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HAS THE DELTA SCUTI STAR BE Lyn A COMPANION?

The high amplitude δ Scuti-type variation (V=8.6-9.0 mag, A3) of BE Lyn (= HD 79889 = HIC 45649) was discovered by Oja (1986, 1987). The period change was discussed in some papers (Rodríguez et al., 1990a, Liu et al., 1991, Tang et al., 1992, Wunder et al., 1992, Liu and Jiang 1994, Rodríguez et al., 1995). Earlier the O−C diagram was fitted with a negative parabola, later with a positive parabola. The aim of our measurement was to obtain new points on the O−C diagram in order to determine the recent period variation.

We carried out photoelectric photometry (through Johnson UBV filters) of BE Lyncis on three nights: 31 Jan, 5 and 13 Feb 1995 with the 40 cm Cassegrain telescope and SSP-5A photometer of Szeged Observatory, Hungary. The comparison star was HIC 45515 (V=9.30 mag, F8). The phase diagram of the light curve is plotted in Figure 1. The period was determined with the Phase Dispersion Method.

The new times of maxima are listed in Table 1, where the O−C residuals have been obtained from the ephemeris:

$$Hel.JD\,max = 2449018.2684 + 0.09586953 \times E$$

The O−C diagram (N=65) can be seen in Figure 2. Instead of parabola we fitted a light-time effect curve supposing a cyclic period variation due to orbital motion in binary system. The parameters of the fit and their estimated errors are given in Table 2.

Accepting $M_1 = 1.7 \pm 0.1\ M_\odot$ mass for the pulsating component (Claret et al. 1990, Rodríguez et al., 1990b), we can calculate the semi-major axis of the orbit of the secondary and its mass with iteration (Table 3). The errors are due to the uncertainty of the P and M_1. The results suggest a red or brown dwarf companion which is probably not detectable in the spectrum of BE Lyn due to its low brightness. The calculated orbital radial velocity amplitude (K) of the delta Scuti star is very small, therefore the spectroscopic measurements cannot help to confirm the binary nature.

There is an interesting possibility to determine the pulsation constant (Jørgensen and Grønbech, 1978). Combining Kepler's third law and the pulsation constant formula

$$\frac{a^3}{P_{orb}^2} = \frac{G}{4\pi^2}(M_1 + M_2), \qquad and \qquad Q = P_{pul}\left(\frac{M_1}{R_1^3}\right)^{1/2} \tag{1}$$

we obtain

$$Q = 0.1159\frac{P_{pul}}{P_{orb}}\left(\frac{R_1}{a}\right)^{-3/2}\left(1 + \frac{M_2}{M_1}\right)^{-1/2} \tag{2}$$

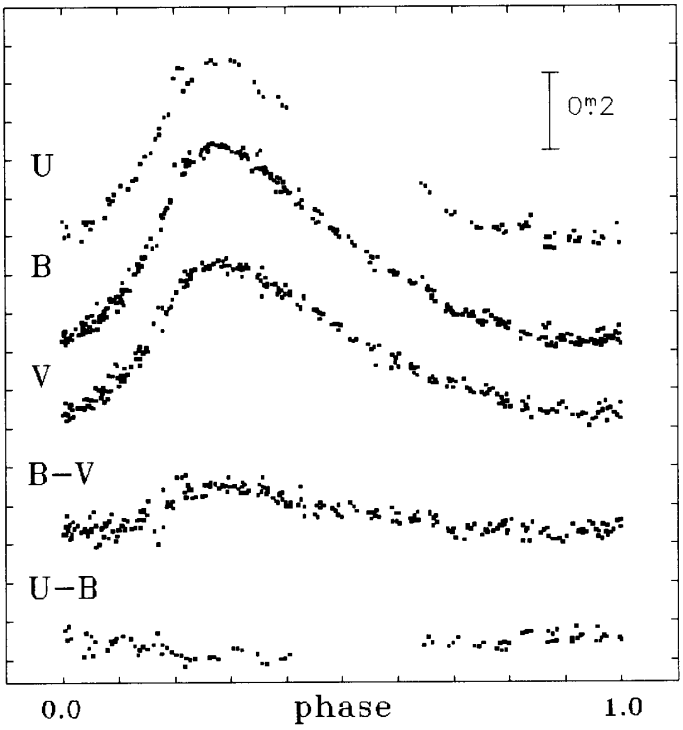

Figure 1. Phase diagram of BE Lyn (P=0.0958784 day, T_0=2449018.2684)

