HIGH-ENERGY-DENSITY INSTABILITY EXPERIMENTS ON THE OMEGA LASER FACILITY AND THE NATIONAL IGNITION FACILITY

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Shear instability in high-energy-density physics is important for elucidating issues in compressible turbulence and in understanding the late time quenching of inertial fusion capsules. A counterflowing shear experiment initially designed for the Omega Laser Facility studies shear instability in isolation by launching 110 km/s shocks into opposite sides of a foam-filled shock tube bisected by an Al tracer plate [1]. When the shocks cross at the tube center, a region of intense shear is created. As the shear instability develops, the tracer layer mixes with the surrounding foam and expands into the tube volume. Radiography records the spreading of the mixing layer and is compared to simulations using the LANL hydrocode RAGE.

However, the Omega experiments are eventually disturbed by transients, due to the 1 ns impulsive drive, and by edge effects, due to the small dimensions of the shock tube. Our campaign on the National Ignition Facility redesigned the experiment for indirect drive with new diagnostics, shock tubes, and drive, to drive and diagnose larger volumes more steadily [2,3]. Data from our first year of experiments indicates that we have successfully extended the range of the Omega experiment, and observation of shear-induced hydrodynamic features surviving to late time (> 34 ns) suggests that we have created a relatively long-lived volume of pure shear evolution. The design and techniques developed for this experiment are of general interest to those designing indirectly-driven shock tube experiments on NIF, and have been used to perform Rayleigh-Taylor, radiation-instability coupling experiments in an astrophysical regime.

Recent campaigns have expanded the parameter space of the shear experiment by creating and deploying enhanced-roughness tracer foils, with high amplitude, broadband perturbations impressed into the tracer, as well as foils prepared by deforming the foil into a single-mode shape. The former confirm predictions that controlling the roughness can speed or slow the early-time evolution of the instability [4], and the latter improve our understanding of Kelvin-Helmholtz dynamics in the geometry of the experiment.

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