Searching for CoRoT-TESS triple stellar candidates

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Abstract

We report the first result of a search for CoRoT eclipsing binaries (EBs), which eclipse timing variation (ETV) shows the sign of potential light-travel time effect. To reveal their true nature, we needed longer time scales, thus we complement the CoRoT data with TESS measurements. Of about 2300 EBs, we focus our investigation on those systems, which were observed more than once both by CoRoT and TESS (in sectors 6 and 33), separately. We recalculate all of the orbital periods using phase dispersion minimization method, then produce the $O - C$ diagrams. Finally, we analyze those systems in details that show sinusoidal ETVs with Markov chain Monte Carlo method. Here we present the analysis of a new hierarchical triple stellar system candidate.

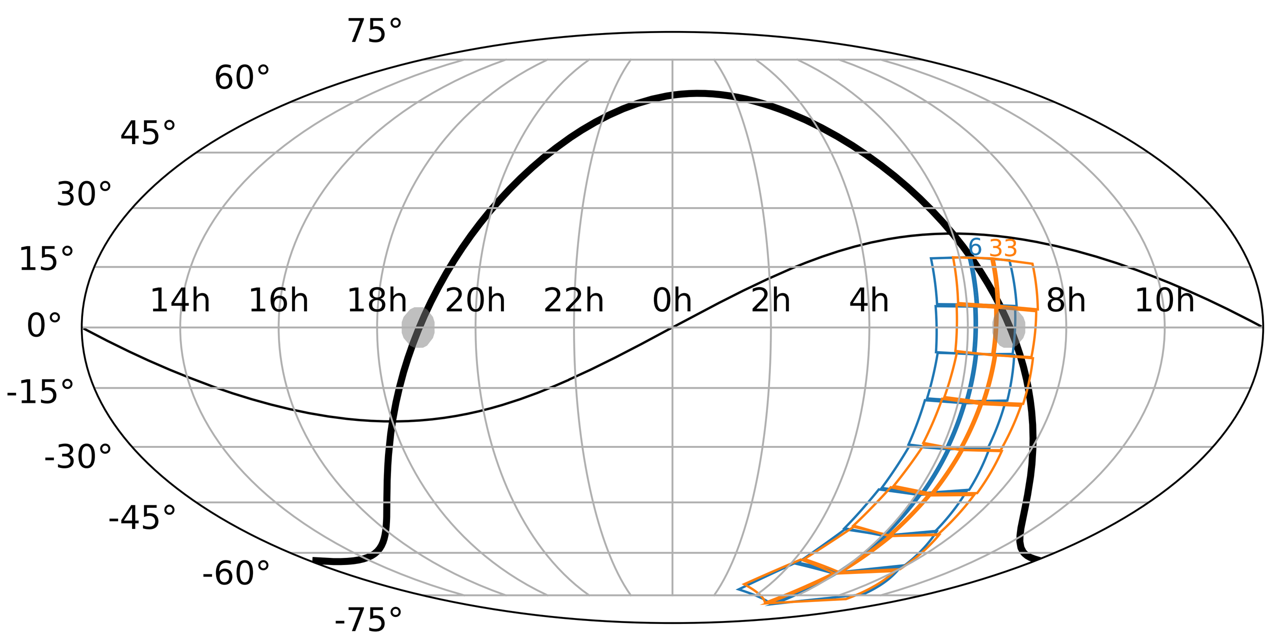
Introduction

The analysis of hierarchical triple stellar systems plays significant role in the understanding of the evolution of short periodic binary systems (Toonen et al. 2016). These systems are basically studied by eclipse timing variation (ETV) which shape tells fundamental information about the outer orbit. The light-travel time effect (LTTE) that causes the main variation in the ETV was described by Irwin (1952) in the following form:

$$\Delta_{\mathrm{LTTE}} = -\frac{a_{\mathrm{AB}} \sin i_2}{c} \frac{\left(1 - e_2^2\right) \sin\left(v_2 + \omega_2\right)}{1 + e_2 \cos v_2}, \qquad (1)$$

In the last few years the number of known multiple systems grown rapidly thanks to the space telescopes like *Kepler* (Borkovits et al. 2016) and ground based sky surveys like *OGLE* (Hajdu et al. 2019), however there wasn't too much overlap between the observed fields.

CoRoT, like the *Kepler* space telescope, observed thousands of eclipsing binaries, but due to the short observational sequences, the observed ETVs are alone not suitable for finding multiples.



CoRoT (gray patches) and TESS field of views.

Therefore here we present a recently discovered *CoRoT-TESS* triple system, **CoRoT 102760539**, which true nature is only determinable if we use both *CoRoT* and *TESS* light curves.

