Entropy-calibrated modelling of solar type stars

L. Manchon, F. Spada, M. Deal, M.-J. Goupil, A. Serenelli, L. Gizon

Modelling of convection is a long standing problem in stellar physics. In a one dimensional code, convection is described using ad hoc theories that all rely on an adjustable parameter α. However, at the moment, there exists no analytical expression that predicts its value. To fix α's value, in the best cases, one can tune it so that the model matches some observational constrains. In the worst cases, modellers are often left with no other choice than using, for any star, the solar value found for this convection parameter α. Moreover, α is assumed to stay fixed along stellar evolution and a bad choice has a strong impact on it.

In the past years, Spada et al. (2018, 2019, 2021) have designed a method to constrain the value of α with the entropy at the bottom of the convective envelope. In most of the convective envelope, a region called the adiabat, the entropy is constant. The value of this entropy and of α are intimately linked. In the past two decades, grids of stellar atmospheres have been computed that allow to derive prescriptions giving the adiabatic entropy as a function of $T_{\rm eff}$, $\log g$ and [Fe/H] (Ludwig+1999, Magic+2013, Tanner+2016). Along the evolution of a model, the value of α is then adjusted so that the entropy of the adiabat in the model matches the one predicted by the prescriptions. This method thus allow to have a precise constrain the value of α and allow it to vary along evolution. I implemented this method in the stellar evolution code CESTAM and I will present its impact on the Sun as well and solar-like stars such as the 16 Cyg and aCen systems.