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**DISCOVERY OF A SHORT-PERIODIC PULSATING COMPONENT  
IN THE ALGOL-TYPE ECLIPSING BINARY SYSTEM TU Her**

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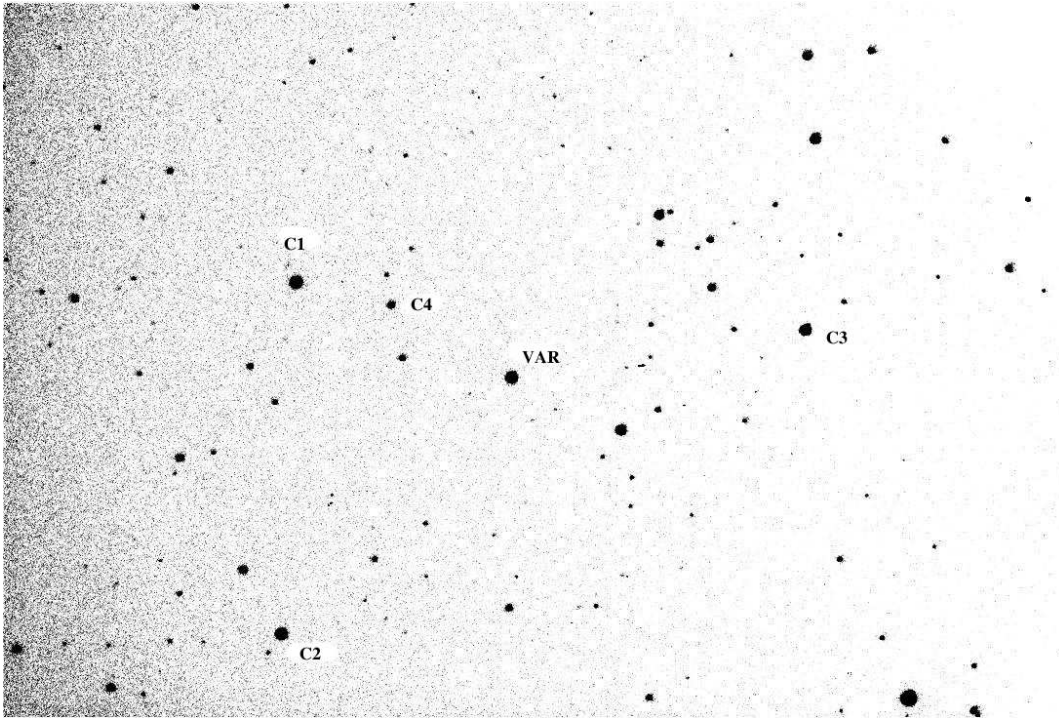
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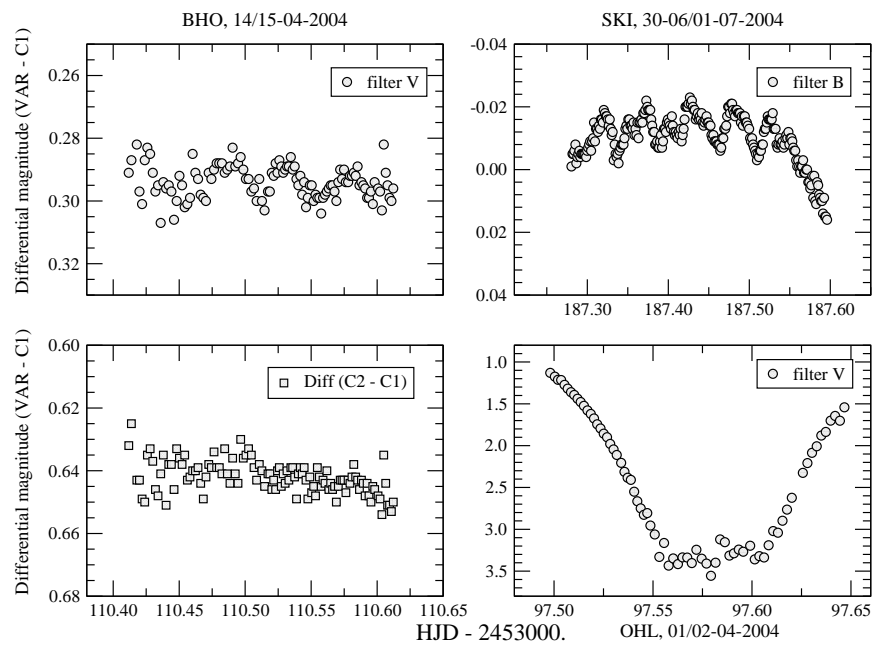
As a part of international photometric survey projects to search for A-type pulsating components in eclipsing binary systems (Mkrtichian et al. 2002; Kim et al. 2003), we monitored several candidate targets during spring 2004 using telescopes across Europe and in the US. The instruments used were the 1.0 m telescope of the Universitätssternwarte Hoher List (OHL, Bonn, Germany), the 1.3 m Ritchey-Chrétien telescope of the Skinakas Observatory<sup>†</sup> (SKI, Crete) the 1.0 m telescope of the Mt. Lemmon Optical Astronomy Observatory (LOAO, USA) and the 0.4 m telescope of the Beersel Hills Observatory (BHO, Belgium). These telescopes were respectively equipped with the 2K×2K HoLiCam CCD (OHL), a 1K×1K CH360 CCD (SKI), a 2K×2K CCD (LOAO) and a 1.5K×1K ST-10 CCD (BHO).

