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# STUDY OF PULSATION SPECTRUM OF MASS-ACCRETING COMPONENT OF ALGOL-TYPE SYSTEM VV UMa

GUNSRIWIWAT, K.[1]; MKRTICHIAN, D.E.[2]

[1] Department of Physics and Materials Science, Faculty of Science, Chiang Mai University, Muang, 50200 Chiang Mai, Thailand

[2] National Astronomical Research Institute of Thailand, 191 Siriphanich Bldg., Huay Kaew Rd., Suthep, Muang, 50200 Chiang Mai, Thailand

VV UMa is an eclipsing, semi-detached (Algol-type) close binary system with a short period of 0.6873801 day. It was found to be a variable by Gitz (1936) based on the photographic plates taken at the Moscow Observatory. Afterwards, Struve (1950) classified VV UMa as a single-lined spectroscopic binary with spectral type A0V, a mass ratio q∼0.23 and semi-amplitude $K_1 = 59\,\mathrm{km\,s^{-1}}$. Hill et al. (1975) classified the primary component as A2V. The first set of complete uvby light curves of VV UMa was acquired in 2000 January and analyzed by Lázaro et al. (2001). They reported about detection of pulsational light variations with periodicity of about 0.048 days (20.88 c/d) and 0.020 days (50.76 c/d). Later, with new observations, Lázaro et al. (2002) confirmed the periodicity of about 0.0216 days (46.2 c/d) and derived effective temperatures of the primary and the secondary as $T_{\rm eff}$=9250±150 K and $T_{\rm eff}$=5600±100 K, respectively. Kim et al. (2005) confirmed the pulsations and assign VV UMa system to so called new class of oEA stars suggested by Mkrtichian et al. (2002, 2004). Kim et al. *B*-filter CCD photometric light curve and period search analysis definitely show of 51.239 c/d (0.0195 day) and 47.46 c/d (0.0211 day) pulsations.

We conducted a new photometric observations of VV UMa within frames of Thai Sky Survey for oEA Stars (THASSOS) in order to get improved information about oscillation spectrum. The photometric observations were acquired from 26 December 2013 to 23 March 2014 at the Thai National Observatory (TNO, 18° 35′ 17″ N, 98° 29′ 11″ E). The 0.5 meter Cassegrain Telescope, the Apogee Alta U9000 3056 × 3056 pixels CCD camera and 10 seconds exposure times though V filter were used. The data were reduced by using Maxim DL5 program. Comparison stars are listed in Table 1. The phased, differential light curve folded with the period of 0.6873801 day is plotted in Figure 1.

Table 1: Data on VV UMa, comparison and check stars.

| Star | RA (J2000) | DEC (J2000) | *V* |
|---|---|---|---|
| VV UMa | $09^{\rm h}38^{\rm m}06\overset{\rm s}{.}72$ | $+56°01'07\overset{''}{.}25$ | 10.28 |
| TYC 3810-1503-1 (Comparison Star) | $09^{\rm h}38^{\rm m}32\overset{\rm s}{.}22$ | $+55°52'06\overset{''}{.}52$ | 10.17 |
| TYC 3810-1120-1 (Check Star) | $09^{\rm h}37^{\rm m}43\overset{\rm s}{.}28$ | $+55°49'19\overset{''}{.}76$ | 10.36 |

