Spectroscopic parameters for solar-type stars with moderate and high rotation

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Introduction

Fundamental stellar parameters (**T_{eff}, logg, [Fe/H], υsini**) are the key to characterize a star. Additionally, if stars harbor planets, the planetary properties are directly linked to the properties of their hosts.
Due to rotation, spectral lines become broadened and blended, often unable to resolve. In these cases, measuring the equivalent width (EW) is difficult, if not impossible, and the standard EW method is not applicable. For stars with moderate-to-high rotation, spectral synthesis is required for stellar parameter determination.

In this work, we present a refinement of the spectral synthesis technique designed to provide precise stellar parameters for fast rotating stars.
This work has implications on transit planet hosts as they show wider dispersion in rotational velocities compared to hosts observed with the radial velocity technique due to selection effects.

Method

Line list: The initial line list is based on our previous work (Tsantaki et al 2013). It is comprised of 51 FeI and FeII lines around 42 intervals of 2 Å in length.

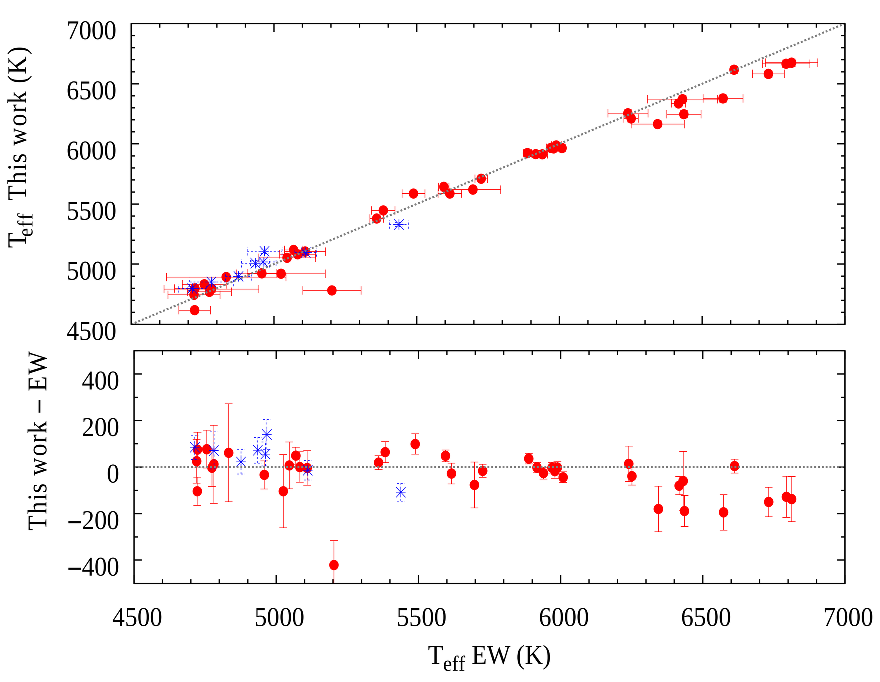
Spectral synthesis: We use the package '**Spectroscopy Made Easy**' (Valenti & Piskunov 1996), adopting ATLAS9 (Kurucz 1993) model atmospheres. The parameter optimization is based on a χ^2 algorithm.

