How the modeling of mixing and nuclear energy production impacts the extent of convective cores

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Abstract

Convective cores are the hydrogen reservoirs of main-sequence stars that are more massive than around 1.2 solar masses. The characteristics of the cores consequently have a strong impact on the structure and evolution of the star. The high quality of the Kepler mission dataset allowed to better constrain the core extension and therefore to obtain more accurate ages. However, such results rely on stellar evolution codes, in which simple assumptions are often made on the physics in the core. Indeed, the convective mixing is commonly considered to be instantaneous and the most basic nuclear networks assume that both Lithium and Beryllium are at their equilibrium abundance. In this talk, we show how those two hypotheses lead to significant differences in the central composition of the elements for which the timescale to reach nuclear equilibrium is lower than the convective timescale. We present how this impacts the nuclear energy production and therefore the size of convective cores in low-mass stars. As those stars exhibit solar-like oscillations, we use data from the Kepler mission to study the impact of this effect on the seismic modelling. We find that the overshoot parameter of the best-fit model is significantly higher when using basic nuclear reaction networks. Thus, it is necessary to have consistent nuclear reactions and central mixing prescriptions when using observationally-calibrated overshoot parameters. This is key in the framework of the Plato mission, especially to ensure accurate age determinations within the main-sequence grid modeling pipeline.

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