Laboratory Experiments of Supersonic Flows through Clumpy Media

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Over the past decade, high resolution images from the Hubble Space telescope of a variety of astrophysical objects, including planetary nebulae and Herbig-Haro (HH) objects, have revealed complex, chaotic, evolving morphologies of bow shocks, knots, and filamentary structure. In the case of HH flows, measurements of knot proper motion typically indicate that pre-existing knots, or clumps, are being overrun by faster moving bow shocks. To investigate how inhomogeneities play a role in shaping the morphology of such objects, scaled laboratory experiments are underway to study shock propagation through a clumpy environment and subsequent development of small scale structure after shock passage. The first experiments were recently performed on the Omega Laser Facility. In these experiments, a 5 kJ, 1-ns laser pulse heated a halfraum to 180 eV to indirectly drive a near planar shock into a 300 mg/cc RF ($C_{15}H_{12}O_4$) foam cylinder. Two types of downstream targets were embedded in the RF cylinder: a clumpy target consisting of a ~ 1000 μm-diameter RF foam sphere containing up to 44 randomly distributed 130-μm diameter ruby microspheres, and a ~1000 μm-diameter sphere target of "uniformly" mixed RF foam with sapphire nanopowder. Both targets had close to the same average density (~670 mg/cc). To study the hydrodynamic evolution of the targets, backlighter images were taken at 60, 100, 120, 160, and 200 ns after the start of the drive pulse. The backlighter consisted of a tantalum pinhole substrate backed by either nickel or zinc foil with pinhole sizes of 10 μm (Ni) and 20 μm (Ni and Zn). One backlighter image was obtained per shot with times determined by delaying the backlighter beams with respect to the drive beams. A description of the experiment, experimental results, and comparison with 3-D simulations will be presented.

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