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The Impact of Convective Boundary Mixing Uncertainties on pre-Supernovae Structure and Nucleosynthesis

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Convection plays a key role in stellar evolution by both transporting energy and mixing composition. Convective mixing alters the internal structure and lengthens significantly the duration of burning stages when it is present. Convective boundary mixing is crucial for the creation of the 13C pocket in low-mass stars (main s-process site) and to determine the extent of convective zones in massive stars. In the case of massive stars, several recent studies have shown the sensitivity of the pre-supernova (pre-SN) structure and their explosion likelihood (e.,g. compactness parameter) to the details of their complex convective history.
Despite the importance of convection, these processes are still not well understood and their implementations in 1D stellar evolution codes have large uncertainties and inconstancies due to missing details in the treatment of convective energy transport and turbulent mixing. Hence, it is urgent to improve or even replace the current theory.
One longstanding conundrum in all 1D stellar evolution codes is the treatment of convective boundaries. In this work, we illustrate the effects of some convective boundary mixing uncertainties, for example the positioning of the convective boundaries or the strength of convective boundary mixing. We will present the impact of these uncertainties on both the pre-SN structure and the corresponding nucleosynthesis. The goal of this study is to highlight, which aspects of the physics lead to the largest uncertainties in the model prediction as well as which observational tests and 3D hydrodynamic simulations may help constrain convective modelling in 1D stellar evolution models.

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