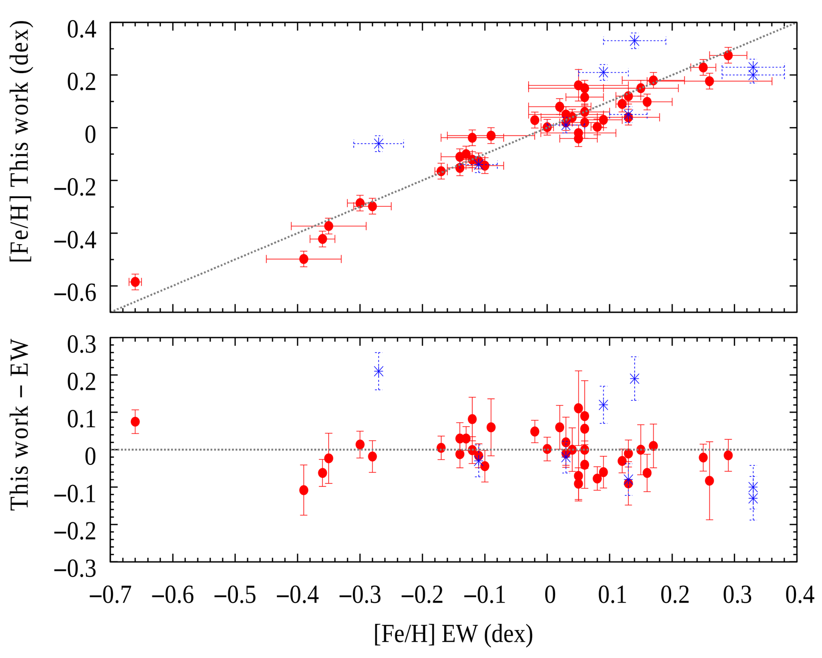
Initial conditions: For temperature, we used the color calibration of Valenti & Fischer (2005). Surface gravities were calculated using Hipparcos parallaxes (van Leeuwen 2007). We set microturbulence according to the correlation of Tsantaki et al. (2013) for dwarfs and of Mortier et al (2013) for giants. We set macroturbulence following the relation of Valenti & Fischer (2005).

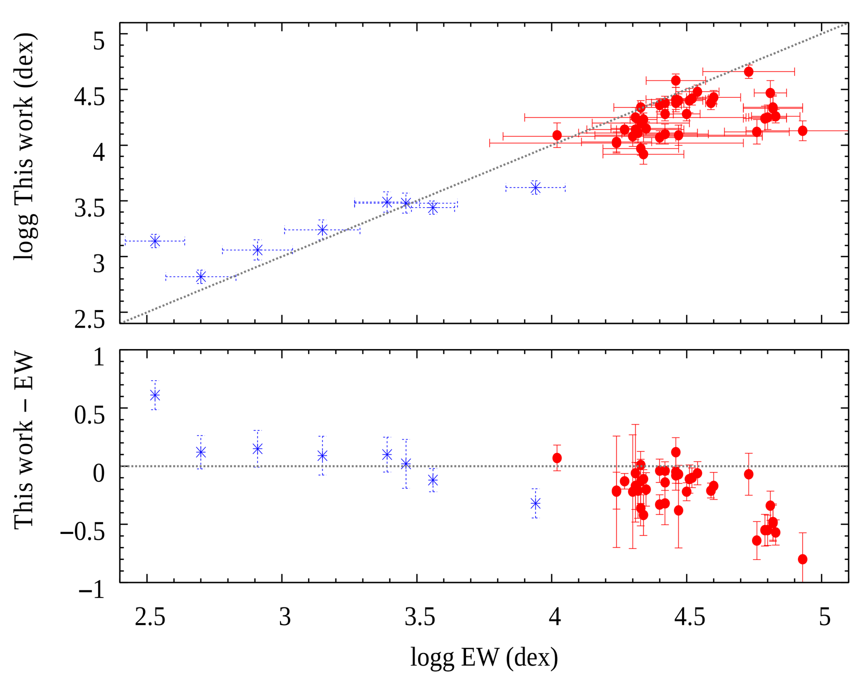
Internal error analysis: The errors are calculated for different rotational profiles (initial, 15, 25, 35, 45, and 55 km/s) for two different sources: 1) the initial conditions, and 2) the choice of wavelength intervals.

