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DISCOVERY OF SHORT-PERIODIC PULSATING COMPONENT IN THE ECLIPSING BINARY Y LEONIS

TURCU, V.; POP, A.; MOLDOVAN, D.

Cluj-Napoca Astronomical Observatory, Romanian Academy, Cluj-Napoca Branch, Str.Cireşilor 19, RO-400487 Cluj-Napoca, Romania, (e-mail: vladturcu@yahoo.com)

Y Leo (HIP 47178=SAO 80927) is a less studied Algol binary system with orbital period of 1.68610 d, and deep primary eclipses of about 3.1 magnitudes. Spectral type of the primary component is A3 according with Struve (1945). Based on Struve's radial velocity determinations and the most extensive photoelectric $UBVI$ observational study of Y Leo, up to date, made by Johnson (1960), Giuricin et al. (1980) solved the system and determined mass of the primary ($M_h = 2.6 M_{Sun}$).

We have observed Y Leo during winter-spring 2008 season. We present here observations made outside primary eclipse in three nights (orbital phase 0.764 ...0.922 on JD 2454517, 0.680 ...0.877 on JD 2454522, and 0.325 ...0.470 on JD 2454545). The orbital phases were determined with following new ephemeris, based on our data:

$$t_n = HJD\ 2454509.35034 + 1.68610897 \cdot n$$

The telescope used was a 16″Meade LX200 Schmidt-Cassegrain (D = 40cm, F/D =10) at Cluj-Napoca Astronomical Observatory, Feleacu Station (Long. = 23°35′37.″1 E, Lat. = 46°42′36.″3 N, Alt. = 756 m). The CCD camera were SBIG ST-8XMEI with V filter (from Custom Scientific $UBVRI$ set). Integration time was 20 seconds in analog binning mode (18μm × 18 μm, 765 × 510 binned pixels).

The calibration and photometric reductions were performed using AIP4WIN2 software (Berry & Burnell, 2005). Calibrations of CCD images were made with dark frame substraction and flat field correction. Photometric reduction was made in aperture photometry mode with 7.″27 star aperture radius, and 10.″91 to 14.″55 sky annulus radii. Seeing was less than 2″ on each night.

Table 1. Photometric parameters of observed stars from the Tycho-2 catalogue (ESA 1997) and ESO/ST-ECF GSC

ID	Name	RA (J2000)	Dec (J2000)	V_T	(B_T - V_T)
VAR	Y Leo	$9^h36^m51^s.807$	+26°13′57.″66	$10^m.090$	$0^m.296$
C1	GSC 01962 1289	$9^h37^m25^s.353$	+26°07′36.″34	$10^m.698$	$0^m.670$
C2	GSC 01962 1118	$9^h37^m14^s.36$	+26°12′58.″6	$(11^m.53)^\dagger$	–
C3	GSC 01962 1325	$9^h37^m03^s.22$	+26°11′55.″4	$(13^m.47)^\dagger$	–

