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Creating a Driven, Collapsed Radiative Shock in the Laboratory

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We report details of the first experimental campaign to create a driven, planar, radiatively collapsed in laboratory experiment. Radiation hydrodynamics experiments are challenging to realize in a laboratory setting, requiring high temperatures in a system of sufficient extent. The Omega laser at $\sim 10^{15}$ W/cm^2 drives a thin slab of low-Z material at >100 km/s gas via laser ablation pressure. This slab initially shocks, then continues driving a shock through a cylindrical volume of Xe gas at 6 mg/cc. Simulations predict a collapsed layer in which the density reaches ~ 45 times initial density. Side-on x-ray backlighting was the principal diagnostic. We have successfully imaged shocks with average velocities between 95-205 km/sec, with measured thicknesses of 45-150 μm in experiments lasting up to 20 ns and spanning up 2.5 mm in extent. Comparison of the shock position as a function of time from these experiments to 1D radiation hydrodynamic simulation results show some discrepancy, which will be explored. Optical depth before and behind the shock is important for meaningful comparison to these astrophysical systems. This shock is optically thin to emitted radiation in the unshocked region and optically thick to radiation in the shocked, dense region. We compare this system to collapsed shocks in astrophysical systems with similar optical depth profiles. An experiment using a Thomson scattering diagnostic across the shock front is also discussed. This research was sponsored by the National Nuclear Security Administration under the Stewardship Science Academic Alliances program through DOE Research Grants DE-FG52-03NA00064, DE-FG53-2005-NA26014, and other grants and contracts.