Evidences of Star-Planet Interactions from PTPS

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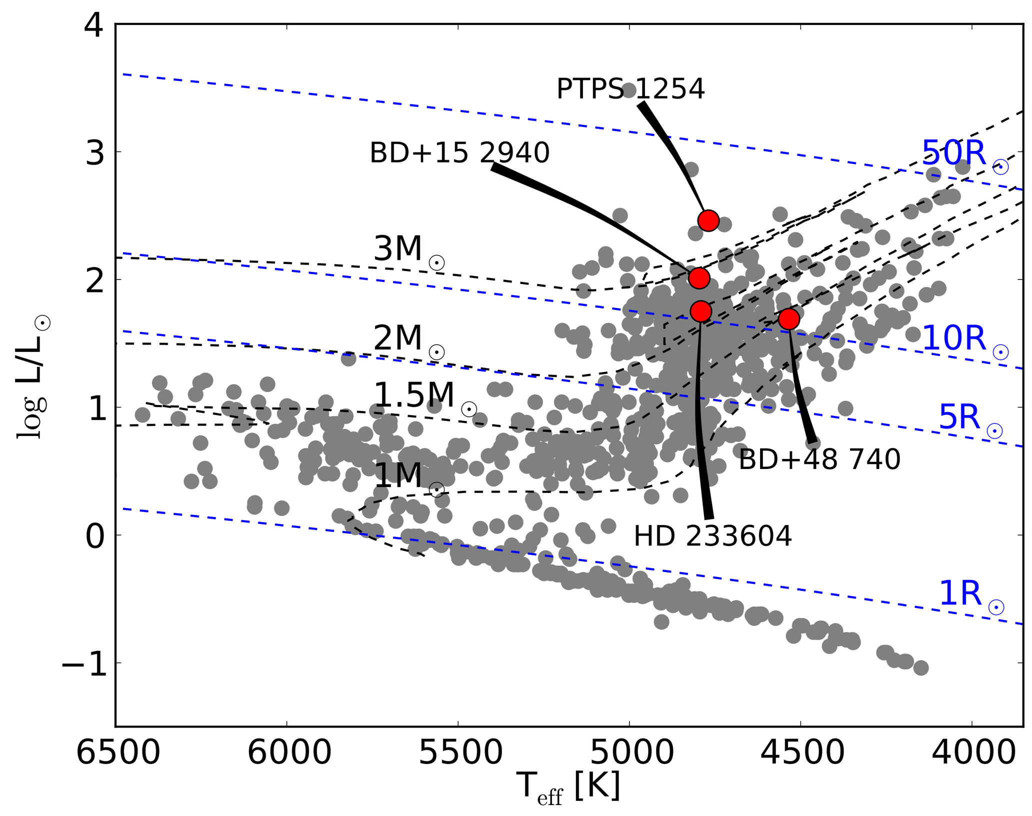
Introduction