† Photographic magnitudes

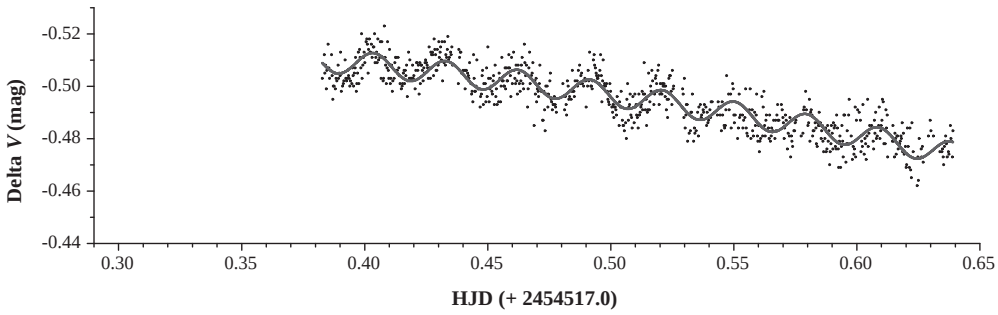

Figure 1. Light curve of Y Leo on February 20/21, 2008

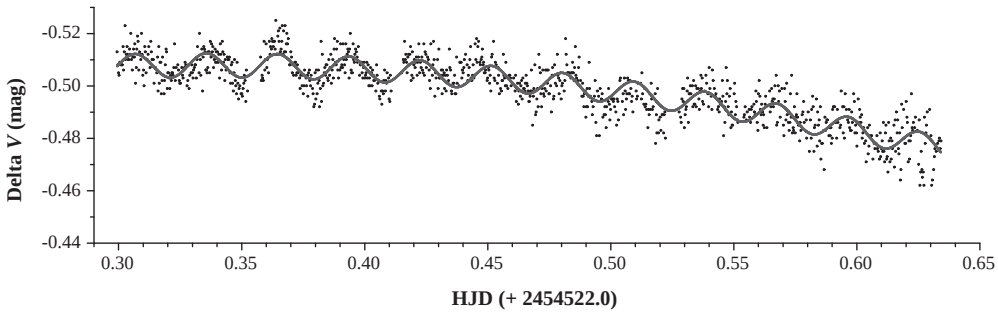

Figure 2. Light curve of Y Leo on February 25/26, 2008

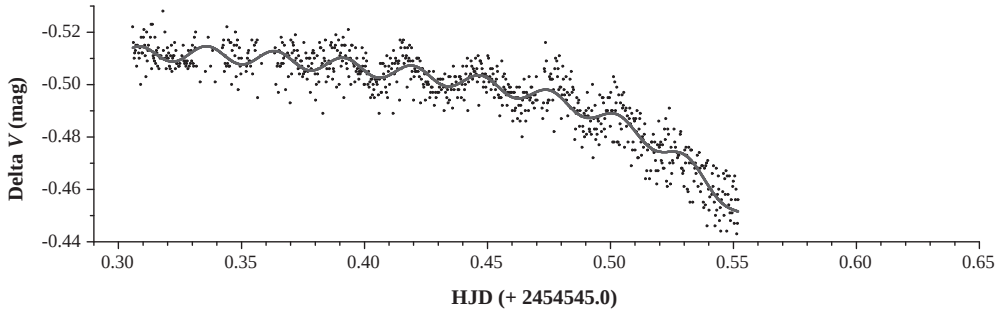

Figure 3. Light curve of Y Leo on March 19/20, 2008

The V time series in instrumental system for VAR-C1, C1- C2, and C3-C1, obtained during each night, were separately analyzed, taking into account the individual weights derived from the observational errors. Their amplitude spectra were analyzed using the methods of Kuschnig et al. (1997) and that proposed by Pop (2005), which was derived from the previous one [see also Pop (2005) and Pop & Vamoş (2007)].

The C2-C1 and C3-C1 observations performed during each of the three nights proved to be photometrically stable within the limits of the observational errors.

All the three VAR-C1 data sets (Figs. 1-3) obviously display rapid low-amplitude oscillations superposed on the eclipsing binary light curve. We analyzed the amplitude spectra of each of these data sets through the above mentioned methods after performing a preliminary detrending. For the first two nights we used second order polynomials, while for the third one, covering descending part of the shallow secondary eclipse, a fourth order polynomial was necessary.