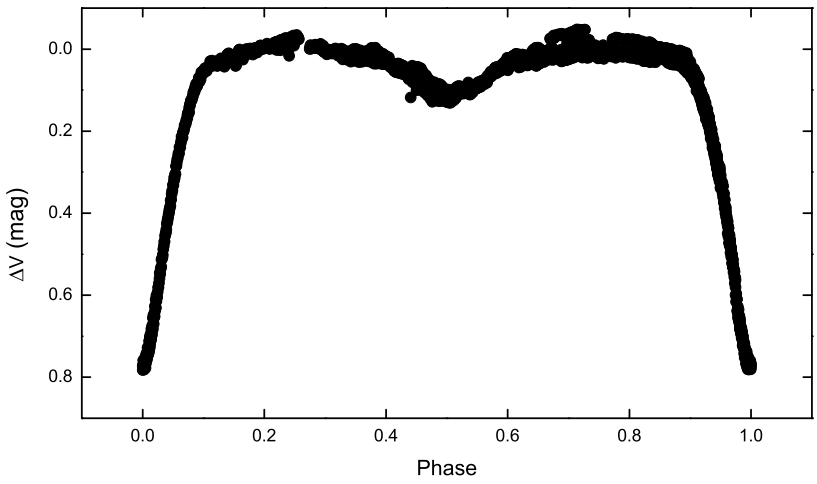


**Figure 1.** The phased V-filter light curve of VVUMa folded on the period of 0.68738 days.

Times of binary curve minima were measured using quadratic polynomial fitting method and are presented in the Table 2. The residuals from the out-of-eclipse light curves were obtained by removal of low-degree polinomial fits to the light curves of every night and are shown in Figure 2. Residuals exhibit strong amplitude modulation – an indicator of multiperiodiciy of pulsations.

Table 2: Times of light minima of VV UMa.

| Date | Minima HJD time | Type of eclipse |
|---|---|---|
| 3 January 2014 | 2456661.44963 | primary |
| 9 February 2014 | 2456698.23069 | secondary |
| 11 February 2014 | 2456700.28931 | secondary |
| 13 March 2014 | 2456730.18678 | primary |

Table 3: Pulsation frequencies and amplitudes found in the primary component.

| Frequency (c/d) | Amplitude (mag) |
|---|---|
| $F_1$=48.8483±0.0003 | 0.0028±0.0001 |
| $F_2$=47.0152±0.0005 | 0.0018±0.0001 |
| $F_3$=19.4359±0.0008 | 0.0018±0.0001 |

The Discrete Fourier Transform (DFT) analysis was applied to the residual data to find the pulsation frequencies of the primary component. We use a pre-whitening technique for consecutive detections of signals. The periodograms of consecutive steps of the DFT analyses of the primary component of VV UMa are shown in Figure 3 from top to bottom. We detected three oscillation frequencies listed in Table 3.

In summary, during new photometric study of pulsations in a primary, mass-accreting component of Algol-type system VV UMa we found four new times of binary light minima. We confirmed pulsations of the primary component and found three pulsation periods at

frequencies of 48.8483 c/d (0.0205 d), 47.0152 c/d (0.0213) and 19.4359 c/d (0.0515 d). First two frequencies are close to the values reported by Kim et al. (2005), but we believe that our frequencies are more accurate. We are going to combine our photometric results with results of spectroscopic observations of VV UMa obtained by us in 2014-2015 using 2.4 m telescope at TNO in order to get accurate orbital parameters of VV UMa system.

