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Title: Characterizing the Brown Dwarf candidate KOI-1152.01: A short period transiting companion with high obliquity and eccentric orbit.

Type: Poster

Session: Eclipsing and Interacting Binaries

Abstract: Authors:T. N. Varga, Gy. M. Szabó, A. Simon
In this study we aim to reconstruct the 3D orbital parameters of the Brown Dwarf candidate companion of the Kepler star KOI-1152. Methods for constraining the sky-projected obliquity of the orbit of transiting exoplanets and binaries have already been developed and for active stars it has been shown by previous studies (Sanchis-Ojeda et al 2011 ApJ, and Nutzman et al. 2011 ApJl) that the in-transit observation of spot related light-curve features could be used effectively to obtain the obliquity of the orbit. In the case of the KOI-1152 system both the out-of-transit rotational modulation and the in-transit eclipsing of the active regions were observed in the available Kepler short cadence light curves. A mean stellar rotational period of 2.93 days, and the presence of at least two active regions located at different latitudes were identified. We reconstructed the surface spot distribution of the star using the out-of-transit light curves, and simulated transits of the companion in front of the stellar surface. We modeled 2*10^6 independent transits with random input parameter values (R/R*, duration, obliquity angle and impact parameter) using a Monte-Carlo method to constrain the shape of the goodness of fit surface. Two distinct orbital configuration was identified, both consistent with a non-coplanar orbit of the companion. An additional constraint could also be given on the shape of the orbit as a significant phase offset is present between the transit and the occultation of the companion, indicating an excentricity of at least 0.26 (Szabó et al. 2013 A&A). This system could be a very good target for future planet searches, as the short circularization time scale and the relative old age of the system seem to require an additional body driving the observed obliquity and eccentricity of the orbit.