Contrib. Astron. Obs. Skalnaté Pleso **55/3**, 490 – 492, (2025)
https://doi.org/10.31577/caosp.2025.55.3.490

Binary stars in Pennsylvania-Toruń Planet Search

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Received: December 16, 2024; Accepted: January 13, 2025

Abstract. We present preliminary results of binary star frequency study within the Pennsylvania-Toruń Planet Search sample.

Key words: stares: late type – stars:binary

1. Introduction

The Pennsylvania-Toruń Planet Search (PTPS) is one of the most extensive RV searches for exoplanets around evolved stars. The project was designed to use the Hobby-Eberly Telescope (HET; Tull 1998) and its High-Resolution Spectrograph (HRS; Ramsey et al. 1998). It has surveyed a sample of stars distributed across the northern sky, with the typical, apparent V magnitudes between 7.5 and 10.5 mag, and the B–V colour indices between 0.6 and 1.3. On the Hertzsprung-Russell diagram, these stars occupy an area delimited by the MS, the instability strip, and the coronal dividing line Linsky & Haisch (1979). In total, the program sample of 885 stars contains 515 giants, 238 subgiants, and 132 dwarfs Deka-Szymankiewicz et al. (2018). A detailed description of this sample, including their atmospheric and integrated parameters (masses, luminosities, and radii), is presented in a series of papers: Zieliński et al. (2012); Adamów et al. (2014); Niedzielski et al. (2016); Adamczyk et al. (2016); Deka-Szymankiewicz et al. (2018). The first detection of a gas giant orbiting a red giant star by the PTPS project was reported by Niedzielski et al. (2007). The project is continued within the TAPAS (Tracking Advanced Planetary Systems) project with Harps-N Niedzielski et al. (2015), and over 30 exoplanets were detected so far.

2. The sample and the data

This research project is based on existing, unpublished high precision (typical uncertainty of 6-9 m s^{-1}) radial velocity (RV) measurements collected between 2004 and 2014 with HET/HRS.

After acquiring multiple epochs of RV, many of these stars were found to be unsuitable for further observations aiming at planetary-mass companions detection. They either presented RV variations of up to 50 m s^{-1} and, were rejected as potentially single stars, or were found to be RV variables at a level above 2000 m s^{-1} and were rejected as potentially stellar binaries.

Altogether, several thousands of precise multi-epoch RVs will be used in this study of 517 stars. The sample contains 83 dwarfs, 162 subgiants, and 272 giants from the entire PTPS sample. The main goal is to present results for the new spectroscopic binaries identified in the sample. Our coarse analysis of the data shows that our sample contains 51 new SBs with enough data to present orbital solutions, 45 systems with not enough data for orbital solutions, for which only preliminary system parameters can be presented based on HET/HRS data alone.

3. Binary and multiple stars in PTPS

First (preliminary) estimates of binary frequency in our sample show that: among dwarfs 11±5% stars are spectroscopic binaries, 59±8% appear to be single and 30±7% stars are potentially hosts of low-mass companions; 18±5% of subgiants are spectroscopic binaries, 55±6% are single stars, and 27±5% are potentially hosts of low-mass companions; 14±3% of giants appear binary, 43±4% are single, and 43±4% represent potential planetary/BD-mass companions and/or active stars.

We note that our estimates of single stars fractions among dwarfs 57±4% and subgiants 53±3% are consistent with results of Raghavan et al. (2010) 54±2%. Also our estimate of spectroscopic binaries fraction among (K) giants 15±2% is in agreement with results of Famaey et al. (2005) - 13.7%.

Acknowledgements. The HET is a joint project of the University of Texas at Austin, the Pennsylvania State University, Stanford University, Ludwig-Maximilians-Universität München, and Georg-August-Universität Göttingen. The HET is named in honor of its principal benefactors, William P. Hobby and Robert E. Eberly. This research was partly supported by "Excellence Initiative – Research University" programme through the Nicolaus Copernicus University in Toruń.

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