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A VARIABLE STAR IN THE FIELD AROUND TRES-4

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Transits of exoplanets were occasionally observed on Maidanak Observatory of Uzbekistan in the period from 2010 to 2013 using Zeiss-600 telescope equipped with FLI IMG1001E (in 2010) and FLI MicroLine (2012-2013) with FoV equal to $11\farcm7 \times 11\farcm7$. Observations of exoplanet host star TrES-4 ($RA_{2000}=17^h53^m13\fs058$; $DEC_{2000}=+37°12'42\farcs36$) was performed in 2010 in filter Cousins R and in 2012 and 2013 using filter Bessell R. We also provide with additional information on observation in Table 1: start and end times of observation (at middle time of exposure), the exposure time, air mass for the first and the last frames for each night and average Full Width on Half Maximum (FWHM) of a star profile. In 2012 the air mass initially decreased down to 1.001 and then increased again.

Table 1: Observational info

Date (UTC)	Start time (UTC)	End time (UTC)	Exp. time	Air mass	FWHM
	hh:mm:ss	hh:mm:ss	sec	start : end	arcsec
Aug 30, 2010	15:11:37	20:41:04	30	1.003 : 2.489	2.02
July 23, 2012	15:58:21	21:10:03	60	1.039 : 1.415	2.00
June 12, 2013	16:32:58	19:15:26	40, 60	1.414 : 1.012	1.73

Table 2: Mode parameters

Date	Frequency c/d	σ_F c/d	Amplitude mmag	σ_A mmag	SNR
2010	11.802	-	19.9	0.4	18.4
2012	11.781	-	19.8	0.3	18.8
2013	11.511	-	19.5	0.5	42.8
All	11.805823	0.000005	19.8	0.2	28.2

Basic reduction of the frames was done using standard IRAF† software. We did the aperture photometry for all stars which can be used as the comparison stars. In the end, we selected 7 stars for further analyses. In Figure 1 we show our field of view in 2012 and mark the comparison stars as Sn, $n = 1, 2....$ In 2010 and 2013 we used $S1$, $S2$ and $S3$

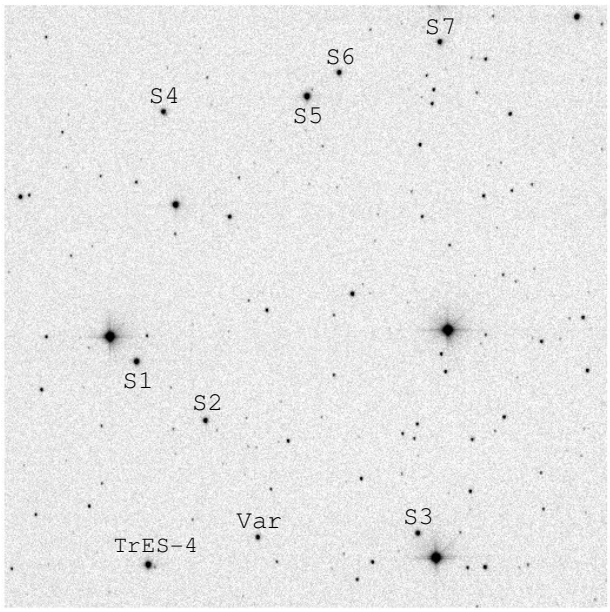

Figure 1. Image taken on July 23, 2012. TrES-4, the new variable star (Var) and comparison stars are marked. North is up and East is to the left.