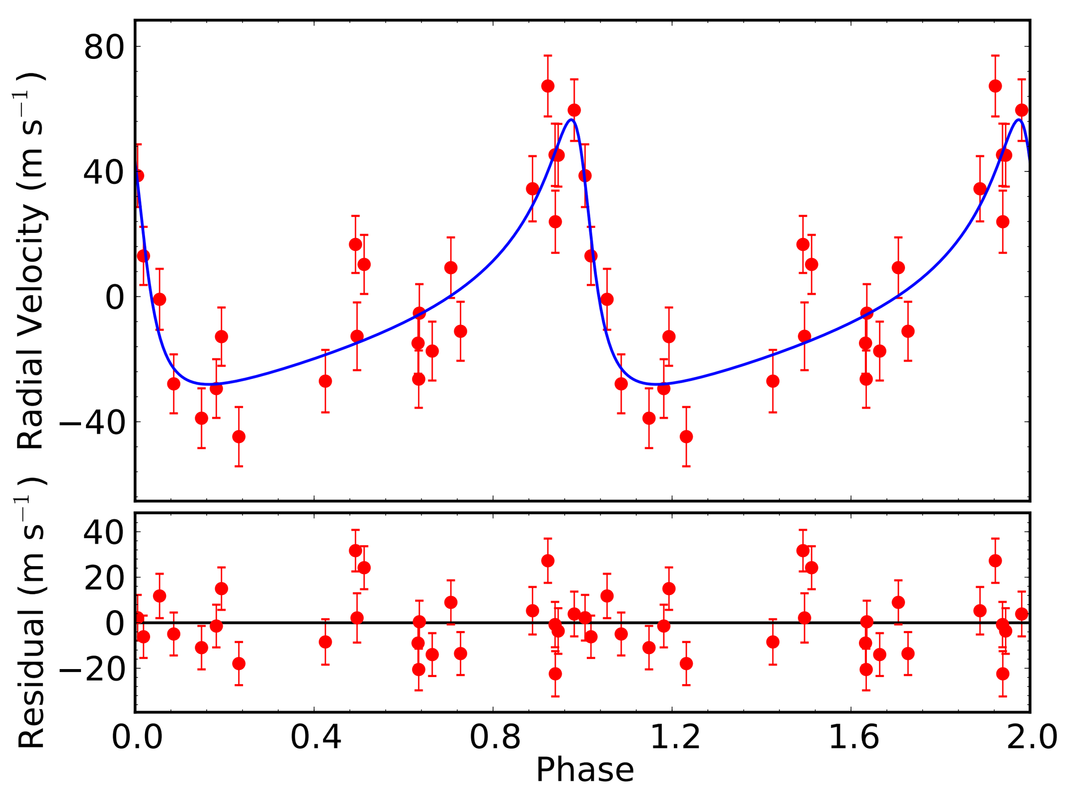
The wealth of exoplanets and the architectures of planetary systems that continue to emerge, is astounding and raises questions about the general picture of planet formation and evolution. To achieve such a stage of understanding, continuing studies of planetary systems in various stellar environments are essential. At present, of about 900 known exoplanets only about 50 around evolved stars are known. Searches for planets around evolved stars represent a very important complement to projects focused on the solar type stars because each detection of a planetary system around a sufficiently evolved star provides a "snapshot" of the changes in its dynamical configuration powered by evolution of the parent star. After the star leaves the MS, the tidal interactions become important and extend their range significantly. The observed absence of tight planetary orbits around giants has been interpreted in terms of a tidal interaction between an expanding giant and an orbiting planet. It appears that this interaction would make any planet in an initial orbit smaller than 0.3-0.4 au inevitably spiral into the stellar envelope. Observational evidences of such interactions were missing until very recently. Only very few examples of such interactions exist in the literature. Here we present those recently obtained within PTPS - a long-term RV survey of a sample of GK-evolved stars with the Hobby-Eberly Telescope in search for planets, recently extended with chemical abundance analysis.

HR Diagram



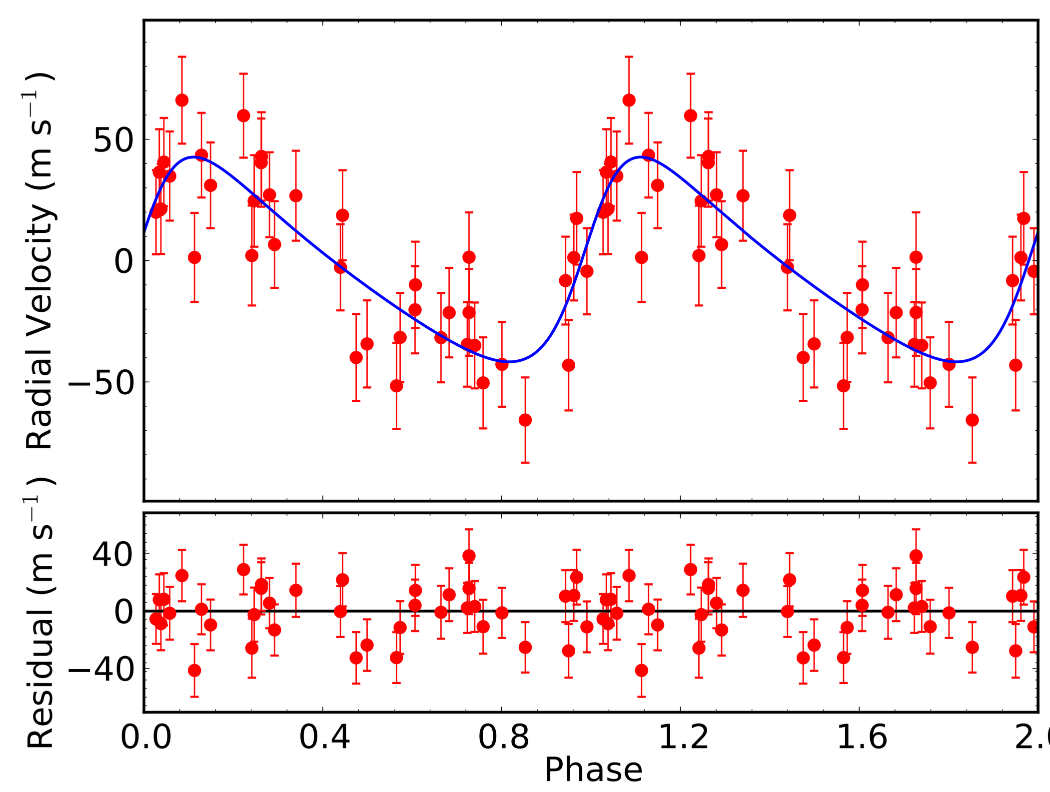
On the above HR diagram we present 1036 stars (grey points) monitored with the HET/HRS for RV variations using the high precision I_2 cell technique. The sample is mainly composed of evolved low-mass and intermediate-mass stars: giants and sub-giants, but it also contains slightly evolved dwarfs. Four featured stars discussed here are planet hosts, which planetary systems have been probably recently influenced by stellar evolution. To put some constraints on their evolutionary stage, evolutionary tracks and estimates on stellar radii are also included on the diagram.