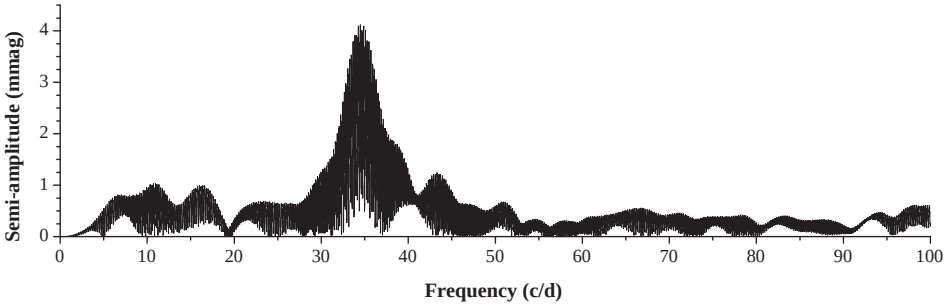

Figure 4. Amplitude spectra of detrended and merged data

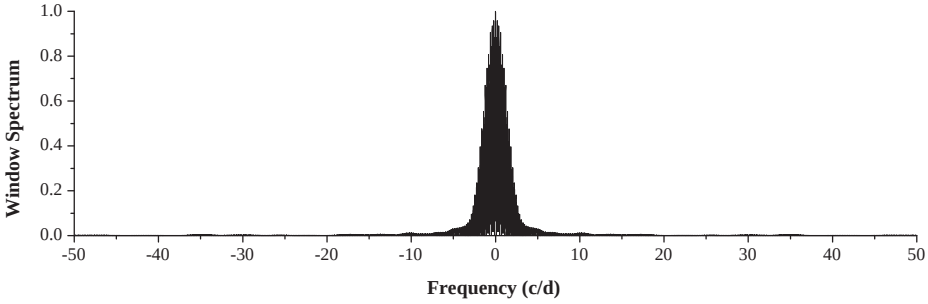

Figure 5. Power spectral window of merged data

The highest peak in three amplitude spectra appeared at about 35 c/d, i.e. a periodicity of about 41 minutes. In all cases it was found to be statistically significant at confidence levels of 100%. The application of Breger's et al. (1993) method, in the same frequency domain, supplied us the following values of the S/N ratio: 8.19, 6.61, and 3.91. These results agree with those obtained through the previously mentioned methods. In Fig. 4 we presented the amplitude spectrum of the three detrended and merged data sets, while in Fig. 5 we displayed the corresponding power spectral window.

The application of Pop's method (2005, 2007) [and also Pop & Vamoş (2007)] emphasized the presence of noise levels significantly higher than expected from the observational noise. We also note the presence of a cycle-to-cycle variability of the light curve, as well as the asymmetric shape of the highest peak in the amplitude spectrum (see the structure of window spectrum in Fig. 5). In order to clarify the actual character of the pulsations, more observations are needed and a proper decoupling of the pulsation and binarity, including frequency modulation due to the light-time effect (e.g. Pop & Turcu, 1993).

Considering the amplitude and period of its oscillations and also its spectral type and mass, this star is a δ Scuti pulsator with frequency of 34.48337($\pm$ 0.00056) c/d and semiamplitude 4.09($\pm$ 0.15) mmag. Yoon et al. (2004) found some Hα line profile variations in Y Leo, probably related to the presence of mass transfer phenomena in the system, or that of some gas streams etc. Thus, Y Leo is a new candidate for the "oEA" (oscillating EA) stars group (Mkrtichian et al., 2004).

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References:

Berry, R., Burnell, J., 2005, *The Handbook of Astronomical Image Processing*, Second Edition, Willmann-Bell, Inc., Richmond, Virginia, USA

Breger, M., Stich, J., Garrido, R., Martin, B., Shi-yang, J., Zhi-ping, L., Hube, D.P., Ostermann, W., Paparo, M., Scheck, M., 1993, *A&A*, **271**, 482

ESA, 1997, *The Hipparcos and Tycho Catalogues*, ESA SP-1200

Johnson, H.J., 1960, *ApJ*, **131**, 127

Kuschnig, R., Weiss, W.W., Gruber, R., Bely, P.Y., Jenkner, H., 1997, *A&A*, **328**, 544

Giuricin,G., Mardirossian, F., Predolin, F., 1980, *IBVS*, 1786

Mkrtichian, D.E., Kusakin, A.V., Rodriguez, E., Gamarova, A.Yu., Kim, C., Kim, S.-L., Lee, J.W., Youn, J.-H., Kang, Y.W., Olson, E.C., Grankin, K., 2004, *A&A*, **419**, 1015

Pop, A., 2005, in *The light-time effect in astrophysics. Causes and cures of the $O-C$ diagram*, edited by C. Sterken, ASP Conf. Ser., Vol. 335, San Francisco: Astronomical Society of Pacific, p. 263

Pop, A., 2007, *RoAJ*, **17**, 35

Pop, A., Turcu, V., 1993, *Ap&SS*, **204**, 233

Pop, A., Vamoş, C., 2007, submitted to *RoAJ*

Struve, O., 1945, *ApJ*, **102**, 74

Yoon, T.S., Lee, J.A., Byeon, J.G., Kim, K.M., Kim, J.H., Yoo, K.H., Kim, S.H., 2004, *New Astron. Rev.*, **48**, 759