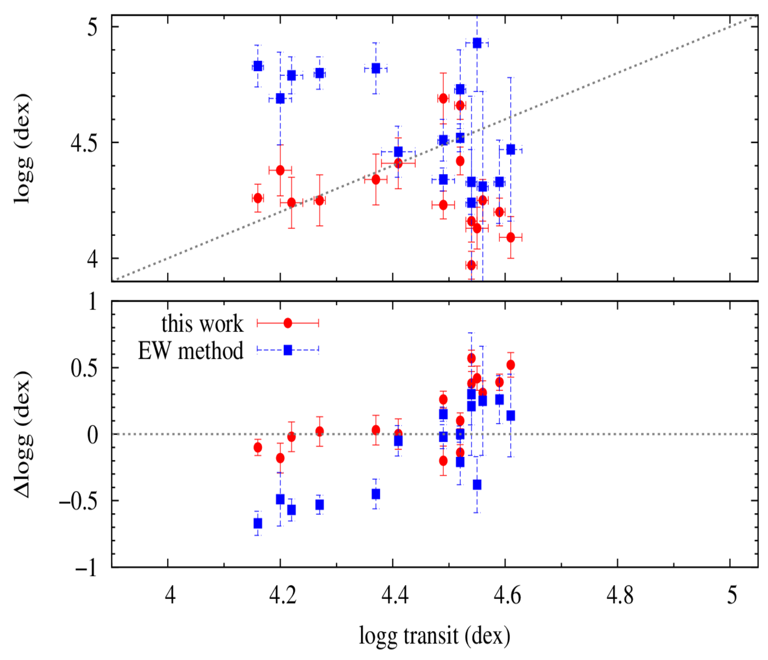
Spectral synthesis vs. the EW method

A comparison between this work and the EW method shows:
1) T_{eff} only for F-type stars is slightly lower compared to the EW method
2) [Fe/H] is in excellent agreement
3) *log*g only for dwarfs is underestimated compared to the EW method