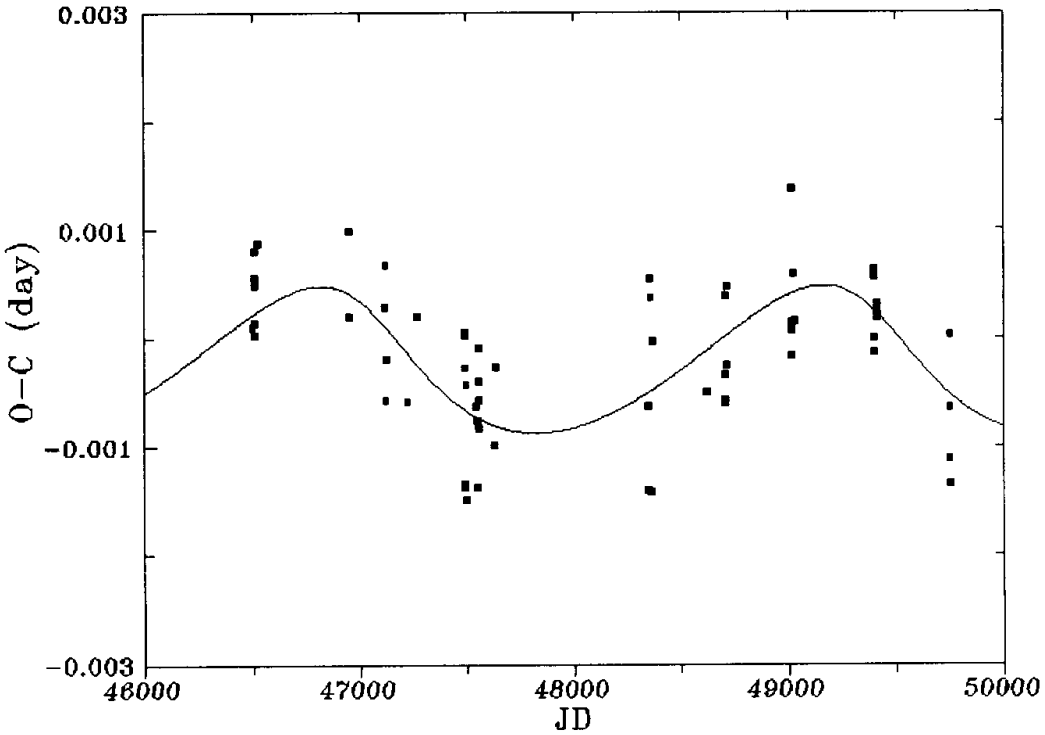

Figure 2. O−C diagram of BE Lyn with the fitted light-time curve (P=2350 day)

Table 1. Times of maximum light in early 1995

No.	Hel.JD	O−C (day)
1	2449749.4642	−0.00111
2	2449749.5612	+0.00003
3	2449749.6564	−0.00064
4	2449754.3533	−0.00135

Table 2. Parameters of the light-time curve

$P_{orb} = 2350 \pm 100\ day$
$a_1 sin\, i = 18 \pm 2 \times 10^6\ km$
$e = 0.30 \pm 0.05$
$\omega = 140° \pm 5°$
$\tau = 2447050 \pm 50$
$t_0(O - C = 0) = 2448700 \pm 50$
$K = 0.58 \pm 0.10\ km/s$
$f(M_2) = (4 \pm 1) \times 10^{-5}$
$A_{O-C} = (6.8 \pm 1.0) \times 10^{-4}\ day$

Table 3. Inclination, semi-major axis of the orbit and mass of the companion

$i(deg)$	$a(AU)$ ±0.08	$M_2(M_\odot)$ ±0.012
10	4.35	0.313
30	4.19	0.101
50	4.17	0.065
70	4.16	0.053
90	4.15	0.049

Adopting $P_{pul} = 0.09587$ days, $P_{orb} = 2350 \pm 50$ days, $R_1 = 2.43 \pm 0.10\ R_\odot$, $a = 4.2 \pm 0.1$ AU, $M_1 = 1.7 \pm 0.1\ M_\odot$ and $M_2 = 0.05 - 0.3\ M_\odot$ we calculated $Q = 0.033 \pm 0.004$. This value corresponds to the radial fundamental mode (eg. Petersen and Jorgensen 1972). Rodríguez et al. (1990b) and Garrido et al. (1990) also concluded that this mode is excited.

On the other hand accepting M_1 and R_1 (Rodríguez et al., 1990b) the $m16\epsilon07-08-09$ and $m18\epsilon07-08-09$ models of Milligan and Carson (1992) give for the linear adiabatic periods $P = 0.086 - 0.107$ days with an average of $P = 0.094$ days which is very close to the observed P_{pul}. The pulsation constant from these models $Q = 0.0326 \pm 0.0001$ which is similar to the value calculated above.

This means that the physical parameters of the star, the radial pulsation in the fundamental mode and the binary orbit determined from the O−C diagram are in agreement.

We conclude that BE Lyn may have a low mass companion. Of course, the binary hypothesis can be confirmed only a few years later.

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References:

Claret, A., Rodríguez, E., García, J.M., 1990, *Rev. Mexicana Astron. Astrof.*, **21**, 389
Garrido, R., García-Lobo, E., Rodríguez, E., 1990, *Astron. Astrophys.*, **234**, 262
Jørgensen, H.E., Grønbech, B., 1978, *Astron. Astrophys.*, **66**, 377
Liu, Y.Y., Jiang, S.Y., Cao, M., 1991, *Inf. Bull. Var. Stars*, No. 3607
Liu, Z., Jiang, S.Y., 1994, *Inf. Bull. Var. Stars*, No. 4077
Milligan, H., Carson, T.R., 1992, *Astrophys. Space Sci.*, **189**, 181
Oja, T., 1986, *Astron. Astrophys. Suppl. Ser.*, **65**, 405
Oja, T., 1987, *Astron. Astrophys.*, **184**, 215
Petersen, J.O., Jørgensen, H.E., 1972, *Astron. Astrophys.*, **17**, 367
Rodríguez, E., López de Coca, P., Rolland, A., Garrido, R., 1990a, *Rev. Mexicana Astron. Astrof.*, **20**, 37
Rodríguez, E., Rolland, A., López de Coca, P., 1990b, *Astrophys. Space Sci.*, **169**, 113
Rodríguez, E., López de Coca, P., Costa, V., Martín, S., 1995, *Proc. IAU Coll. 155, Cape Town*, preprint
Tang, Q.Q., Yang, D.W., Jiang, S.Y., 1992, *Inf. Bull. Var. Stars*, No. 3771
Wunder, E., Wieck, M., Garzarolli, M., 1992, *Inf. Bull. Var. Stars*, No. 3791