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Searching for co-orbital planets by combining transit and radial-velocity measurements

P. Robutel (1), A. Leleu (2,1) A. C. M. Correia (3,1) and J. Lillo-Box (4)
(1)IMCCE, Observatoire de Paris - PSL Research University, UPMC Univ. Paris 06Paris, France (philippe.robutel@obspm.fr) (2) CHEOPS fellow, Physikalisches Institut, Universitaet BernBern, Switzerland (ladrien.leleu@space.unibe.ch) (3) CIDMA, Departamento de Física, Universidade de AveiroAveiro, Portugal (correia@ua.pt) (4) European Southern ObservatorySantiago, Chile (jlillobo@eso.org)

Abstract

Co-orbital planetary systems consist of two planets orbiting with the same period a central star. If co-orbital bodies are common in the solar system and are also a natural output of planetary formation models [1][2], so far none have been found in extrasolar systems. This lack may be due to observational biases, since the main detection methods are unable to spot co-orbital companions when they are small or near the Lagrangian equilibrium points.

Ford & Gaudi [3] noticed that, contrarily to the case of a single planet in a circular orbit, if the planet that is transiting has a co-orbital companion located at one of its Lagrangian points, there is a time shift between the mid-transit and the mean radial-velocity, depending on the properties of the co-orbital companion. Therefore, when we combine transit and radial-velocity measurements, it is possible to infer the presence of a co-orbital companion. This method was developed for circular orbits and for a companion at the exact Lagrangian point (without libration). Although it remains valid for small libration amplitudes (which would just slightly modify the determined mass), co-orbital exoplanets can be stable for any amplitude of libration. Moreover, for a single transiting planet in a slightly eccentric orbit, we can also observe the same kind of time shift, without requiring the presence of a co-orbital companion.

Here, we generalise the work by Ford & Gaudi to eccentric planets in any Trojan or Horseshoe configuration (any libration amplitude). When a planet is simultaneously observed through the transit and radial-velocity techniques, we propose a simple method for detecting the presence of a co-orbital companion that relies on a single dimensionless parameter α which is proportional to the planets mass ratio. Therefore, when α is statistically different from zero, we have a strong candidate to harbour a co-orbital companion and we get an estimation of its mass. We also discuss the possibility of false positive detections due to other effects.

This method is applied to archival radial velocity data of 46 close-in (orbital period smaller than 5 days) transiting planets (without detected companions) with information from high-precision radial velocity instruments. We identify 13 systems where the archival data provides at least 1σ evidence for a mass imbalance between L_4 and L_5. Four of them provide more than 2σ detection, being the best candidates for subsequent follow-up observations.

References

[1] Cresswell, P. and Nelson, R. P. , aap, Vol. 482, pp. 677-690, 2008

[2] Cresswell, P. and Nelson, R. P. , A&A, Vol. 493, pp. 1141-1147, 2009

[3] Ford, E. B. and Gaudi, B. S. , ApJL, Vol. 652, L137-L140, 2006

[4] Leleu, A., Robutel P. Correia A. C. M. and Lillo-Box J. , A&A, Vol. 599, L7, 2017