An attempt to calibrate the amount of core overshooting of low-mass stars with Kepler seismic data

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Abstract

The extent of the mixed regions associated with convective cores remains uncertain due to our poor understanding of the interface between convective and radiative zones (e.g. overshooting). This generates large uncertainties on stellar ages.

The seismic study of low-mass stars can play a specific role in the study of the extra mixing at the edge of stellar cores. Indeed, it has been shown that even a mild amount of overshooting can spectacularly increase the lifetime of the small convective core that low-mass stars have at the ZAMS due to nuclear reactions outside of equilibrium. This can be used to place constraints on the size of the overshoot regions because the presence or absence of a convective core can be tested using seismology.

The Kepler satellite has observed stars with high-precision photometry in the same field of view for over three years. Among the solar-like pulsators observed by Kepler, we selected 25 low-mass targets. We extracted the mode frequencies using the complete Kepler data set available. We confronted the parameters of a linear regression of seismic indexes that are particularly sensitive to the core structure (the deltanu01 and deltanu10 small separations) to those of a grid of models. Preliminary results show that all the targets that are discriminating very consistently rule out the case of an extra mixing extending over 0.2 Hp (pressure scale height) and above. Besides, main sequence stars that have a convective core are all inconsistent with the "no extra mixing" scenario and favor distances of overshooting from 0.1 to 0.15 Hp. For about ten targets, the amount of extra mixing can be precisely constrained, and the results suggest that the amount of core overshooting increases with stellar mass.

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