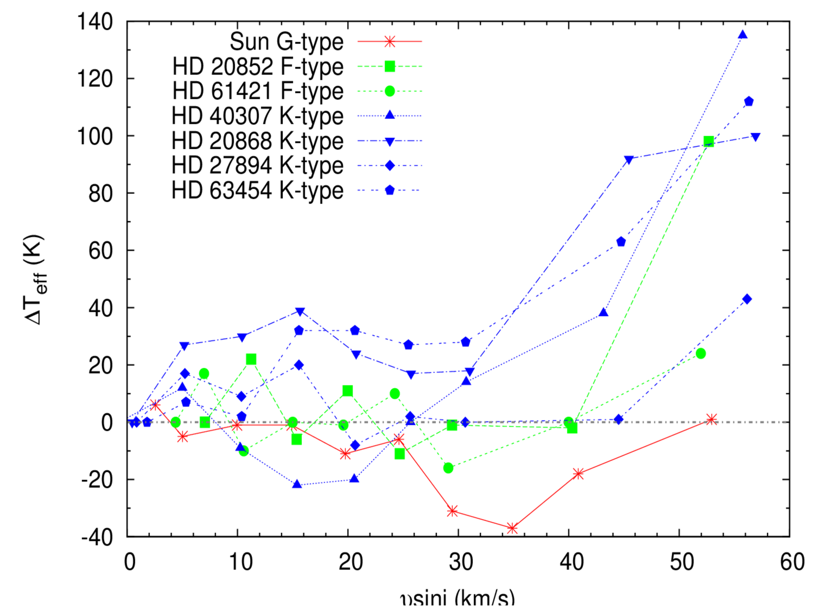


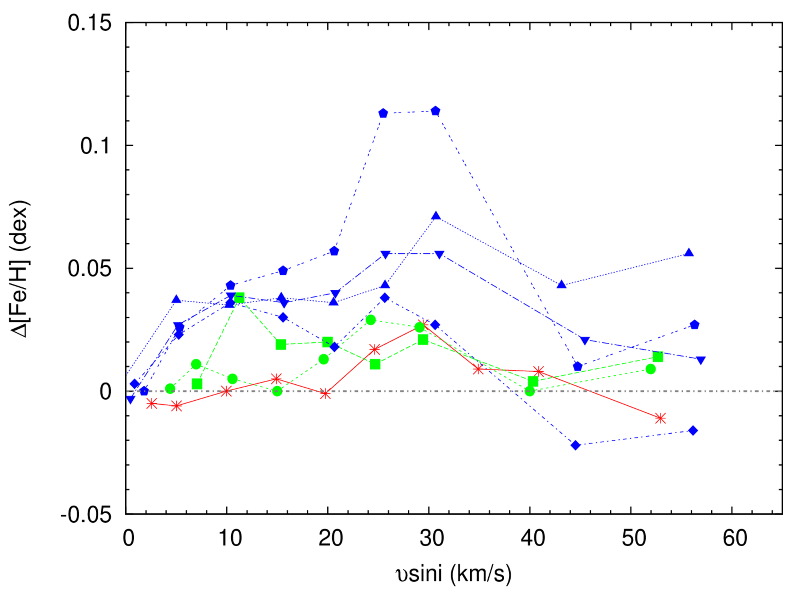


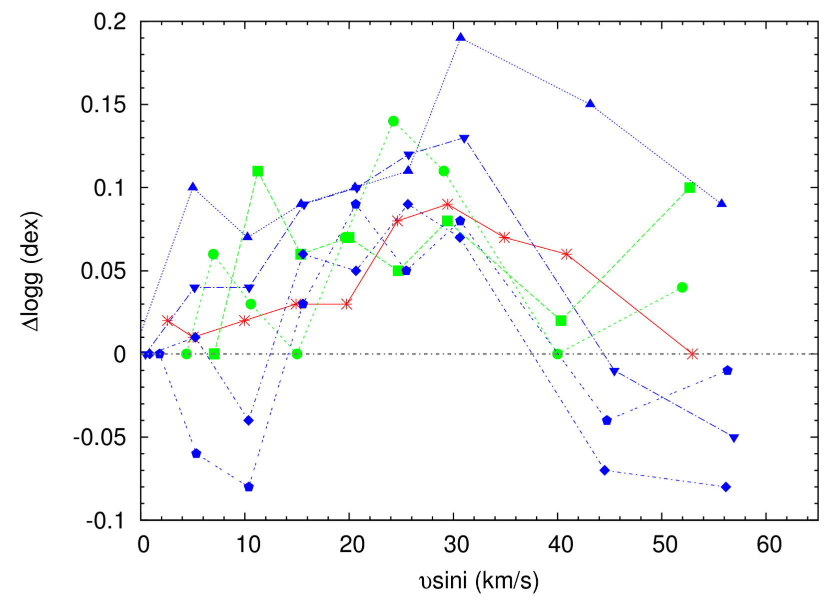
Figs 1-3: Comparison between the spectral synthesis method (This work) and the results of our EW method for: temperature, metallicity, and surface gravity. Circles represent dwarfs and asterisks giants. Fig. 4: Comparison of surface gravity from the transit fit with 1) This work and 2) the EW method. Δlogg represents 'transit - this work' (red circles) and 'transit - EW method' (blue squares).

Stellar parameters for fast rotating stars

We derived stellar parameters for reference stars of different spectral types convolved with a set of rotational profiles (initial, 5, 10, 15, 20, 25, 30, 40, 50 km/s). We investigate how stellar parameters differ for each star by adding rotation in their spectra.

