Tight asteroseismic constraints on core overshooting and diffusive mixing in the slowly rotating pulsating B8.3V star KIC 10526294

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KIC 10526294 was recently discovered to be a very slowly rotating and slowly pulsating late B-type star. Its 19 consecutive dipole gravity modes constitute a series with almost constant period spacing. This unique collection of identified modes probes the near-core environment of this star and holds the potential to reveal the size and structure of the overshooting zone above the convective core, as well as the mixing properties of the star.

We revisit the asteroseismic modelling of this star with specific emphasis on the properties of the core overshooting, while considering additional diffusive mixing throughout the radiative envelope of the star.

We pursued forward seismic modelling based on adiabatic eigenfrequencies of equilibrium models for eight extensive evolutionary grids tuned to KIC 10526294 by varying the initial mass, metallicity, chemical mixture, and the extent of the overshooting layer on top of the convective core. We examined models for both OP and OPAL opacities and tested the occurrence of extra diffusive mixing throughout the radiative interior.

We find a tight mass-metallicity relation within the
ranges M from 3.13 to 3.25 M_sun and Z from 0.014 to 0.028. We deduce that an exponentially decaying diffusive core overshooting prescription describes the seismic data better than a step function formulation and derive a value of f_ov between 0.017 and 0.018. Moreover, the inclusion of extra diffusive mixing with a value of log D_{mix} between 1.75 and 2.00 dex (with D_{mix} in cm^2/sec) improves the goodness-of-fit based on the observed and modelled frequencies by a factor 11 compared to the case where no extra mixing is considered, irrespective of the (M,Z) combination within the allowed seismic range.

The inclusion of diffusive mixing in addition to core overshooting is essential to explain the structure in the observed period spacing pattern of this star. Moreover, for the input physics and chemical mixtures we investigated, we deduce that an exponentially decaying prescription for the core overshooting is to be preferred over a step function, regardless of the adopted mixture or choice of opacity tables. Our best models for KIC 10526294 approach the seismic data to a level that they can serve future inversion of its stellar structure.

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