EPSC Abstracts
Vol. 8, EPSC2013-940, 2013
European Planetary Science Congress 2013

The GAPS Programme with HARPS-N@TNG: A Search for Additional Planets in Transiting Planet Systems

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Abstract

We present results from the Global Architecture of Planetary Systems (GAPS) Long-Term Programme with the HARPS-N spectrograph on the TNG. We focus on the GAPS program element encompassing a targeted search for additional, outer planets in a sample of known transiting Hot Jupiter systems. We describe the status of the program, and present preliminary findings, including: 1) significant refinement of the orbits of some transiting planets; 2) evidence for previously undetected long-period objects 3) a study of the mass-period-eccentricity relation for transiting systems in connection with tidal dissipation effects; 4) a homogeneous determination of stellar parameters (metallicity, effective temperature, surface gravity) in transiting systems to assess the significance of emerging differences among samples uncovered by different transit surveys, and 5) a study of the Ca H&K activity levels of transiting planet hosts in connection with the presence of the close-in orbiting companion.

1. Introduction

GAPS (Global Architecture of Planetary Systems) is an Italian project devoted to understanding the architectural properties of planetary systems in connection with the characteristics of their host stars, taking advantage of the surgical (<1 m/s) radial velocity precision provided by HARPS-N@TNG. This project is the result of a concerted collaborative effort of a large fraction of the Italian community interested in exoplanets together with few well known foreign experts. This team has joined forces and its long-term expertise in high resolution spectroscopy, stellar rotation and activity, crowded stellar environments, formation of planetary systems, planetary dynamics, and data handling, with the aim to achieve the overarching goals of the program. These goals include the detection of low-mass planets around northern low mass stars and metal-poor stars, the search for new companions in already known planetary systems, to assess the frequency of planets in crowded and dense stellar environments, and the testing of migration mechanism and tidal and magnetic interactions between planets and host stars. GAPS recently published its first results: a) the detailed characterization of the transiting system Qatar-1 (Covino et al. 2013), inclusive of the accurate determination of the degree of spin-orbit alignment via Rossiter-McLaughlin effect measurement during transit, and b) the high-precision radial monitoring of the very metal poor ([Fe/H=-1.9) star HIP 11952 (Desidera et al. 2013), that allowed us to exclude the presence of its two recently announced giant planets, thus cleaning the sample of known exoplanets from a case that represented a severe challenge for the model of planet formation.

2. Bright, Hot, and Weird: Are They Alone?

The sample of hundreds of short-period transiting giant planets uncovered by survey programs such as SuperWASP and HATNet around relatively bright (V<12) F-G-K dwarfs and sub-giants allows for in-depth studies of planetary migration and tidal evolution. However, many of these systems are not routinely followed up in order to fully characterize their orbital architecture.

One of the GAPS programme elements aims at furthering our understanding of this matter by gathering additional high-precision radial-velocities

(RV) with HARPS-N of some 40 bright (V < 12) transiting planet hosts (excluding some high-jitter fast-rotating stars). The observations are aimed at the detection of outer planets in the systems. The program, which has been ongoing since Summer 2012, is beginning to produce interesting results. In particular, the areas in which this GAPS sub-program can provide useful insights include: 1) significant refinement of the orbits of some transiting planets; 2) evidence for previously undetected long-period objects 3) a study of the mass-period-eccentricity relation for transiting systems in connection with tidal dissipation effects; 4) a homogeneous determination of stellar parameters (metallicity, effective temperature, surface gravity) in transiting systems to assess the significance of emerging differences among samples uncovered by different transit surveys; and 5) a study of the Ca H&K activity levels of transiting planet hosts in connection with the presence of the close-in orbiting companion. An example of the ongoing analysis is provided in Figure 1.

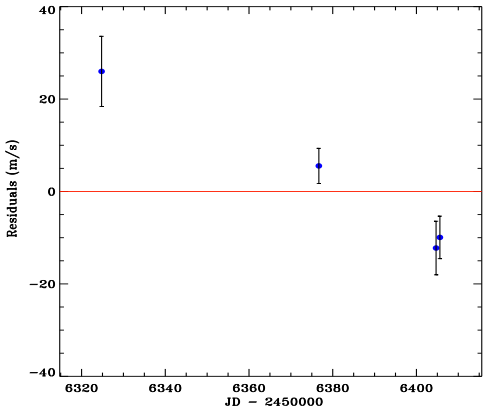

Figure 1: a long-term RV trend for a known transiting system, highlighting the possible presence of a previously undetected long-period companion.

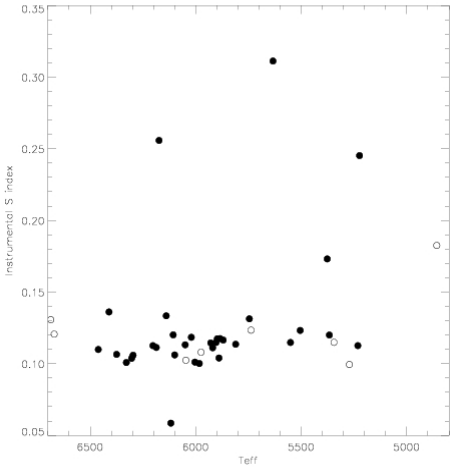

Figure 2: S activity index as a function of effective temperature for the sample of transiting system observed by GAPS. The very low S-value for WASP-12 is confirmed (probably due to extra-absorption in the evaporating planet atmosphere).

Acknowledgements

This work has been partially supported by PRIN INAF 2010. We gratefully acknowledge support from the the Italian Ministry of University and Research 'Progetti Premiali' funding scheme. This research made use of the SIMBAD database, operated at the CDS (Strasbourg, France).

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