Diverging Core-Collapse Supernova Experiments on NIF

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Abstract

We present a computer-based design of an experiment relevant to core-collapse supernovae (ccSNe), using a spherically diverging system with two or more interfaces. The mass of the layers between the interfaces is scaled to actual values from models of SN 1987A, as accumulated mass is the key parameter for blast wave dynamics and blast-wave-driven instabilities. The structure on the interfaces is based on the simulation and analysis of structure in presupernova stars. The design builds on our previous work at Omega, which proved insufficient to drive a massive hemi-spherical target. Currently NIF is the only existing experimental facility that can accomplish the proposed experiment and produce mixing in a diverging, multi-layer system relevant to ccSNe.

To simulate the experimental systems we use a multiphysics fluids code, CRASH, developed at the Center for Radiative Shock Hydrodynamics at the University of Michigan. The CRASH code is equipped with a laser energy deposition package that allows for generating the

initial conditions including time-dependent laser-driven structure of the flow entering computational domain, in multiple dimensions. Using CRASH, we perform a series of numerical experiments to assess sensitivity of the model to numerical diffusion, target fabrication errors, and variation in laser drive parameters. We also briefly discuss a possible contribution due to magnetic fields.