The eclipsing binary system TU Her was monitored during 1 (partial) night at the Hoher List Observatory (filter Johnson *V*), three (partial) nights at Beersel Hills Observatory (filters Johnson *V* and *B*), 1 (full) night at the Skinakas Observatory (filter Johnson *B*) and two (partial) nights at Mt. Lemmon Observatory (filter Johnson *B*). In total we observed two eclipses and obtained out-of-eclipse data during the remaining four nights. The same comparison star C1 was used at all the sites. Additional comparison stars were observed when the CCD's fields were sufficiently large (larger than 8'5×8'5). From the first runs at BHO we suspected small-amplitude short-periodic oscillations in the light of TU Her (cf. Fig. 2, upper left panel). Follow-up observations to confirm these rapid variations were next performed at Skinakas and Mt. Lemmon in June and July 2004. These data are available upon request.

Standard aperture photometry was applied to all the frames to obtain differential instrumental magnitudes with respect to C1 as well as a few other comparison stars. Fig. 1 displays a sample CCD image of the field. Also indicated are the positions of the comparison and check stars. Several light curves acquired in the *V* and *B* passbands are shown in Figs. 2 and 3. From the out-of-eclipse light curves one can clearly distinguish short-periodic oscillations with a peak-to-peak amplitude of about 0.02 mag. A preliminary analysis of the data out-of-eclipse shows a main periodicity near 18 ( $\pm 0.2$ ) c/d with a semi-amplitude of only 4-5 mmag.



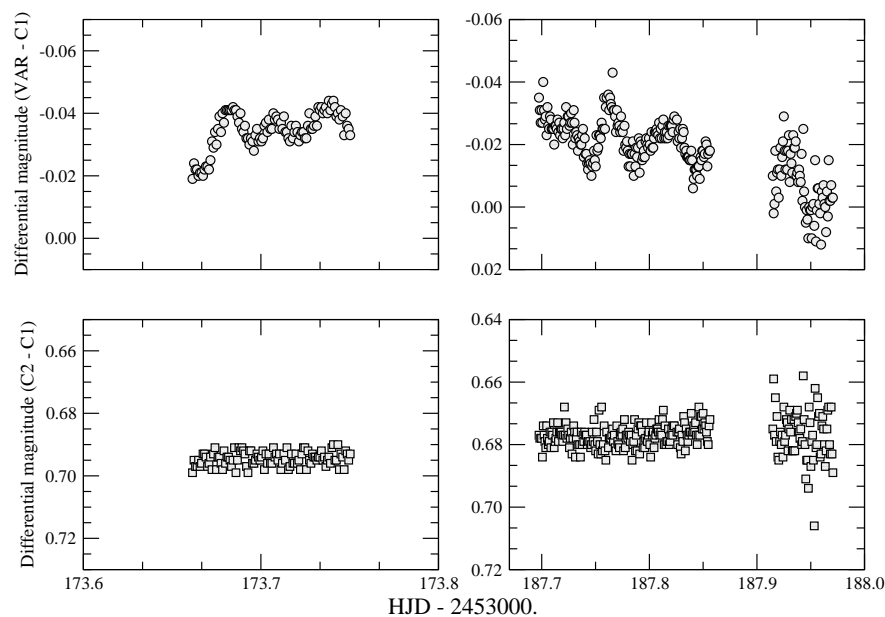
**Figure 1.** Field of the eclipsing binary TU Her (field size is  $24' \times 16'$ ). The comparison (C1) and check stars (C2,C3,C4) are also marked. North is up and east is to the left.