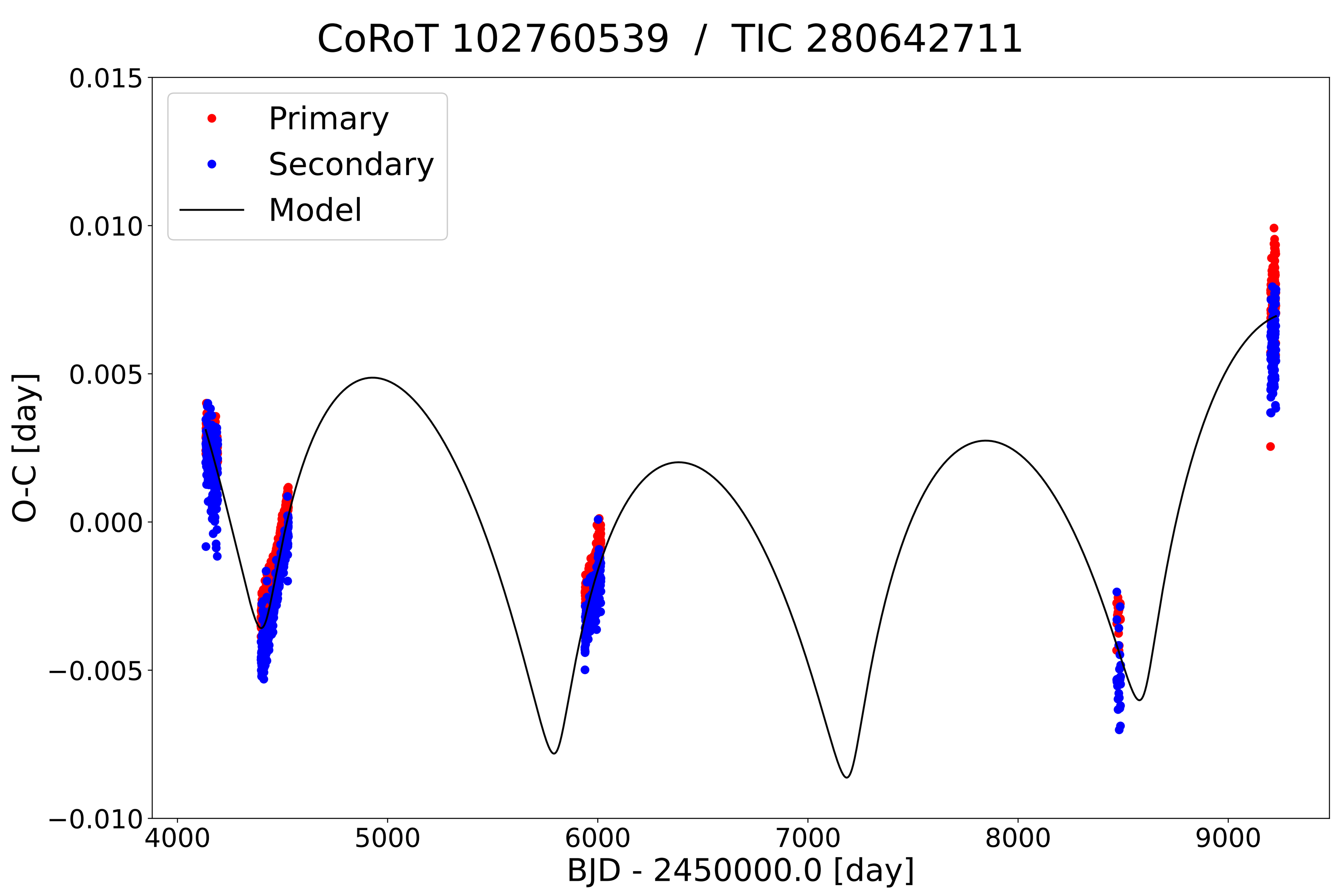
Method

We used the `TESScut` package (Brasseur et al. 2019) to extract light curves from all pixels in the vicinity of CoRoT 102760539. Of these, we selected only those which folded light curve have signal to noise ratio > 3. Then, we produced the system's ETV, which shows significant variations. This can only be explained by the effect of a third body.

The LTTE parameters were fitted via Levenberg-Marquardt algorithm and for reliable errors we used Markov chain Monte Carlo method.

Results

As a result we determined the orbital parameters of the triple system. Here we also present the fitted ETV.



ETV of the system and the best-fitting model.

The orbital parameters derived from Levenberg-Marquardt fit and the errors estimated via MCMC sampling are the following:

$a_2 \sin(i_2)$ [Au]	P_2 [day]	e_2	τ_2 [BJD+2400000 day]	ω_2 [deg]
0.95(2)	1396(3)	0.66(1)	54415(4)	111(2)

Based on the period-mass correlation of W UMa type binaries (Dimitrov & Kjurkchieva 2015), the EB's mass was found to be $M_{EB} = 1.14 M_{\odot}$. Thus, the minimum mass of the third body can also be determined as a function of the orbital elements, which gives $M_{Cmin} = 0.56 M_{\odot}$.

This finding proves that it is worth re-studying *CoRoT* EB systems with the help of TESS observations.

Acknowledgements

This project has partly been supported by the Hungarian National Research, Development and Innovation Office, NKFIH-OTKA grants KH-130372, the Lendület Program, project No. LP2018-7/2021 and the MW-Gaia COST Action (CA18104).

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