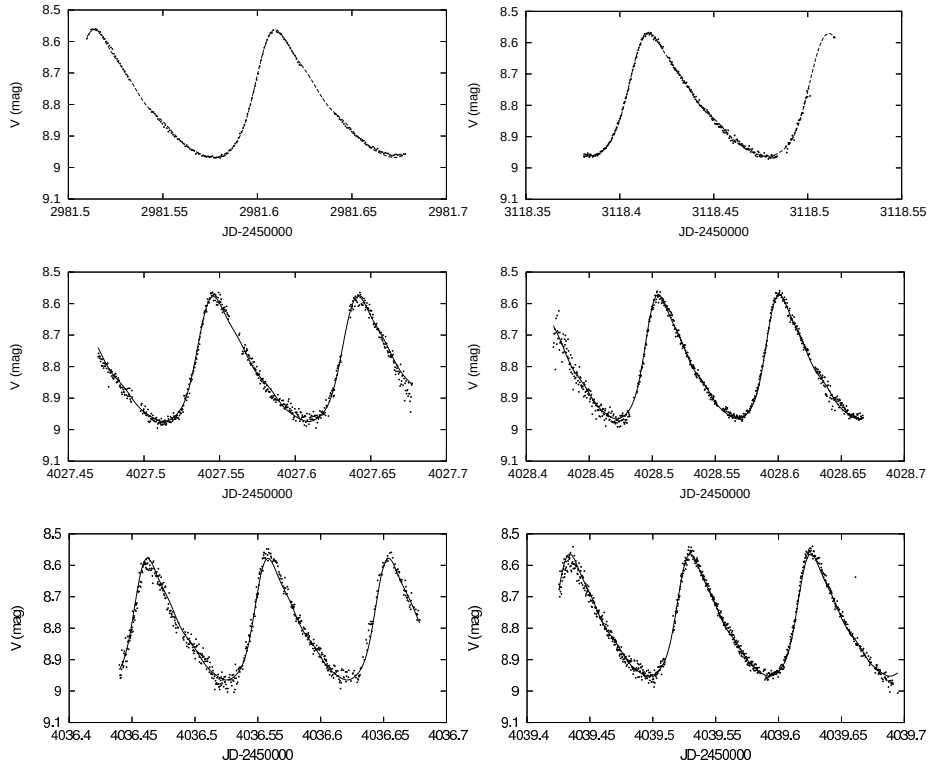

Figure 1. New light curves of BE Lyncis

In addition to the new observations, we collected light curves obtained between 1987 and 2007 from the literature. A template curve was determined by a 5-th order Fourier fit to all observations,

$$f(t) = a_0 + A \sum_{k=1}^{5} \left(a_k \sin k\phi + b_k \cos k\phi \right),$$

where A is the relative amplitude, a_0 is the mean brightness and $\phi = 2\pi t/P$. The resulted coefficients defining the template curve are: $a_0 = 8.8128$, $a_1 = 0.0740$, $b_1 = -0.1578$, $a_2 = 0.0523$, $b_2 = 0.0151$, $a_3 = 0$, $b_3 = 0.0207$, $a_4 = -0.0097$, $b_4 = 0$, $a_5 = -0.0034$, $b_5 = -0.0041$. If $A = 1$, this template curve has a total amplitude of 0.395 mag. The template curve was then fitted to the individual observing runs allowing a slight global phase shift. Because the observed light curve varied slightly, the A amplitude parameter and the a_0 mean brightness was also fitted as a free parameter. The time of maximum of the best-fit model light curve can be similarly evaluated as the $O-C$, using calculated moments of maxima as $C = 2449749.4651 + 0.09586952 \cdot E$. We determined a refined period as $P = 0\overset{\mathrm{d}}{.}09586952 \pm 0\overset{\mathrm{d}}{.}00000003$ at 3–σ confidence level.

Photometric data were available for us from Oja, 1987; Rodríguez et al., 1990, Kiss & Szatmáry, 1995; D03 and the measurements published here. We show the $O-C$ diagram of maxima for all published data in the upper panel of Fig. 2. The lower panel shows the phase shift diagram ($O-C$ of the fitted template curves) from the available photometries suitable for re-analysis (for comparison, these points are highlighted with filled circles in the upper panel). The errors were calculated from the correlation matrices of the parameters.

All new and re-determined times of maxima and amplitudes are available at the IBVS

site (as `5816-t3.txt`). This table also includes the moments of maxima from the archive time series even if the data were not available for the present analysis, in this case the appropriate columns are vacant.