**Figure 2.** Light curves obtained at Beersel Hills, Skinakas and Hoher List observatories: differential magnitudes between the variable star TU Her and the main comparison star,  $\Delta V(V-C1)$  resp.  $\Delta B(V-C1)$ . In one instance, the differential data of the check star  $\Delta V(C2-C1)$  are displayed for comparison (lower left). On 01/02-04-2004, a total primary eclipse was observed (lower right).

**Table 1.** Photometric properties of target and comparison stars from the Tycho-2 catalogue (ESA 1997)

ID	Name/GSC	RA (J2000)	DEC (J2000)	$V_T$	$(B_T - V_T)$	Observatory
VAR	TU Her	17 <sup>h</sup> 13 <sup>m</sup> 35 <sup>s</sup> .37	+30°42′36″.0	11 <sup>m</sup> 153	0 <sup>m</sup> 123	all
C1	02591-00191	17 <sup>h</sup> 13 <sup>m</sup> 58 <sup>s</sup> .96	+30°45′16″.3	10 <sup>m</sup> 597	-0 <sup>m</sup> 197	all
C2	02591-00264	17 <sup>h</sup> 14 <sup>m</sup> 03 <sup>s</sup> .35	+30°36′45″.9	11 <sup>m</sup> 225	0 <sup>m</sup> 852	BHO; LOAO
C3	02591-00115	17 <sup>h</sup> 13 <sup>m</sup> 01 <sup>s</sup> .78	+30°43′16″.0	11 <sup>m</sup> 473	0 <sup>m</sup> 522	LOAO
C4	02591-00161	17 <sup>h</sup> 13 <sup>m</sup> 48 <sup>s</sup> .44	+30°44′35″.5	(12 <sup>m</sup> 9)	–	OHL

**Figure 3.** Two light curves obtained at Mt. Lemmon Observatory: differential magnitudes between the variable star TU Her and the main comparison star,  $\Delta B(V-C1)$ . Differential data of the check star,  $\Delta B(C2-C1)$ , are displayed in the lower panels for comparison.

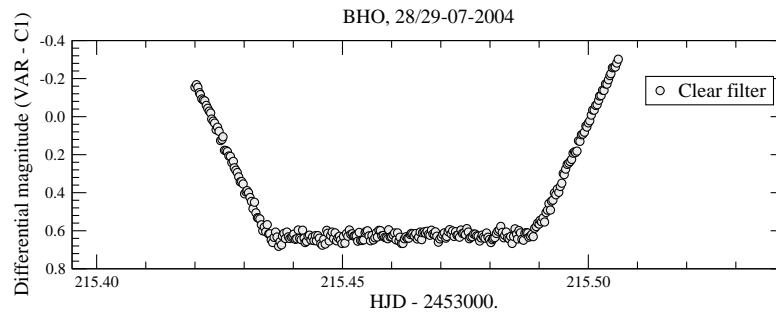
Total eclipses were observed on two occasions: on the night of April 01/02, 2004 at OHL and on the night of July 28/29, 2004 at BHO (see also Fig. 4). These phenomena were used to compute two new times of mid-eclipse. TU Her, with a period of 2.2671 days in the GCVS catalogue (Kholopov et al. 1988), shows a rapidly decreasing orbital period (Shengbang 2000). Table 2 lists the new times and their residuals with respect to the quadratic ephemeris determined by Shengbang (2000) (cf. equ. 6). The increasing residuals indicate that the observed times (again) deviate from their expected values.

The new pulsating variable star is classified as of spectral type A5 (SIMBAD, CDS), but also F0 III/IV (Halbedel 1984). In view of the similarity between the characteristics of the shown light curves and those typical of a  $\delta$  Scuti star (period, amplitude), the spectral type and the semi-detached binary configuration, we propose that TU Her is a new member of the group of mass-accreting pulsating components in Algol-type eclipsing

<sup>†</sup>The Skinakas Observatory is a collaborative project of the University of Crete, the Foundation for Research and Technology – Hellas, and the Max-Planck-Institut für Extraterrestrische Physik.

**Table 2.** Times and residuals for two new mid-eclipse events of TU Her

HJD $\pm$ error	Min.	Cycle Nr.	Predicted HJD	( $O - C$ )
2453097.5800 $\pm$ 0.0008	I	6897	2453097.4651	0.1149
2453215.4615 $\pm$ 0.0005	I	6949	2453215.3429	0.1186

**Figure 4.** Light curve obtained at BHO showing a total eclipse of TU Her.

binary systems (oEA stars; cf. Table 3 in Mkrtychian et al. 2004). Thus the number of known oEA stars is presently thirteen, including the recent discoveries of four new oEA stars during this same year (Caton 2004; Kim et al. 2004a, 2004b).

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