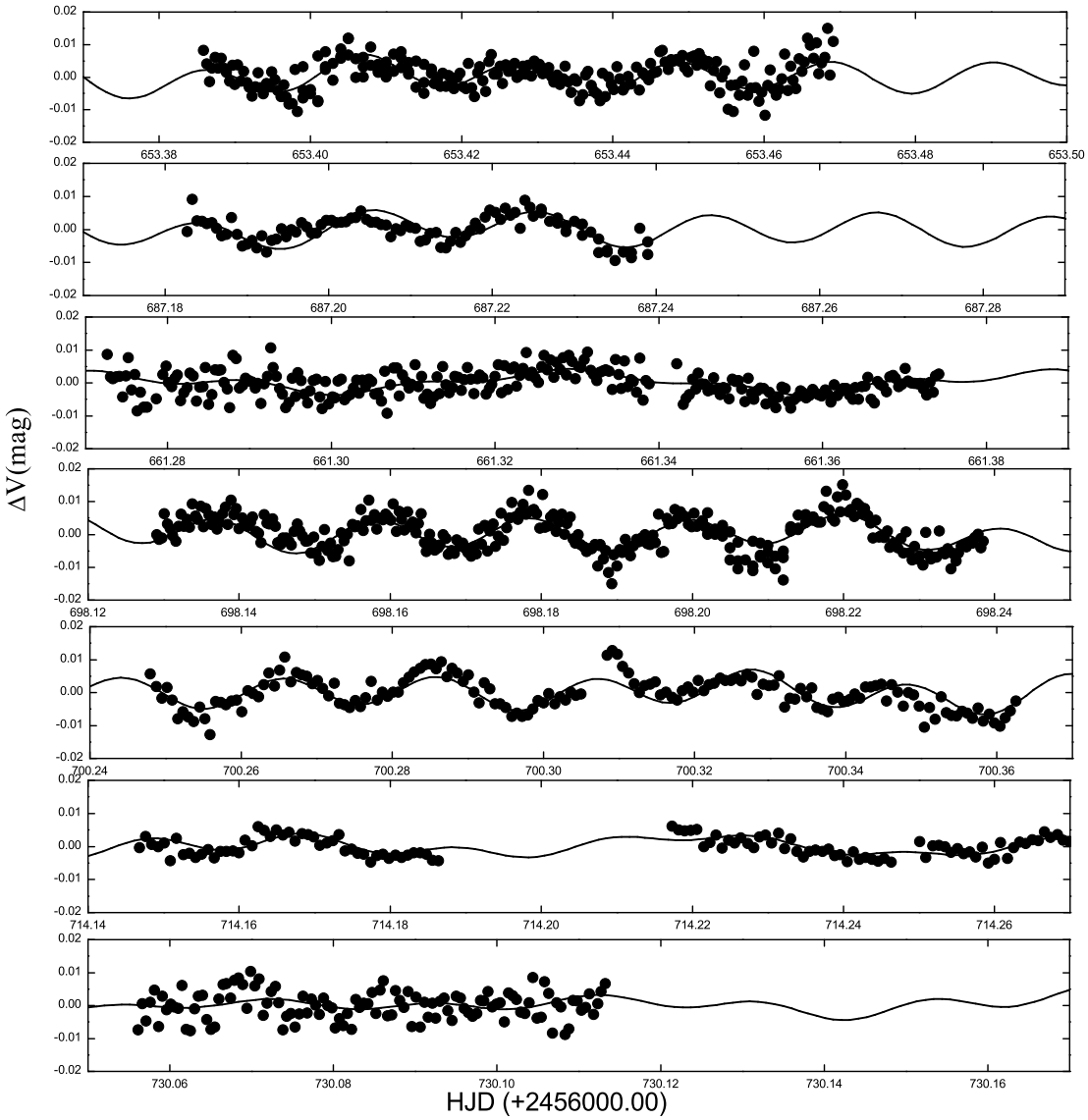


**Figure 2.** The nightly residual light variations (HJD time zero point is 2456000). Pulsational multiperiodic fits to the light curves are shown by solid line.

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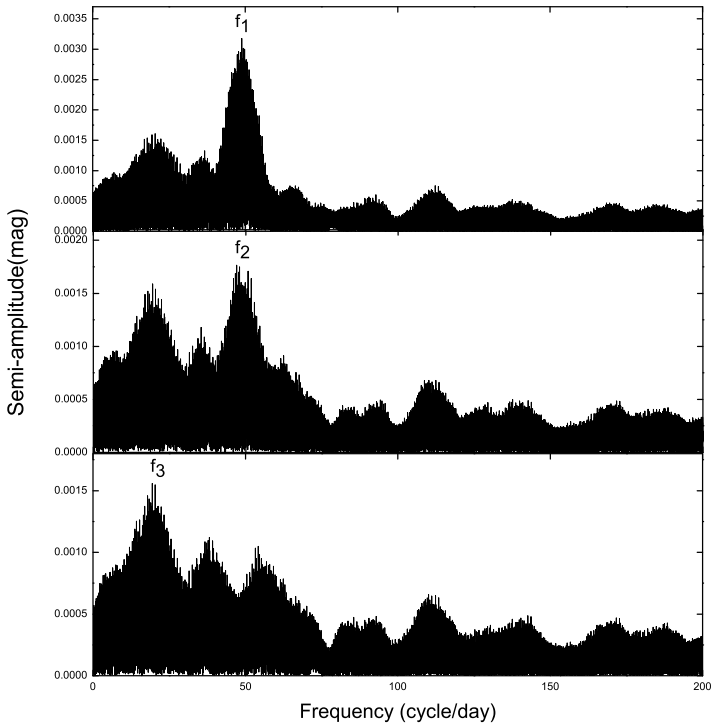


**Figure 3.** The DFT amplitude spectra of the primary component after consecutive (from top to bottom) pre-whitening procedures.

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