Hare-hound exercise: Report on preliminary work on the interpretation of frequencies extracted from simulated time series

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We have considered the set of frequencies extracted by T. Toutain from the simulated time series "Meudon-Appourchaux", hereafter refered as "observed" frequencies. The degrees are given but the radial order have not been identified. This can be done in principle by comparison with the frequencies of a stellar model close to the star. Our first step is to select such a model among the set of models in the HR diagram box.

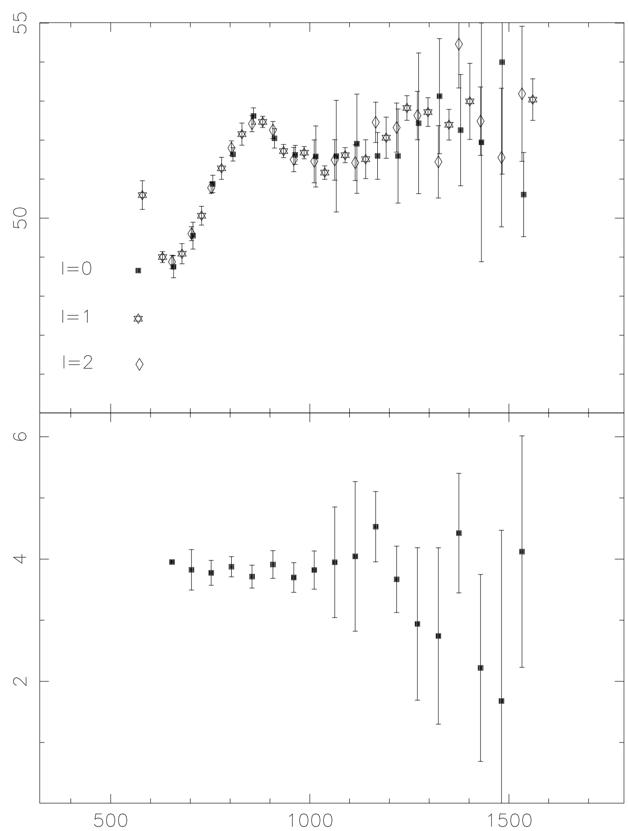
I. **Large and Small differences analysis**

As a first step, we have used the asymptotic properties of the acoustic frequencies and considered the large and small differences defined by:

$$\mathbf{\Delta}\nu_\ell = \nu_{\mathbf{n},\ell} - \nu_{\mathbf{n-1},\ell} \quad (1)$$

$$\delta\nu_{\mathbf{02}} = \nu_{\mathbf{n},\ell=\mathbf{0}} - \nu_{\mathbf{n-1},\ell=\mathbf{2}} \quad (2)$$

The large differences are plotted relatively to the frequency for degrees $l = 0, 1, 2$ in the upper pannel of the first figure, $\delta\nu_{\mathbf{02}}$ is plotted in the lower pannel.

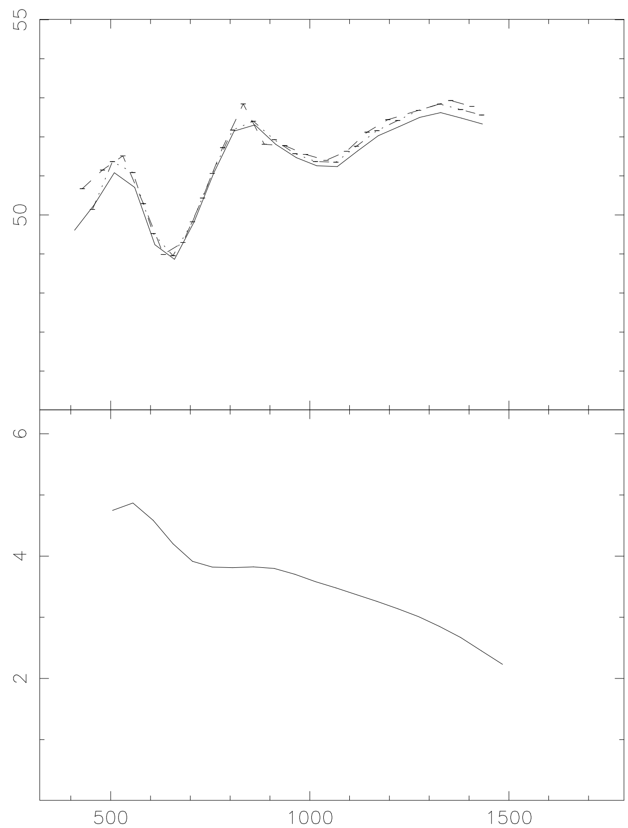


It is seen that the large spacing is not constant. A very crude mean value of large frequencies $\overline{\Delta\nu_0}$ can be defined with some uncertainty: $\overline{\Delta\nu_0} \sim 52. \pm 0.5\mu$Hz. We compute a set of stellar models which satisfy the constraints on luminosity L, effective temperature T_{eff} and chemical composition Z/X defined by the hare hound exercise

$$0.83 < log(L/L_{Sun}) < 0.89; \quad 3.8062 < log(T_{eff}) < 3.8195; \quad 0.019 < Z/X < 0.03$$

Then we select among these models those which frequencies have a large spacing within the "observed" domain. This corresponds to selecting models with given mean density. The same is done for the small spacing. We estimate: $\overline{\delta\nu_{02}} \sim 3.92 \pm 0.15\mu$Hz.

For comparison, the large and small differences for a theoretical model $M/M_\odot = 1.45, \quad Z = 0.015, \quad \zeta = 0.3$ is given in Figure 2.



