Seismic predictions for the CoRoT main target

**HD 52265**

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**Abstract.** HD 52265 is the only exoplanet-host star selected as a main target for the seismology programme of the CoRoT mission, and so it will be observed continuously during five months. This is of great interest in the framework of asteroseismology of exoplanet-host stars, in order to better understand the planetary formation and migration. We performed and extensive analysis of this star, computed models and analysed their frequencies. CoRoT observations should enable us to discriminate between the various models allowed from spectroscopic observations.

1. Introduction

HD 52265 is a solar-type G0V main sequence star, with a Jupiter-mass planet orbiting at 0.5 AU with a period of 119 days [2] [8]. This star has also been observed by the Hipparcos satellite from which its parallax was derived: $\pi = 35.63 \pm 0.84$ mas. The visual magnitude of this star is $V = 6.301$. Its overmetallicity has been established by several observers. In this study, we have computed evolutionary tracks using the TGEC code [9] [3]. We computed the p-mode oscillations frequencies for several characteristic models, using the PULSE code [1] and discuss asteroseismic tests which will help us to choose between the possible models for this star.

2. Modelling of HD 52265

Five groups of observers have derived the metallicity and the external parameters of HD 52265. Using the tables of [5], we obtained a bolometric correction $BC = -0.03 \pm 0.01$ and so a luminosity $\log(L/L_\odot) = 0.29 \pm 0.05$. We computed evolutionary tracks for overmetallic (FIG 1) and accretion models using the three different values of metallicity given by the groups of observers: $[\text{Fe/H}] = 0.19$ [4] [12], 0.23 [10] [6] and 0.27 [7]. We then analysed 8 specific models (6 overmetallic and 2 with accretion) consistent with the observed parameters.

3. Seismic analysis

For each model, we computed the adiabatic oscillation frequencies, for angular degrees $\ell = 0$ to $\ell = 3$, and for radial orders ranging typically from 4 to 100. We then computed the characteristic combinations of frequencies:

- the large separation: $\Delta \nu_{n,\ell} = \nu_{n,\ell} - \nu_{n-1,\ell}$
Figure 1. Evolutionary tracks for overmetallic models with [Fe/H]=0.19. The masses are: $1.18M_\odot$ (red), $1.19M_\odot$ (green), $1.20M_\odot$ (blue), and $1.22M_\odot$ (magenta). The five error boxes shown are from: [6] (black triangles), [4] (white triangles), [7] (asterisks), [12] (crosses), [10] (diamonds).

Figure 2. Echelle diagram for an overmetallic model ([Fe/H]=0.27) of $1.22M_\odot$ and 1.544 Gyr. Diamonds correspond to $\ell=0$, triangles to $\ell=1$, crosses to $\ell=2$ and asterisks to $\ell=3$.

- the small separation: $\delta\nu_{n,l} = \nu_{n,l} - \nu_{n-1,l+2}$ which are very sensitive to the deep stellar interior.

We finally computed the corresponding echelle diagrams.

All models are different in their internal structures and they present clearly visible seismic signatures, as can be seen in the examples shown in FIG 2 and 3.

We found two special cases, the two models lying in the Takeda et al. error box: one model is at the end of the main-sequence, the other at the beginning of the subgiant branch. These models present interesting features, as we can see on FIG. 3 and 4 for the example of the subgiant model: the small separations become negative at a given frequency, and so the lines $\ell=0$ and $\ell=2$ in the echelle diagram cross at that same frequency.

These characteristic features are related to the fact that the models have helium-rich cores, and so the sound velocity profiles present a clear discontinuity (cf. FIG. 5) at the boundary of the cores. The $\ell=2$ modes turn back at a specific depth while the $\ell=0$ modes travel down to the center of the star, this leads to a change of sign in the small separations.
4. Conclusion
We performed an extensive analysis of the planet-hosting star HD 52265, which is one of the main targets of the CoRoT seismology programme.

This star presents a metallicity excess, and from various groups of observers, the determined metallicity values range from \([\text{Fe/H}] = 0.19\) to 0.27.

We computed 8 models consistent with the external parameters of the star \((\text{Fe/H]}, \log g \text{ and } \log T_{\text{eff}}\). They present seismic signatures with differences large enough to be detectable by CoRoT, so we should be able to determine which of the possible models gives the best fit to the observations.

5. References
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Figure 5. Sound speed profile for the overmetallic model ([Fe/H]=0.19) of 1.20\(M_\odot\) and 4.647 Gyr.

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