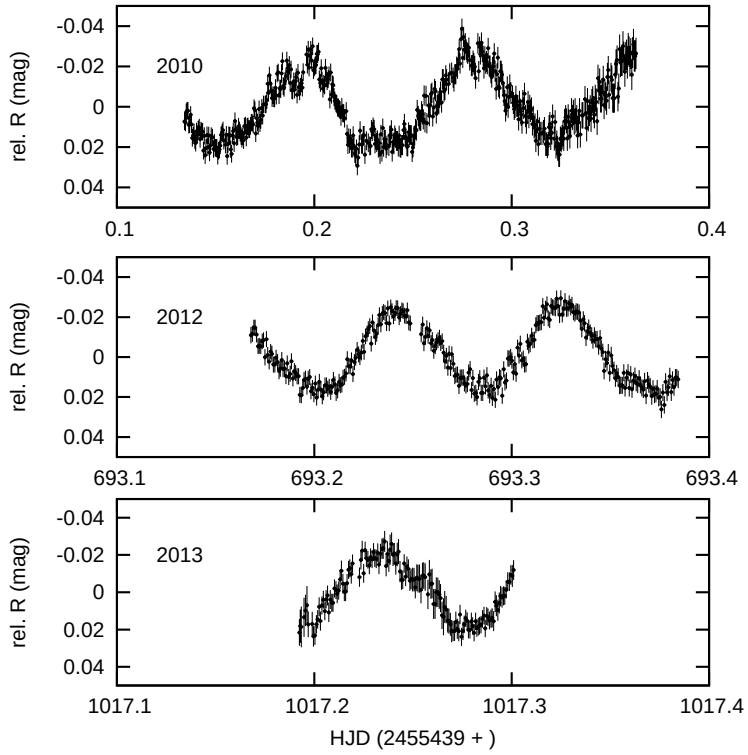

Figure 2. The light curves of the new variable star.

comparison stars and in 2012 we used all seven stars. One star marked as Var has shown variability with an amplitude of ≈ 0.04 mag. Because we used different comparison stars, nightly average values were subtracted from each light curve. Neither linear nor parabolic trends were removed and no differential extinction corrections were applied. We plot the light curves of the variable star in Figure 2. The final light curves contain 509 data points in 2010, 300 data points in 2012 and 147 data points in 2013. The `6136-t3.txt` file containing the photometry is available online.

This Var star is not included in any of catalogues. We did not find any reference on it in the publications devoted to TrES-4. But we have found the short report (DeCoster et al., 2011) where the authors wrote about searching for variable stars in the archival mid-infrared data (4.5-micron) from the Spitzer Space Telescope. They found one star in the TrES-4 field that displayed periodic variability (P = 0.082 days) when phase-folded.

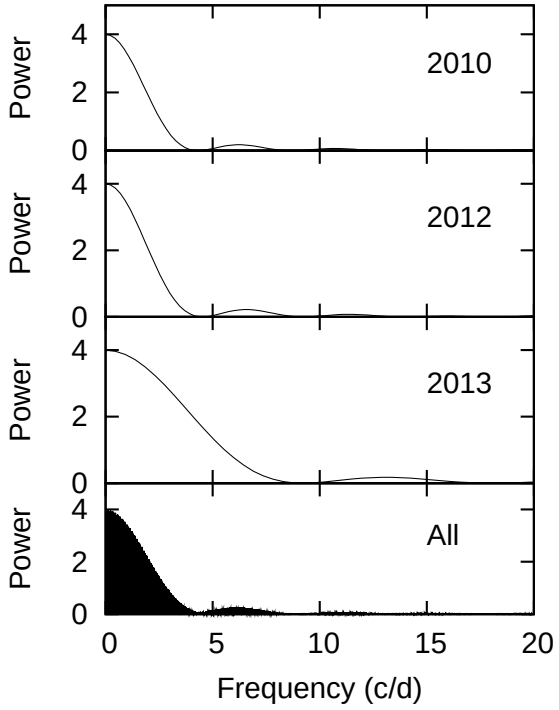

Figure 3. The spectral windows.

For the power spectral analysis of the light curves the FAMIAS software package (Zima, 2008) was used. Figure 3 presents the spectral windows. The width of the smoothing window for noise level estimation (box size) was set to 16 c/d. Amplitudes in power spectra of several modes exceeded 4σ for each light curve. Only one mode was present for all light curves. We show the results in Table 2. The errors of the frequency estimation for individual light curve are not presented due to the low resolution of power spectra which caused instability of frequencies. The spectral analyses of the total light curve (for all 3 years data points) gives the period of P=0.085 days which is very close to that reported in (DeCoster et al., 2011). This suggests that we are probably dealing with the same star.

[†]IRAF is distributed by the NOAO, which are operated by the AURA, Inc., under cooperative agreement with the NSF

Considering the amplitude and period of oscillations we tend to assume that this variable star could belong to δ Sct type.

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