> ## COROT Week 7 - MiniWorkshop on
>
> ## Evolution and Seismic Tools
>
> ## Activity
>
> *2004-12-15, Granada*

1. **R**eference grids of models

2. **C**omparison of stellar models

3. **C**omparison of stellar frequencies

4. **O**rganization of the activity

1. Reference grids of models

For the preparation of the mission it is needed a "standard, nominal reference" so that people understand each other.

It is very urgent to set up a reference code, which will produce reference grids of models and isochrones, to be accessible from a web page.

It does not need to be among the very best. It has to contain what is "standard", but not what is still subject of debate.

1.1 What should the reference be?

- *Standard physics*:
  EOS + Opacities + Reaction rates + MLT
  Should these be specified ?
  [CEFF + OPAL96 + CF88 + BV58 ?]

- *Standard ingredients*:
  no overshoot + no diffusion/settling + no rotation + solar mixture (**new one?**) + solar mixing length + model atmosphere
  A definite list should be adopted !

- *Additional assumptions*:
  metallicity, age zero, etc
  What extra grids for these and non-standard ingredients ?
  What combinations of (Y_0, Z_0) should be made available ?

1.2 Specifications of the grid [a]

- *Mass*:
  <u>Limits</u> → $0.5M_\odot \leq M \leq 10M_\odot$
  <u>Coverage</u> → 0.1 for $M \leq 2M_\odot$,
  0.2 for $2M_\odot \leq M \leq 4M_\odot$,
  0.5 for $M \geq 4M_\odot$.
  Should we consider other values ?

- *Time step*: for the evolutionary sequences, and between extracted structure models (with frequencies)
  When should the tracks end ?

- *Seismic data*:
  <u>Frequencies</u> → $0 \leq l \leq 4$ and all n values for p-modes, and **low (?)** $|n|$ g-modes
  <u>Seismic parameters</u> → frequency separations
  These must be precisely defined !

1.2 Specifications of the grid [b]

- *Evolution code*: different codes may be needed to cover all regimes.
  "Reference" grids from different codes for the same model parameters could be useful !

- *Coverage of the HR diagram*: what are the key areas of the diagram that should be available.
  Are PMS "reference" models needed ?

- *Mixed modes*: calculation of the frequencies of evolved models for the reference grid should determine when mixed modes appear.

- *Documentation*: up-to-date descriptions on how the model and frequency calculations are carried out should be available (eventually, in the published literature).

1.3 Actions and calendar

- *What is already available*:
  COROT/CESAM models and frequencies
  by Y. Lebreton and E. Michel

  etc...

- *What may/will be available*:
  Aarhus models and frequencies
  by J. Christensen-Dalsgaard and co-workers
  Solar models, γ Doradus, δ Scuti, and β Cephei models
  by the Belgian Asteroseismolgy Group
  CESAM PMS models and frequencies
  by J. Marques and co-workers
  etc...

- *What is needed*: **to be identified now**, in order to be made available on the web by the beginning of 2005.

1.4 Exchange of data [a]

- *Evolutionary sequences*: ASCII files with
  $[M, L, T_{\mathrm{eff}}, R, \mathrm{age}, X_c, M_{\mathrm{bol}}, g,$
  $\quad M_{\mathrm{cor}}/M, R_{\mathrm{cor}}/R, R_{\mathrm{env}}/R]$

  Anything else ?
  $M_{\mathrm{bol},\odot}$ **and** $L_\odot$ **should be set !**

- *Stellar models*: ASCII files with all relevant quantities necessary to calculate the frequencies and analyze the models. The formats being used are:
  ⋆ <u>GONG</u> format,
  ⋆ CESAM <u>OSC</u> format (very similar to the previous one),
  ⋆ etc.

- *Conversion tools*: simple conversion tools for formats and to extract relevant information will be made available.
  Suggestions and contributions welcome !

1.4 Exchange of data [b]

- *Frequencies - model files*: the models used to calculated the frequencies will be by default the ones mentioned before. Specific formats (as the AMDL files used by JCD) will be extracted using the conversion tools available.
  Each seismic code has to define what files will be needed !

- *Frequency data*: ASCII files with
  $[l, n, \nu(\mu Hz), E_{nl}]$
  What else is necessary ?

- *Eigenfunctions and kernels*:
  What will be needed ?

2. Comparison of stellar models

In order to proceed with the models comparison between different codes we need to define

- the strategy to follow,

- and the calendar.

There is an urgent need to integrate the different activities already taking place by setting common objectives and by extending the exercises being done.

2.1 Strategy for comparing models

1. *Comparing evolutionary sequences*: using the reference grids produced for the same stellar parameters by different evolution codes.

2. *Comparing models of the Sun*: calculated with different combinations of the standard and non-standard ingredients, in order to compare the implementation of the physics.

3. *Comparing specific stellar cases*: by identifying a few (∼5 or so) representative cases in the HR diagram. Detailed models produced with different codes and combinations of the physics would be compared.

4. *Other options*: as problems arise and as suggested by the results of the other tasks.

   Any suggestions on these or on alternatives ?

2.2 Calendar for comparing models

- *Comparing the grids*: would be done as soon as the grids are available [**to start in the beginning of 2005 as soon as the grids are calculated**].

- *Comparing solar models*: to be done as soon as possible [**activities should start now**].

- *Comparing specific stellar cases*: the particular cases should be identified now (or over the next three weeks), so that the models can be calculated very soon [**to be initiated now**].

- *Results*: should be available for discussion in the next COROT Week on all components.

3. Comparison of stellar frequencies

The comparison can start as soon as we have stellar models available. It should include;

- comparing the frequencies calculated with different codes,

- and look at some of the aspects relevant for the calculation of the frequencies.

  Some of these should be identified now!

3.1 Calculation of the frequencies

- *Model meshes*: care must be taken in order to secure that an adequate mesh (distribution of the points and representation of particularly problematic regions of the models) is used.

- *Mixed modes*: the calculation of frequencies for evolved stellar models has to be checked.

- *Upper boundary condition*: different alternatives to implement the reflection of the modes at the stellar surface should be discussed.

- *etc...*

3.2 Application of seismic tools

In order to effectively use some of the seismic tools available there are aspects of the calculation of the frequencies that should be looked at.

- *Eigenfunctions*: used in the calculation of inversion kernels should also be considered.

- *Frequencies in the presence of sharp variations*: can be used to test some of the relevant aspects of the observations. But a correct calibration by the models requires that these layers in the models and in the calculation of the frequencies are adequately represented.

- *etc...*

4. Organization

- All information and data will be organized in a webpage at the following URL:

  `Http://www.astro.up.pt/corot/`

- The coordination of the efforts on the different aspects of the activity, and the information on what is being done will be managed through the webpage and email lists (when necessary). Help on data conversions, model and frequencies calculations, seismic tools, etc, is also available.

- All colleagues with tools and data relevant for these tasks are urged to join this activity and to contact me, please, at:

  `Email: mjm@astro.up.pt`