BD+48 740 - update



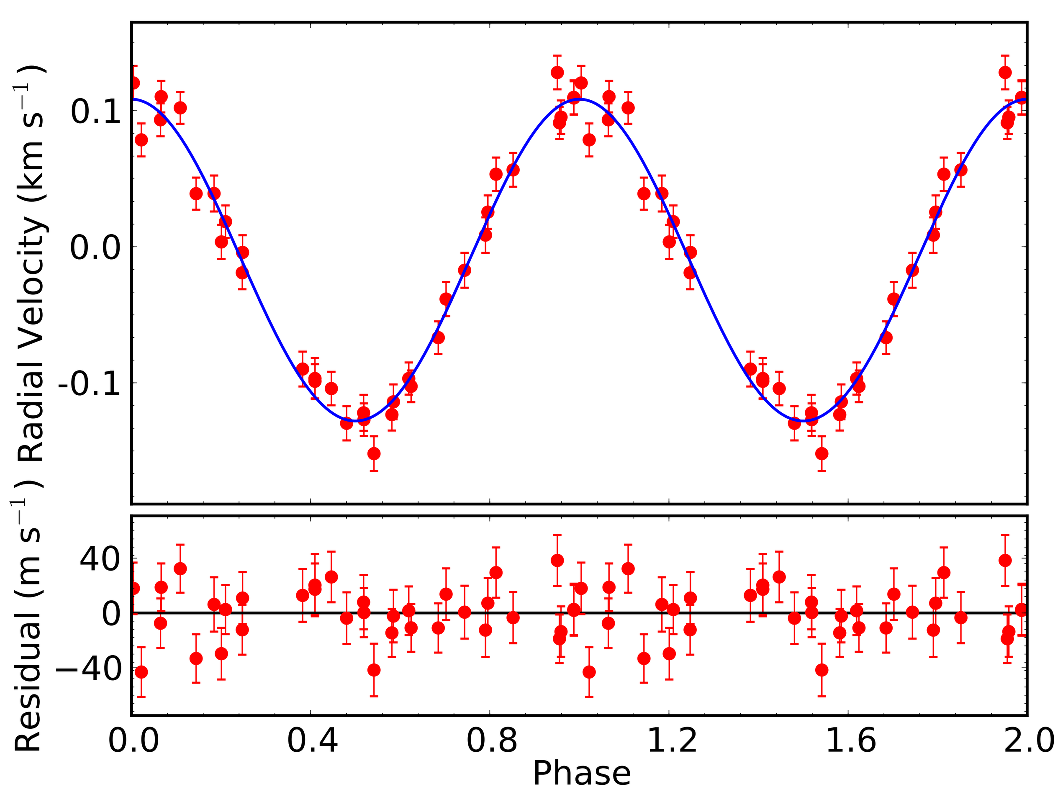
BD+48 740 is an unique, Li-rich giant with $A(\mathrm{Li}) = 2.33$ that might represent the first example of the remnant of a multiple planetary system possibly affected by stellar evolution (Adamów et al. ApJL, 754:L15, 2012).
After 15 epochs of observation, it exhibited RV variations consistent with a 1.6 M_J companion in a highly eccentric, ($e = 0.67$) and extended, ($a = 1.89$ au), orbit. After adding 10 new epochs of RV observations, we confirm previously determined semi-major axis and period as well as high eccentricity. Yet, observations are still ongoing.

