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Laboratory blast wave driven instabilities

CAROLYN KURANZ, University of Michigan

This presentation discusses experiments involving the evolution of hydrodynamic instabilities in the laboratory under high-energy-density (HED) conditions. These instabilities are driven by blast waves, which 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. Instabilities evolving under HED conditions are relevant to astrophysics. 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 an interface having a 2D or 3D sinusoidal structure that serves as a seed perturbation for hydrodynamic instabilities. This produces unstable growth dominated by the Rayleigh-Taylor (RT) instability in the nonlinear regime. We have detected the interface structure under these conditions using x-ray backlighting. Recent advances in our diagnostic 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 or predicted by current simulations. The observed effect is potentially of great importance as a source of mass transport to places not anticipated by current theory and simulation. I will discuss the amount of mass in these spike extensions, the associated uncertainties, and hypotheses regarding their origin We also plan to show comparisons of experiments using single mode and multimode as well as 2D and 3D initial conditions. This work is sponsored by DOE/NNSA Research Grants DE-FG52-07NA28058 (Stewardship Sciences Academic Alliances) and DE-FG52-04NA00064 (National Laser User Facility).