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TYC 1083-12-1 – an SB2 binary mimicking an exoplanetary candidate

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Abstract. TYC 1083-12-1 (sp. type F8V) was identified as a potential exoplanetary candidate in the data from a photometric survey with a 30-cm telescope. From the radial velocity observations of the star, we found that it is a double-lined binary with very similar components. We present the basic parameters of this system.

Key words: Stars: binaries – Techniques: photometric – Techniques: spectroscopic – Methods: analysis

1. Introduction

Many new exoplanetary candidates are being discovered through large-sky surveys such as *TESS* (Ricker et al., 2015). However, to confirm these candidates, spectroscopic follow-up observations are necessary to identify false positives. In 2013, a star TYC 1083-12-1 (RAJ2000=19:55:24.32, DEJ2000=+13:11:05.9, $V = 12.52$ mag, $B - V = 0.53$ mag, Zacharias et al., 2013) was identified as a variable star of EA type and designated as CzeV3837 in the catalogue of variable stars discovered by Czech astronomers (Skarka et al., 2017). Due to the shallow eclipses with the same depth, we suspected CzeV3837 to be an exoplanetary candidate.

2. Observations

We collected 3,238 clear-filter observations with a mean photometric error of 4 mmag between September 2011 and July 2020. During the observing seasons

between 2011 and 2020, we used telescopes of 25cm and 30cm (after 2015) that were equipped with Kodak KAF-16803 CCD-based G4-16000 camera. Since 2015, we have used a C4-16000 camera with a GSENSE4040 CMOS chip. For the binary model, we utilized *TESS* data processed with the SPOC pipeline (Jenkins et al., 2016). We then downloaded and detrended this data using the LIGHTKURVE package (Lightkurve Collaboration et al., 2018). Both data sets are displayed in the top left panel of Fig. 1. We phase-folded them with the orbital period of 3.23647(1) days and zero epoch BJD= 2456204.3435(13). We estimated zero epoch using our observations.

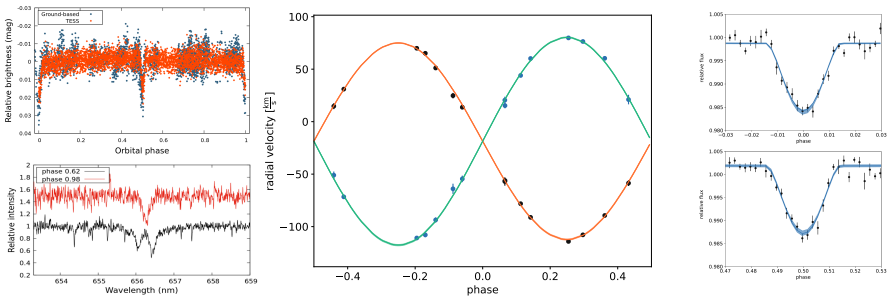

Figure 1. Photometric data (top left), spectra in different orbital phases (bottom left), radial-velocity curve showing both model and observations (middle panel) and models of primary (top right) and secondary eclipses (bottom right). Photometric data were binned for better readability.

We used the OES spectrograph (R≈ 50000, Koubský et al., 2004; Kabáth et al., 2020) mounted on the 2m telescope located in Ondřejov, Czech Republic to collect spectroscopic observations. From July to September 2020, we obtained 17 spectra with signal-to-noise ratios ranging from 5 to 21. The examples of spectra in different orbital phases are shown in the bottom left panel of Fig. 1 giving a clear picture of the binary nature of the radial-velocity variations.

3. Analysis

We used ELLC (Maxted, 2016) to model the system based on the radial velocity observations (determined with fxcor task in IRAF package, middle panel of Fig. 1) and *TESS* photometry (righ-hand panels of Fig. 1). We fixed the temperature of the primary star T_1 at 6200 K (from the B-V based on relations from Ballesteros (2012)). This value is consistent with 6251 K from Gaia DR3 catalogue (Gaia Collaboration, 2022) which is based on *BP/RP* spectra and includes stellar extinction. We used logarithmic prescription for the limb darkening

Table 1. System parameters from the modeling.

q	0.945(5)	i (deg)	79.69(3)	T_2/T_1	1.02(2)	$(R_1+R_2)/a$	0.200(5)
e	< 0.02	a ($R_\odot$)	12.54(4)	R_2/R_1	0.92(12)	γ (km/s)	-18.58(20)

with coefficients for a given temperature from the atmospheric tables by Husser et al. (2013) and values of albedo $A = 0.6$, gravity darkening $\beta = 0.32$. From system parameters in Table 1 we derived radii and masses of the components as $R_1 = 1.31(9)\,\mathrm{R}_\odot$, $R_2 = 1.2(1)\,\mathrm{R}_\odot$, $M_1 = 1.301(17)\,\mathrm{M}_\odot$, $M_2 = 1.229(18)\,\mathrm{M}_\odot$.

4. Conclusions

We used spectroscopic observations to demonstrate that TYC 1083-12-1 is an SB2 eclipsing binary star, rather than an exoplanet. The stellar parameters of both components match those of F8 and F6 spectral type stars listed in the recent version[1] of the table by Pecaut et al. (2012) within uncertainties. According to Raghavan et al. (2010), TYC 1083-12-1 belongs to the 20 % of FGK stars that have a semi-major axis less than 10 au.

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