Mean values of Large and Small frequency differences for a set of models

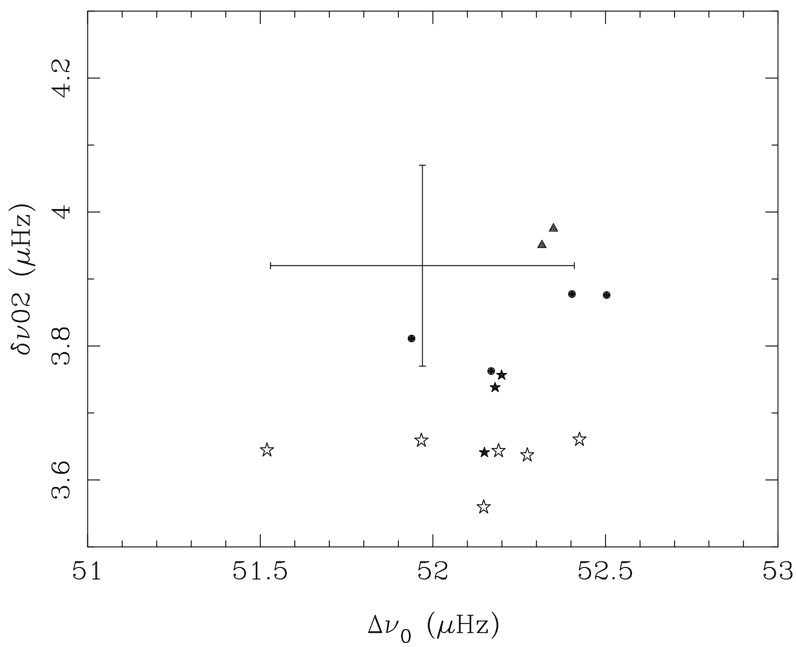
A set of models has been computed with different values of the core overshoot parameter ζ, the mass $M/M_\odot$ and the heavy element abundances Z. The figure represents the mean values of the small difference $\delta\nu_{02}$ relatively to the mean large difference $\Delta\nu_0$ for these models with the following characteristics:

ζ= 0. (M/M$_\odot$, Z): (1.5, 0.015), (1.59, 0.02) (full triangle)

ζ= 0.1 : (1.45-1.47, 0.015), (1.53, 0.0175), (1.54, 0.02) (full circle)

ζ= 0.2 : (1.45-1.47, 0.015), (1.525, 0.02) (full star)

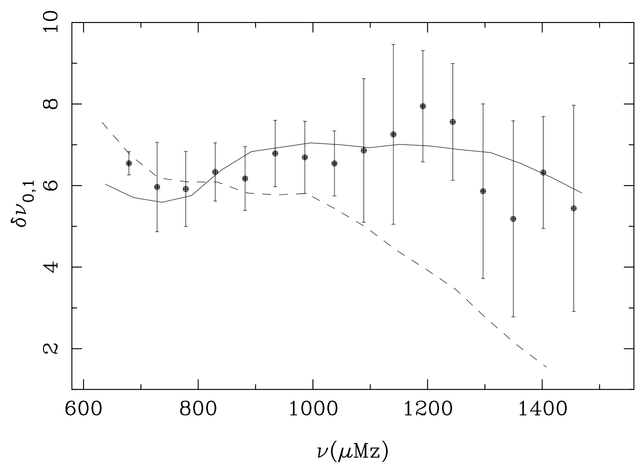
ζ= 0.3 : (1.45-1.47, 0.015), (1.47, 0.0175) (open star)



The cross in the figure represents the domain in $\delta\nu_{02}$ and $\Delta\nu_0$ estimated from the "observed" frequencies.

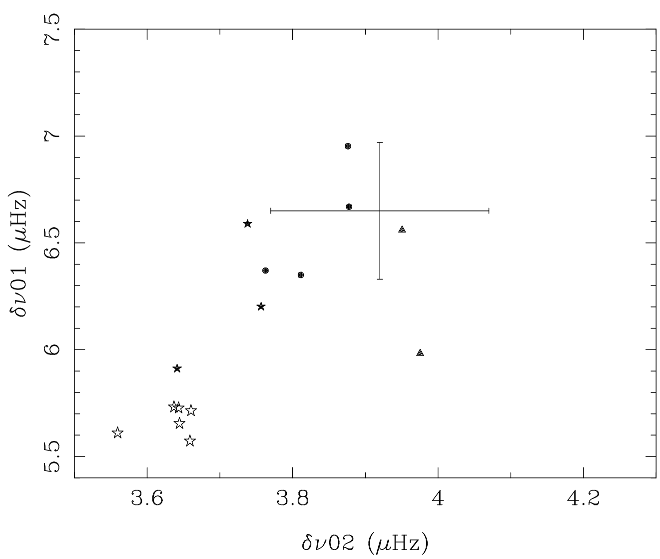
Small frequency differences $\delta\nu_{0,1}$ for TT-TA-Meudon and models

$$\delta\nu_{\mathbf{0,1}} = \mathbf{2}\nu_{\mathbf{n},\ell=\mathbf{0}} - (\nu_{\mathbf{n},\ell=\mathbf{1}} + \nu_{\mathbf{n-1},\ell=\mathbf{1}})$$



The full line corresponds to a model with $M/M_\odot = 1.5$, $Z = 0.015$, $\zeta = 0.05$, the dashed line corresponds to the model of figure 2.

Mean small frequency differences $\delta\nu_{0,1}$ and $\delta\nu_{0,2}$ for a set of models



In conclusion:
On the basis of the considered criteria, the models with low core overshoot parameter better fit the "observed" data.
This analysis allows to select some models to carry on some inversions.
Others global characteristics of the frequencies are needed to infer properties of the unknown model.