COROT Hare and Hound exercise

Introduction

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During the year 2000, two hare-hound exercises had been performed, independently by the two teams of the COROT sismogroup: "Data Analysis" and "Constraint in terms of stellar internal structure". The aim of such exercises, which are commonly used in helioseismology, is to prepare the data analysis and scientific interpretation of asteroseismic COROT observations. It helps to develop and test in that way the tools which are needed to do that work. At the present stage of the COROT preparation programme, this activity is also intended to bring indications and criteria to optimize the field selection. The procedure and some results were reported during COROT/SWG/Milestone2000 meeting and are available in the proceedings (see the reports of Appourchaux Th. et al., Berthomieu G,. Provost J.). They showed that interesting things could be learned from such exercises but it appeared that this was a first very simplified step and that it was worth performing a more realistic exercise which would involve the two groups. This imply more relevant oscillation spectra for synthetic light curves to be analysed and more relevant precision on seismic parameters used for seismic interpretation.

Thus the responsibles of the two groups tried to work out a second hare hound exercise which consists in constructing simulated time series which represent as well as possible what the observation by COROT of a pulsating star would give. These time series are then used to extract the frequencies and interpret them in terms of internal structure and rotation of the star.

I) Organization odf the hare hound exercise

The exercise is devided in the four following steps:

1) **Produce a set of theoretical oscillation frequencies** (with degrees l = 0,1,2,3) and their rotational splittings for a stellar model satisfying given constraints on luminosity L, effective temperature T_{eff} and chemical composition Z/X. We have chosen the following constraints which correspond to a solar like star. These domain of mass and evolutionary stage are interesting because they correspond to models with a convective core large enough for significant effects of overshoot beeing expected.

$$0.83 < log(L/L_{Sun}) < 0.89 \tag{1}$$

$$3.8062 < log(T_{eff}) < 3.8195 \tag{2}$$

$$0.019 < Z/X < 0.03 \tag{3}$$

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2) **Construct a COROT simulated time series** including that set of theoretical frequencies, COROT noise, stellar noise, inclination angle of the rotation axis, amplitude and life time of the modes.....

3) **Extract** from the synthetic spectra **the frequencies and splittings** with their **estimated errors** leading to an **"observed"** set of frequencies.

4) **Derive the structure and rotation** of the stellar model from the **"observed"** set of frequencies

This was proposed to the members of the COROT sismogroup, asking for who wanted to participate and to what step of the exercise. We had many responses of volonteers from different laboratories and we tried to regroup them in three teams listed hereafter. The belgian asteroseismology groupjoined the exercise very recently and constitutes the fourth team.

Step 1) and 2) Produce a set of frequencies and construct a simulated time series:

Team A: 1) G. Berthomieu, J. Provost, P. Morel (Nice)
2) T. Toutain
Team B: 1) Y. Lebreton, M.J. Goupil,E. Michel, B. Popieslki (Meudon)
2) T. Appourchaux
Team C: 1) I. Roxburgh, S. Vorontsov
2) C. Barban
Team D: 1) Dupret M.-A., Noels A., Scuflaire R. (BAG)
2) P. Magain

Step 3) Synthetic spectra analysis:

Team A: Toutain, F.Baudin, P.Boumier
Team B: T.Appourchaux, E.Fossat, D.Salabert
Team C: M. Bossi, S. Martin Ruiz, L. Mantegazza , C.Barban,
Team D: Briquet M. (with Aerts C. et her team)

Step 4) Theoretical interpretation:

Team A: G. Berthomieu, J. Provost, T. Corbard, H. Pikall
Team B: Y. Lebreton, M.J. Goupil,E. Michel, B. Popieslki
Team C: M. Bossi, S. Martin Ruiz, L. Mantegazza ,Garrido , I. Roxburgh, S. Vorontsov
Team D: Bancken F., Magain P., Thoul, A. Vatovez B.

II Preliminary Results

The hare-hound exercise is not yet achieved but much work has been done already. Three simulated time series have been constructed by teams A,B,C, using theoretical

frequencies of models of stars satisfying the constraints and introducing amplitudes and life times of the modes, stellar and instrumental noise accordint to the available litterature. Some inclination of the rotation axix relatively to the line of sight has also been introduced. These time serries have been named respectively:

Nice-Toutain; Meudon-Appourchaux; Roxburgh-Barban .

The initial theoretical set of frequencies and the precise way the time series have been obtained will not be commented here, but at the end of the exercise.

The simulated time series have been analysed and, up to now four sets of frequencies have been extracted by each team named:

Meudon-Appourchaux-Toutain; Meudon-Appourchaux-IAS;
Nice-Toutain-Appourchaux; Barban-Roxburgh-Appourchaux.

Let us note that two different sets of frequencies have been extracted from the same simulated time series. This will allow fruitful comparisons between data analysis methods. Different presentations concerning the way the sets have been obtained will be given in the session.

As far as the interpretation of the set of frequencies in terms of internal structure and rotation of the star are concerned, some work has started and preliminary results are presented during the session.

In conclusion, this exercise has rised much interest due to the fact that it is a good way to progress in preparing the analysis and interpretation of the future seismic COROT observations. A web site, where simulated time series and extracted sets of frequencies will be available, is under construction.