Accuracy of stellar parameters of exoplanet-host stars determined from asteroseismology

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\section*{Introduction}

The successful launching of Corot produces data for transiting exoplanets with unprecedented accuracy compared to ground-based observations. The measure of planetary mass and radius provides priceless information on the mean density and bulk composition of exoplanets. Unfortunately, a remaining source of uncertainty on the planetary parameters (mass and radius) is due to uncertainties on the stellar parameters.

Our goal is to examine the accuracy on the latter parameters that could be obtained using asteroseismology with the expected accuracy on oscillation frequencies of COROT. We explore the space of stellar parameters, in terms of mass, effective temperature, luminosity, metallicity and mixing length parameter and we analyse the sensitivity of predicted spectrum of oscillation frequencies to these parameters. Adopting various levels of stellar and white noises, we analyse the frequency uncertainty for oscillation modes of given amplitude and lifetime. This analysis is done taking into account the performances of COROT in the Asteroseismology and Planet Finder channels (Auvergne et al. 2008).

\section*{Accuracy of frequency determination}

The pulsation calculations are performed with a nonradial nonadiabatic code originally developed by Lee (1985) and Mulet-Marquis et al. (2007). The equations are linearized around hydrostatic equilibrium, and eigenfunctions are expressed with spherical harmonics $Y_{lm}$. The opacity used are the Livermore ones. The system of equations is solved with Henyey-type relaxation method. A linear non-adiabatic stability analysis gives the eigenfunctions expressed with spherical harmonics $Y_{lm}$ and the eigenfrequencies $\nu = \nu_{l}^{\text{rad}} + \iota_{l}$ (Mulet-Marquis et al. 2007).


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\section*{Stars studied}

The large difference between the fundamental parameters of XO-3 of Johns-Krull et al 2008 (M=1.41±0.08 M\sun\textsuperscript{1}; R=2.13±0.21 R\sun\textsuperscript{1}) and of Winn et al 2008 (M=1.213±0.066 M\sun, R=1.377±0.083 R\sun) was a strong motivation to study how accurately the fundamental parameters of a star (mass, radius, luminosity) can be determined with asteroseismology alone. This difference yields large uncertainty on the fundamental parameters of the planet XO-3b.

We concentrate on stars with characteristics close to those of the planet-host star XO-3 (M=1.4 Msun, R=1.5 R\sun, T=6400 K, planet XO-3b M=11.79±0.59 M\textsubscript{J}, R=1.217±0.073 R\textsubscript{J}, Winn et al 2008).

We focus on modes with low value of l (0 ≤ l ≤ 3) and radial order n between 5 and 15.

\section*{Results}

Comparing two spectra generated for two sets of stellar parameters, $\delta \nu$ is defined as the largest difference between frequencies of a mode with given radial order n and degree l. We produce a first coarse grid of stellar models with different values of M, L, T\textsubscript{eff}, and determine the minimum value $\delta \nu_{\text{min}}$ of $\delta \nu$ within a mass range $m_{1}$-$m_{2}$. The variation of $\delta \nu_{\text{min}}$ with $m$ is plotted for a coarse grid of parameters on figure 2\textsuperscript{1}.

For a given mass difference, we analyse the effect of the number N of modes taken into account to compute $\delta \nu_{\text{min}}$. A refined grid is generated around stellar parameters which produce similar mode spectra. The variation of $\delta \nu_{\text{min}}$ with N for a mass difference of 2\%, 4\% and 6\% is shown on figure 3.

\section*{Conclusions}

The refinement of the grid used to compare the spectra of stars has a huge influence. For a mass difference of 6\%, the closest spectra with 40 modes taken into account differ by $\approx 4\%$ and only $0.59 \mu$Hz on the refined grid. As one can expect, the larger the mass difference, the larger the spectra difference, also the larger the number of modes taken into account, the larger the spectra difference.

For asteroseismological analysis of stars in the planet channels of Corot, amplitudes of modes need to be significantly larger than expected in solar type stars. We plan to extend this analysis to stars with different spectral types (from M to F).