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Laboratory blast wave driven instabilities

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This presentation discusses experiments well-scaled to the blast wave driven instabilities during the explosion phase of SN1987A. Blast waves occur following a sudden, finite release of energy, and consist of a shock front followed by a rarefaction wave. When a blast wave crosses an interface with a decrease in density, hydrodynamic instabilities will develop. These experiments include target materials scaled in density to the He/H layer in SN1987A. About 5 kJ of laser energy from the Omega Laser facility irradiates a 150 μm plastic layer that is followed by a low density foam layer. A blast wave structure similar to those in supernovae, is created in the plastic layer. The blast wave crosses a perturbed interface, which produces nonlinear, unstable growth dominated by the Rayleigh-Taylor (RT) instability. Recent experiments have been performed using complex initial conditions featuring a three-dimensional interface structure with a wavelength of 71 μm in two orthogonal directions, at times supplemented by an additional sinusoidal mode of 212 μm or 424 μm. We have detected the interface structure under these conditions, using dual orthogonal radiographs on some shots, and will show some of the resulting data. Recent advancements in our x-ray backlighting techniques have greatly improved the resolution of our x-ray radiographic images. Under certain conditions, the improved images show some mass extending beyond the RT spike and penetrating further than previously observed. Current simulations do not show this phenomenon. This presentation will discuss the amount of mass in these spike extensions as well as the error analysis of this calculation. Future experiments will also be discussed. They will be focusing on realistic initial conditions based on 3D stellar evolution models. This research was sponsored by the Stewardship Science Academic Alliances Program through DOE Research Grants DE-FG52-07NA28058, DE-FG52-04NA00064, and other grants and contracts.