Introduction to the session "Chemical inhomogeneity"

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Why should we worry about chemical inhomogeneities in stars? How should they influence COROT's results?

The importance of chemical inhomogeneities comes from their influence on the equation of state which controls the sound velocity which is the quantity observed by COROT. Chemical inhomogeneities build up during the life of the star and result from the transport mechanisms operating in radiative zones (it is clear that convective zones are chemically homogeneous).

Transport mechanisms in radiative zones are of two kinds: microscopic and macroscopic. The microscopic transport is itself the result of two mechanisms : gravitational settling and radiative levitation; they are slow mechanisms which need long time scales. Hence, microscopic transport is often not efficient enough: for instance lithium depletion in the Sun cannot be explained by it (Vauclair 1998, Zahn 1998). Thus, macroscopic transport coming from fluid flows has to be considered even in radiative zones.

Flows in radiative zone essentially come from the fact that the star is rotating. Indeed, a rotating radiative zone cannot be in hydrostatic equilibrium (von Zeipel theorem); hence, circulations take place and as the resulting motions are unstable to shear instabilities, turbulence is also expected. This is the physical background of Zahn's model for mixing in radiative interiors (Zahn 1992, Maeder 1995). This kind of mixing has been studied in its various consequences through Zahn's model which can be implemented in one dimensional models of stars (see Talon et al. 1997, Charbonnel & Talon 1999 for instance).

However, even that macroscopic mixing is not sufficient to solve all the problems as for instance that of angular momentum in the Sun's radiative zone or the lithium abundance of stars on the cool side of the Li-dip. Thus something is not understood and other mechanisms should be investigated. Currently, gravity waves are good candidates (Zahn et al. 1997, Kumar et al. 1999) but magnetic fields could also play an important part.

At present time, when considering stars other than the Sun, surface abundances are *the* test for transport processes while when COROT fly, we will have access to acoustic frequencies which sample the interior of the stars and there the distribution of elements. We should be prepared to the fact that models which now work may no longer work! In fact, the main weakness of present models is their simplicity: they are one dimensional (to fit in stellar evolution codes) while transport processes are essentially multidimensional processes. Thus (at least) two dimensional star evolution models are really called for so that chemical inhomogeneities conceal no secret for astrophysicists.

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