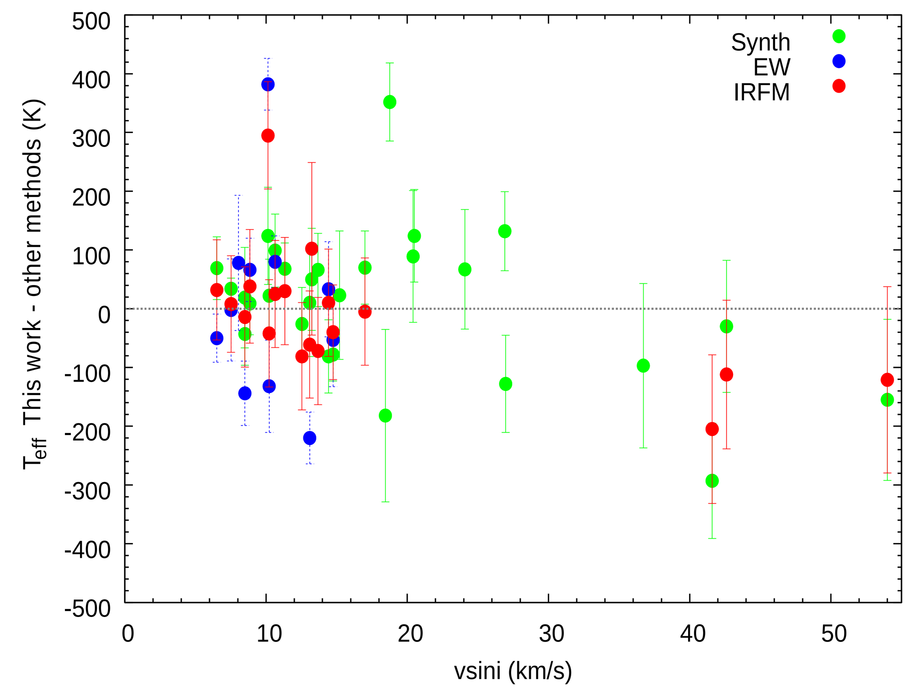




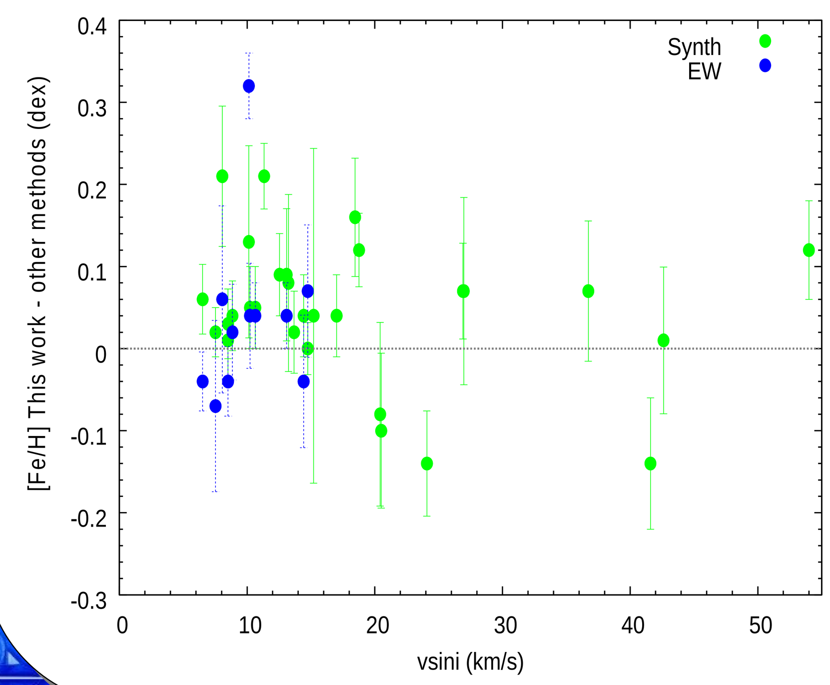


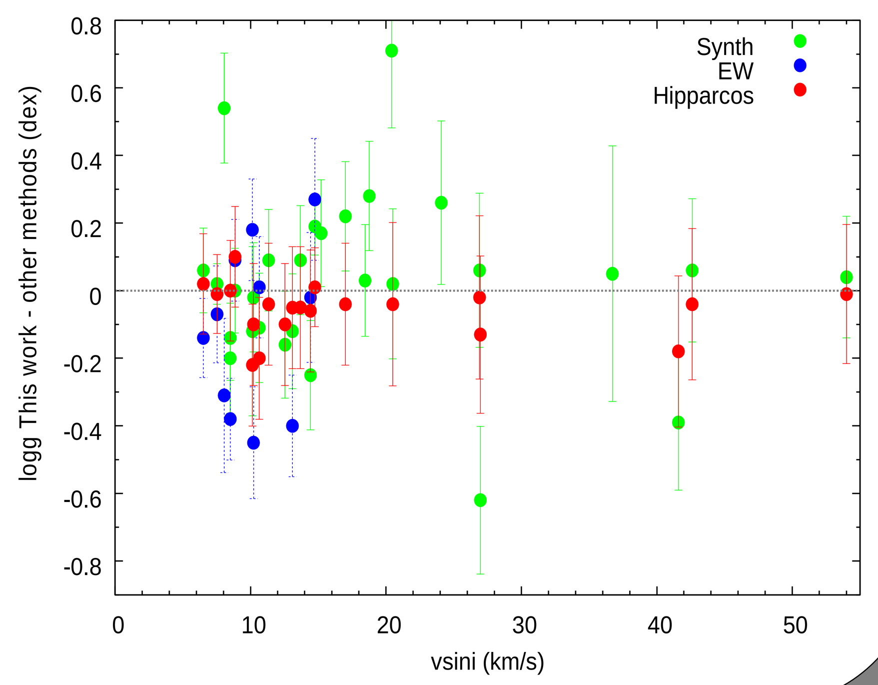
Figs. 5-7: Differences in T_{eff}, *logg*, and [Fe/H] (initial usini minus the different rotational profiles) vs. usini. Each star is represented by a different symbol, and each spectral type by a different color.

