Advancing Nucleosynthesis in Self-consistent, Multidimensional Models of Core-Collapse Supernovae

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We investigate CCSN in polar axisymmetric simulations using the multidimensional radiation hydrodynamics code CHIMERA. Computational costs have traditionally constrained the evolution of the nuclear composition in CCSN models to, at best, a 14-species α-network. However, the limited capacity of the α-network to accurately evolve detailed composition, the neutronization and the nuclear energy generation rate has fettered the ability of prior CCSN simulations to accurately reproduce the chemical abundances and energy distributions as known from observations. These deficits can be partially ameliorated by "post-processing" with a more realistic network. Lagrangian tracer particles placed throughout the star record the temporal evolution of the initial simulation and enable the extension of the nuclear network evolution by incorporating larger systems in post-processing nucleosynthesis calculations. We present post-processing results of four *ab initio* axisymmetric CCSN 2D models[1] evolved with the smaller α-network, and initiated from stellar metallicity, non-rotating progenitors of mass 12, 15, 20, and 25 $M_\odot$[2].As a test of the limitations of post-processing, we provide preliminary results from an ongoing simulation of the 15 $M_\odot$ model evolved with a realistic 150 species nuclear reaction network *in situ*. With more accurate energy generation rates and an improved determination of the thermodynamic trajectories of the tracer particles, we can better unravel the complicated multidimensional "mass-cut" in CCSN simulations and probe for less energetically significant nuclear processes like the νp-process and the r-process, which require still larger networks.

[1] S. W. Bruenn et al., ApJL 767, L6 (2013).
[2] S. E. Woosley & A. Heger, ApJ 442, 269 (2007).