Shell-merger in 3D Core-Collapse Supernova Progenitors

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ABSTRACT

We present shell events of 4π-3D non-rotating $12.28\,M_\odot$ and $12.98\,M_\odot$ supernova progenitors simulated for a period of one-hour before core-collapse. The main interest is to study the interior shell properties (from the kinematic, thermodynamic to the chemical evolution) and their interactions for a period of one-hour before collapse. The high-resolution of these models as well as the 3D geometry are important for capturing the development and evolution of low and high order convective modes. The pre-collapse shell-merger event occurs in the $12.28\,M_\odot$ model, while in the $12.98\,M_\odot$ model shells remain intact until the progenitor phase elapse. The shells of interest are Ne and Si because our studies show that violent shell-merger is triggered roughly at the Ne/Si interface. Our analysis show that at this interface, the entropy flattens out across the Ne and Si shells just before merger. As a consequence, the $12.28\,M_\odot$ progenitor for which shell-merger occurs has higher radial velocity fluctuations and higher turbulent Mach number, and thus higher turbulent kinetic energy compared to the $12.98\,M_\odot$ non-shell merger progenitor. Meaning core-collapse supernova progenitors with shell-merger are more violent than the progenitors without shell-merger.

Keywords: stars:massive – convection – hydrodynamics – supernovae: general – turbulence