Contrib. Astron. Obs. Skalnaté Pleso **49**, 450 – 452, (2019)

A highly eccentric spectroscopic binary star: HD 5624

M. Yılmaz[1], S.O. Selam[1], H. Izumiura[2], I. Bikmaev[3], B. Sato[4], V. Keskin[5] and E. Kambe[2]

[1] *Ankara University, Dep. of Astronomy and Space Sciences, Ankara, Turkey*
[2] *Okayama Astrophysical Observatory, Honjo, Okayama, Japan*
[3] *Kazan Federal University, Dep. of Astronomy and Satellite Geodesy, Kazan, Russia*
[4] *Tokyo Institute of Technology, Ookayama, Meguro-ku, Tokyo, Japan*
[5] *Ege University, Dep. of Astronomy and Space Sciences, İzmir, Turkey*

Received: October 26, 2018; Accepted: January 16, 2019

Abstract. In this study, we present an orbital solution for precise radial velocity (PRV) measurements of HD 5624. We obtained high resolution spectroscopic data using the Coude Echelle Spectrograph (CES) equipped with an iodine (I_2) absorption cell to the 1.5 m RTT150 telescope at TÜBİTAK National Observatory (TUG) and performed a spectroscopic analysis to obtain orbital parameters. The best fit Keplerian orbit was obtained with an eccentricity of $e = 0.64$, the mass of the companion is less than $0.5 M_{\odot}$ and a period of $P = 2392$ days.

Key words: stars – spectroscopic binary – radial velocity

1. Introduction

Since the first discovery of a planetary companion around a solar-like star in 1995 (Mayor & Queloz, 1995), more than 3700 exoplanets have been discovered (see `http://exoplanet.eu/`) and their number is still increasing every year. However, many exoplanet surveys have been focused on G and K type main sequence stars. However, planetary systems in more massive stars, especially around intermediate-mass stars ($1.3 - 5 M_{\odot}$), are particularly important for improving the giant planet formation theory and constraints on the time scale. Also, planets around intermediate-mass stars provide a snapshot of the changes in a dynamical configuration of the planetary system during evolution of the host star. Based on this motivation, we started in 2007 a precise Doppler survey at TUG within the framework of an international collaboration between Turkey, Russia, and Japan. For the past ten years, we have been monitoring the RV measurements of 50 G−K type giants and found that a few stars show significant radial velocity variations between 1 and 10 $\mathrm{km\,s^{-1}}$ (Yılmaz et al., 2017).

In this study, we present precise RV measurements and preliminary orbital characteristic of the HD 5624 giant star for the first time.

2. Observations and data reduction

PRV observations of HD 5624 were obtained using the CES equipped with an I_2-cell to the 1.5 m RTT150 telescope at TUG. The CES spectra covered a wavelength region from 3500 Å to 8000 Å, with resolving power $R \sim 55000$. We obtained signal-to-noise ratios S/N = 70-120 per pixel, with an exposure time of 1800 seconds for the target.

The extraction of echelle data from raw CCD images was carried out using the IRAF software packages in the standard way. Following the data reduction, precise RV measurements of the target were derived from the observed star $+I_2$ spectrum using a specific IDL code, which is based on the analysis technique described by Butler et al. (1996).

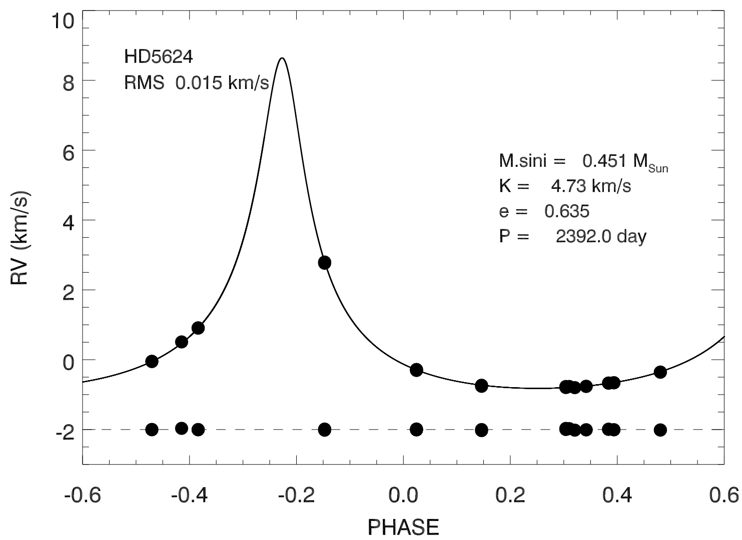

Figure 1. The radial velocities and the best Keplerian orbit (solid line) for HD 5624.

3. Analysis

RV data of HD 5624 show a variability of about 5 km s^{-1}, which indicates that this star is most probably a spectroscopic binary. There are no clear spectroscopic indications for binarity of this star in the literature before. Therefore, we performed the Lomb-Scargle (L-S) periodogram analysis to search for periodicity in the observed RV data first and found a significant periodicity at 2400 days, with a confidence level higher than 99.9% .

In order to obtain orbital parameters of the target, we used the RVLIN code (Wright & Howard, 2009). The best fit Keplerian orbit was obtained with an eccentricity of $e = 0.64$ and a period of 2392 days by estimating the stellar mass

Table 1. Orbital parameters for HD 5624.

Parameter	value	error
P (days)	2392	4.5
K_1 ($\mathrm{km\,s^{-1}}$)	7.73	1.19
e	0.63	0.06
ω (deg)	2.45	0.76
T_p (BJD-2450000)	8383.56	4.31
$m_2 \sin i$ ($M_\odot$)	0.45	0.08
a (AU)	4.62	0.07
RMS ($\mathrm{m\,s^{-1}}$)	15	-

to be 1.85 $M_\odot$. Uncertainties of the orbital parameters were derived using the bootstrapping procedure (see Table 1). The rms of the residuals to the best Keplerian fits are about 15 ms^{-1}, which is in the agreement with our radial precision.

4. Conclusion and discussion

It has been understood from the RV measurements of this star that the target shows extremely large RV variation. The analysis of the RV measurements indicates that the most likely origin of the observed periodicity is the Keplerian motion of the companion. This star is most probably a member of a binary star. The mass of the companion is less than $0.5M_\odot$ and has a highly eccentric (e $\sim$0.64) orbit. The derived orbital parameters are listed in Table 1.

Acknowledgements. This work was supported by The Scientific and Technological Research Council of Turkey (TÜBİTAK), the project number 114F099. The authors would like to thank both TÜBİTAK National Observatory (TUG) and KFU for supports in using RTT150.

References

Butler, R. P., Marcy, G. W., Williams, E., et al., Attaining Doppler Precision of 3 M s-1. 1996, *Publ. Astron. Soc. Pac.*, **108**, 500, DOI: 10.1086/133755

Mayor, M. & Queloz, D., A Jupiter-mass companion to a solar-type star. 1995, *Nature*, **378**, 355, DOI: 10.1038/378355a0

Wright, J. T. & Howard, A. W., Efficient Fitting of Multiplanet Keplerian Models to Radial Velocity and Astrometry Data. 2009, *Astrophys. J., Suppl.*, **182**, 205, DOI: 10.1088/0067-0049/182/1/205

Yılmaz, M., Sato, B., Bikmaev, I., et al., A Jupiter-mass planet around the K0 giant HD 208897. 2017, *Astron. Astrophys.*, **608**, A14, DOI: 10.1051/0004-6361/201731184