We test our method for a sample of FGK dwarfs with moderate-to-high usini. We compare our results with different techniques: other spectral synthesis techniques, the EW method (usini<10 km/s), and the InfraRed Flux Method (IRFM).



Figs. 8-10: Clockwise, differences in T_{eff}, *logg*, and [Fe/H] vs usini for moderate-to-fast rotators.





Application to planet hosts

We are now able to derive homogeneous parameters for planet hosts with low and high rotational velocity. The stellar parameters of FGK-M planet hosts are compiled on the online **SWEET-Cat** catalog (Santos et al. 2013).

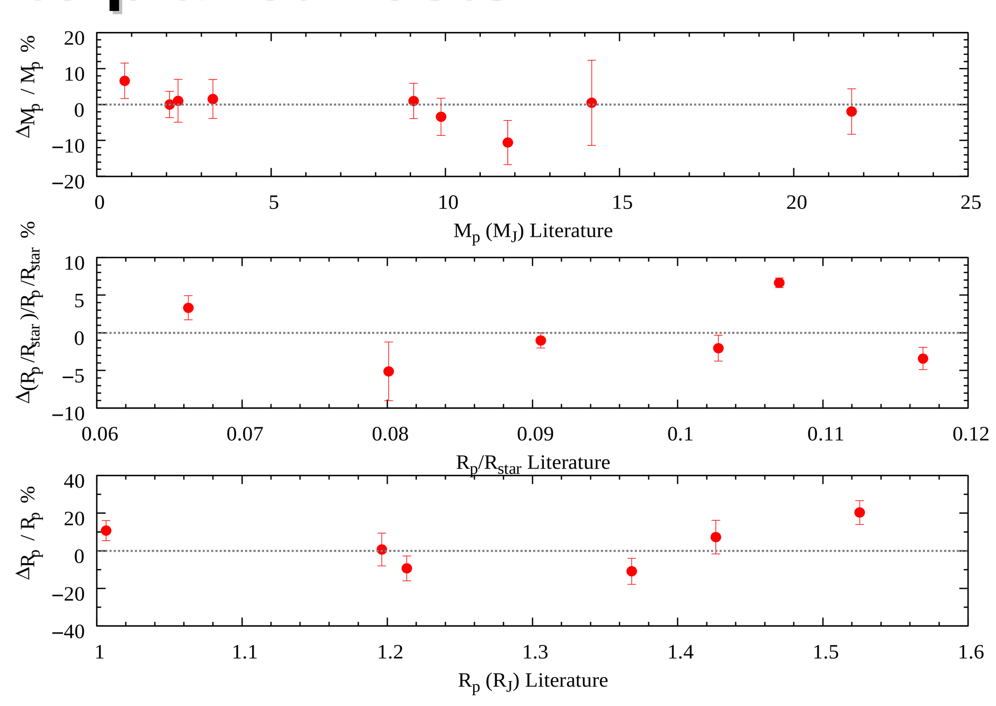


Fig. 11: We explore how planetary mass and radius are affected by new stellar parameters for 10 planet hosts with high usini. From top to bottom, literature data of planetary mass, radii ratio, and planetary radius, vs. this work.

References

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Acknowledgments

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