Name: George Zhou
Email: george.zhou@anu.edu.au
Institution: Australian National University
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Coauthor: Chelsea X. Huang

Abstract:

Spin-orbit alignment is predicted for binary systems by many prominent star formation theories. Surprisingly, whilst the spin-orbit alignment for ~50 transiting planets have been measured to date, few stellar binaries have received the same observations, none of which are located in long-period orbits. The unprecedented photometric precision of Kepler has allowed us to probe the spin-orbit of systems in
parameter spaces normally unreachable from ground-based platforms.
We report the photometrically determined spin-orbit misalignment for the 110-day period M-dwarf companion to the rapidly rotating A-star KOI-368. The orbit obliquity was measured via the distorted transit light curve of the M-dwarf about the gravity darkened host star. A non-zero obliquity transiting body about a gravity darkened star will successively block different latitudes of the stellar disk that have different levels of gravity darkening, resulting in a distorted and potentially asymmetric light curve. We also report the detection of the secondary eclipse, as well as ground-based radial velocity measurements, that allow us to constrain the mass of the companion.

KOI-368 is a distinct system, given its high obliquity, low eccentricity, and long period orbit, in the context of both binary and planetary systems. It provides an interesting case study for binary formation and migration mechanisms. We also highlight the advantages of this technique in measuring spin-orbit alignments for long-period systems, for which the capabilities of traditional RM and spot-crossing techniques are limited. We explore other rapidly rotating stars in the Kepler database with eclipsing companions, for which potential gravity darkening distortions to the transit light curves may be detectable.