The internal rotation profile of a gravity-mode B star pulsator in the Kepler field: the ups and downs in the forward modelling of 19 quasi-equally spaced rotationally-split dipole modes

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Abstract

Pulsating massive main sequence stars are key objects for the much-needed calibration of stellar structure end evolution models in the upper part of the HRD. In this region, various internal mixing processes including core overshooting and differential rotation, among others, have a significant effect on the future stellar life. There are only a handful of cases with seismic constraints on the extent of the core overshoot region, or on the ratio of the core to envelope rotation and the precision of these constraints is not yet satisfactory. Moreover, the sample is too small to provide a meaningful coverage of the instability strips, even without considering the effects of, e.g., different metallicities, rotation rates, or the presence of a magnetic field. We need more detailed studies to achieve a solid seismic understanding of the mentioned processes. In this context, we present a full asteroseismic analysis of a young, single, slowly rotating pulsating B star based on four years of uninterrupted high-precision data from the Kepler satellite. After identifying an unprecedented series of nineteen consecutive quasi-equally spaced l=1 modes, each of which shows rotationally split components, we use the forward-modelling approach to look for the best fitting seismic model in a large and high-resolution grid of models calculated with the MESA evolution and GYRE pulsation codes. We conclude that the star is very young and that its core overshoot parameter is below 0.18 local pressure scale heights. From the rotational splittings, we conclude that the star is an extremely slow rotator, which validates the use of non-rotating models, but also rises the questions what physical process has slowed it down after the star formation process. We derive constraints on the internal rotational profile.

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