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The *TROY* project: II. Multi-technique constraints on exotrojans in nine planetary systems ⋆,⋆⋆,⋆⋆⋆

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ABSTRACT

Context. Co-orbital bodies are the byproduct of planet formation and evolution, as we know from the Solar System. Although planet-size co-orbitals do not exists in our planetary system, dynamical studies show that they can remain stable for long periods of time in the gravitational well of massive planets. Should they exist, their detection is feasible with the current instrumentation.
Aims. In this paper, we present new ground-based observations searching for these bodies co-orbiting with nine close-in ($P < 5$ days) planets, using different observing techniques. The combination of all of them allows us to restrict the parameter space of any possible trojan in the system.
Methods. We use multi-technique observations (radial velocity, precision photometry and transit timing variations), both newly acquired in the context of the *TROY* project and publicly available, to constrain the presence of planet-size trojans in the Lagrangian points of nine known exoplanets.
Results. We find no clear evidence of trojans in these nine systems through any of the techniques used down to the precision of the observations. However, this allows us to constrain the presence of any potential trojan in the system, specially in the trojan mass/radius versus libration amplitude plane. In particular, we can set upper mass limits in the super-Earth mass regime for six of the studied systems.

Key words. Planets and satellites: gaseous planets, fundamental parameters; Techniques: radial velocity, transits; Minor planets, asteroids: general

1. Introduction

The development of state-of-the-art instrumentation and space-based facilities in the past decades boosted the discovery of extrasolar planets up to several thousands of detections[1]. This plethora has shown the wide diversity of intrinsic and orbital properties that planets can have. Exoplanet research is currently focused on the deep understanding of the planet composition, structure and atmosphere, in parallel to the search for Earth analogues. From our own system, we know that extrasolar systems should also host other components that also played an important role in moulding the architecture and properties of the planets. In the Solar System, moons and more recently trojans (e.g., Lucy mission, Levison et al. 2017) are targets for *in situ* exploration since they contain clues on the formation and early evolution of our planetary system (e.g., Morbidelli et al. 2005; Borisov et al. 2017).

Trojan bodies co-rotate with planets in a wide variety of orbital configurations, mainly in tadpole (orbiting the gravity

⋆ Based on observations collected at the Centro Astronómico Hispano Alemán (CAHA) at Calar Alto, operated jointly by the Max-Planck Institut für Astronomie and the Instituto de Astrofísica de Andalucía (CSIC).
⋆⋆ Partly based on data obtained with the STELLA robotic telescopes in Tenerife, an AIP facility jointly operated by AIP and IAC.
⋆⋆⋆ Based on observations collected at the European Organisation for Astronomical Research in the Southern Hemisphere under ESO programmes 297.C-5051, 098.C-0440(A), and 298.C-5009
[1] http://exoplanet.eu