BD+15 2940



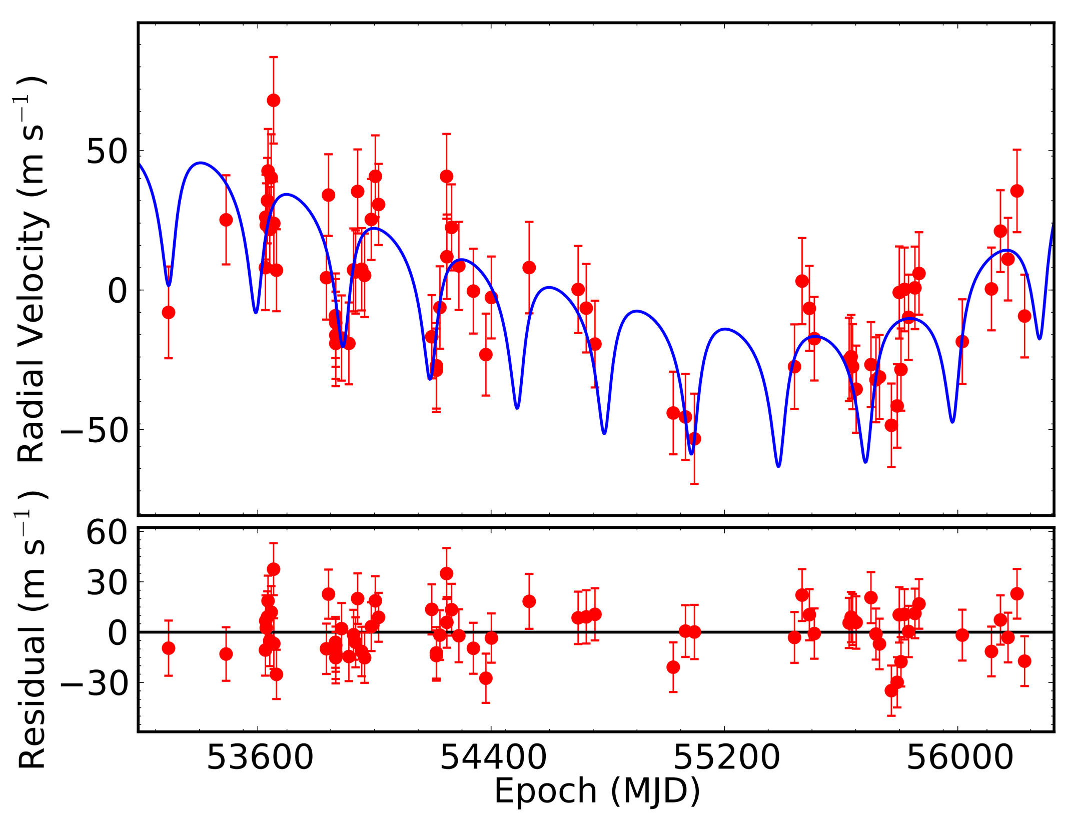
BD+15 2940 is a K0 giant with 1.1 M_J minimum mass companion. The low mass body has a 137.5-day period, moderately eccentric orbit ($e = 0.26$) with a semi-major axis $a = 0.54$ au ($\sim 7.9\,R_*$). It makes it the closest exoplanet around a giant and possible subject of engulfment (Nowak et al. ApJ 770, 53 2013). Its evolutionary status is difficult to determine and requires more detailed analysis. However high luminosity ($\log L/L_\odot = 2.01 \pm 0.75$) suggests, that this star might be a He-burning object, hence it has already finished radius expansion phase.

HD 233604



This object has a planetary companion with $m \sin i = 6.6\,M_J$ on a nearly circular ($e = 0.05$) orbit. Orbital period of 192^d and semi-major axis of 0.75 au ($15\,R_*$) makes it one of the closest planet to the giant star. Its relatively high $A(\mathrm{Li})$ of 1.4 may suggest that some planet engulfment episode happened in this system in the past, however in this case Li enhancement probably stems from ongoing first dredge-up process, what allows to associate this object with lower Red Giant Branch. It means this object has not suffered from severe mass loss and radius expansion yet.

PTPS 1254



PTPS 1254 is a multi-planetary system with Li-rich ($A(\mathrm{Li}) = 2.18$) giant as a host (Niedzielski 2013 in prep.). The preliminary orbital parameters for detected b and c components are: $a =$ 0.88, 4.50 au, $P = 299^d, 3479^d$, $e = 0.48, 0.28$, $m \sin i = 0.7, 2.4\,M_J$, respectively. Stellar parameters determined by Zieliński et al. (2012) put this star above the clump region, however with big uncertainty in $\log L/L_\odot = 2.46 \pm 0.6$. Lithium enrichment seems not to be an effect of Li production during Luminosity Function Bump here, which makes it a interesting case for both stellar and planetary system evolution.

Find me if you have questions

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