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FULLY-COMPRESSIBLE HYDRODYNAMICAL SIMULATIONS OF TURBULENT CONVECTION

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Abstract.
Convection is a key process in stellar interiors. It is characterized by large Reynolds numbers, implying a highly turbulent regime. In this talk, I presented 3D Implicit Large Eddy Simulations of turbulent convection in two very different astrophysical contexts: the oxygen-burning shell of a supernova progenitor and the envelope of a red giant stars. I highlighted common properties and discussed important differences, illustrating how a careful analysis of 3D data allow us to gain insight into this complex phenomenon.

Keywords: convection - stars: interiors - turbulence

1 Summary

Currently, most of our physical understanding of stellar interiors and evolution largely relies on one-dimensional calculations. The description of complex physical processes like time-dependent turbulent convection, rotation or MHD processes mostly relies on simplified, phenomenological approaches, with a predictive power hampered by the use of several free parameters. These approaches have now reached their limits in the understanding of stellar structure and evolution. The development of multi-dimensional hydrodynamical simulations becomes crucial to progress in the field of stellar physics and to meet the enormous observational efforts aimed at producing data of unprecedented quality (COROT, Kepler GAIA).

The talk summarized our recently published paper, Viallet et al. (2013b) , which presents a comparison of 3D Implicit Large Eddy Simulations of turbulent convection in two very different astrophysical contexts: the oxygen-burning shell of a supernova progenitor and the envelope of a red giant stars. The oxygen-burning shell data is similar to the one described in Meakin & Arnett (2007); Arnett et al. (2009). The red giant data was produced with the MUSIC code (see Viallet et al. 2011, 2013a). The analysis framework is provided by mean-field equations that result from averaging the hydrodynamical equations, see Viallet et al. (2013b) for details. Such an averaging procedure allows for a quantitative analysis and comparison of complex 3D data sets. The averaged data and scripts are provided online at www.stellarmodels.org (PI: Casey Meakin).

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