Mapping a star with transits: orbit precession effects in the Kepler-13 system

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Synopsis


The system is a prime astrophysical laboratory showing how stellar rotation and the orbit of the planet interacts with each other. This system has uncovered fundamental processes due to this interaction (Szabó et al. 2011; 2012; 2013):

- **Light curve asymmetry** emerges due to gravity darkening of a rotating star if the transit path is oblique
  — Similar distortions has been found for other systems (e.g. Barnes et al. 2013)
- **Dynamical harmony**. Stellar rotation knows about the orbital period of close-in planets
  — Low-order resonances between stellar rotation and orbital period is a general characteristic for close-in planets (Walkowicz & Basri 2013)
Stellar rotation causes orbital precession, leading to variation of transit duration (TDV)
  — Also found in other systems (Barnes et al. 2013)
- **Stellar surface**. Due to the resonant orbit, Kepler-13 has confirmed the unexpected surface of an A-type star: there are a few well-defined spots with considerable contrast. This is in contrast with earlier expectations counting on low-contrast features extending up to a half of the stellar surface.

Dynamical harmony

Kepler-13 has been the first exoplanet system with exact spin-orbit resonance.

Stellar surface

Comparison of folded and averaged light curves three transits apart (i.e. belonging to the very same stellar surface) in thirty days data. Note the appearing compact spots that has a lifetime of ≈ 30–60 days.

References


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