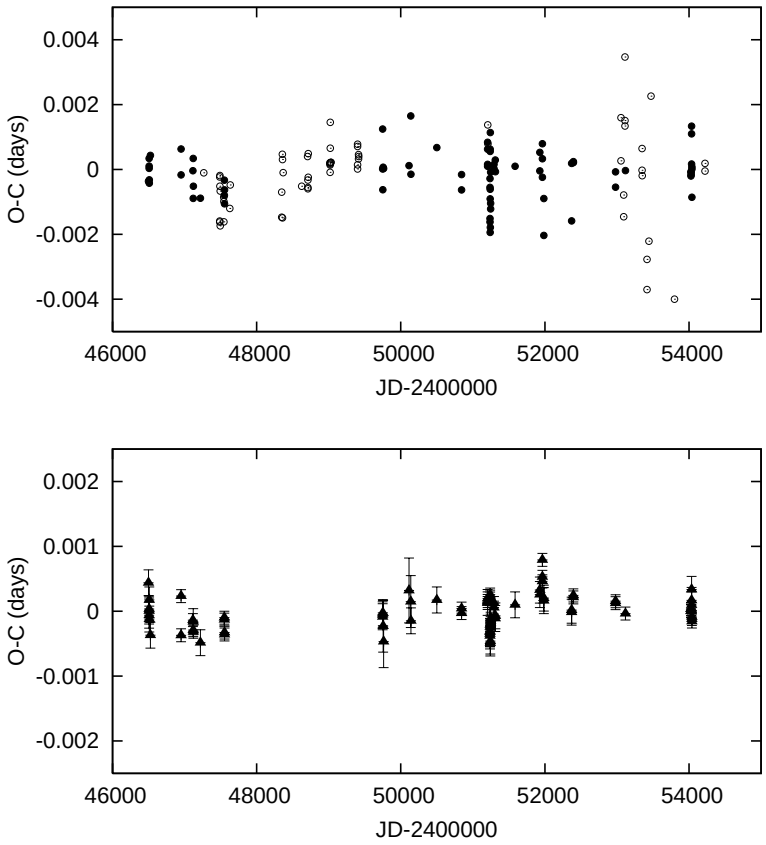

Figure 2. Upper panel: the $O-C$ of BE Lyn from times of maxima. All published data are plotted, filled circles show photometries involved into phase shift analysis. Lower panel: The phase shift diagram of BE Lyncis. Note that the $O-C$ axis has half scale as in the upper panel.

The re-determined times of maxima show only little variation, all data points are practically 0 within some 10 seconds accuracy. This strongly suggests that there is no variation in the global phase of the light curves. On the other hand, we confirm that the scatter of the classical $O-C$ diagram is too high to be a single artefact (as also noted by D03). Thus, we suggest that the phase of the maximum brightness varies slightly, leading to the observed behaviour of the $O-C$ of light maxima.

Amplitude variations are present in the data set with a range of about 0.03 mag (Fig. 3), as first noted by Rodríguez et al. (1996). We revisited the nature of the amplitude variation using Fourier-analysis, and we confirm that it is not periodic. The majority of the observed amplitudes is between 0.375 and 0.415 mag. This may be caused either by the different instrumental systems or simply by the extinction corrections, which lacks in some cases.

The correlated variation of the light curve shape and the amplitude is a known property of the Blazhko RR Lyrae stars (Jurcsik et al., 2005). The suspected variation of the amplitude and the light curve shape of BE Lyncis might suggest that they also vary in

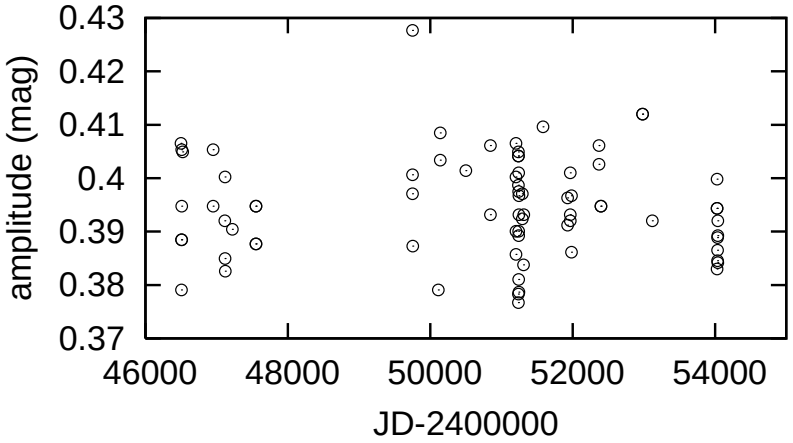

Figure 3. The variation of the total amplitude of BE Lyncis from template fitting.

a correlated way. To test this in BE Lyn, we plotted the phase of the maximum vs. the amplitude, and we found them to be uncorrelated.

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