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An experimental study of the interaction of three Richtmyer-Meshkov-unstable gas cylinders

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We report an experimental investigation of the interaction of three shock-generated vortex pairs. The vortex pairs are generated by the simultaneous interaction of a planar Mach 1.2 shock wave with three heavy gas (SF_6) cylinders in air. The gaseous cylinders are formed by letting the heavy gas fall under gravity from three circular holes in a nozzle at the top of shock tube. The cylinders are separated laterally across the width of the shock tube with spacing S/D = 1.5, where S is the spacing between the cylinder centers and D = 3.1 mm is the cylinder diameter at the nozzle exit. The simultaneous interaction of the planar shock with three gaseous cylinders results in vorticity deposition at the cylinder surface. This vorticity rolls up resulting in three counter-rotating vortex pairs. The interaction of these vortex pairs is studied experimentally using planar laser induced fluorescence (PLIF) of an acetone tracer pre-mixed with SF_6. It is found that four distinct post-shock flow morphologies (shown below in figure 1) result from nominally identical initial conditions. Each frame of figure 1 shows two time sequence PLIF images taken at t = 418 and 583 μs, where t = 0 is the instance when the shock first interacts with the gaseous cylinders. Because we observe multiple complex flow features, we surmise that the shock/three-cylinder-configuration interaction is highly nonlinear. We attempt to explain these complex morphologies with careful analysis of initial conditions. The variation of the overall integral width of these structures with time is reported. Recent experimental images capturing the time evolution of shock propagation through the initial cylinder configuration will also be presented.

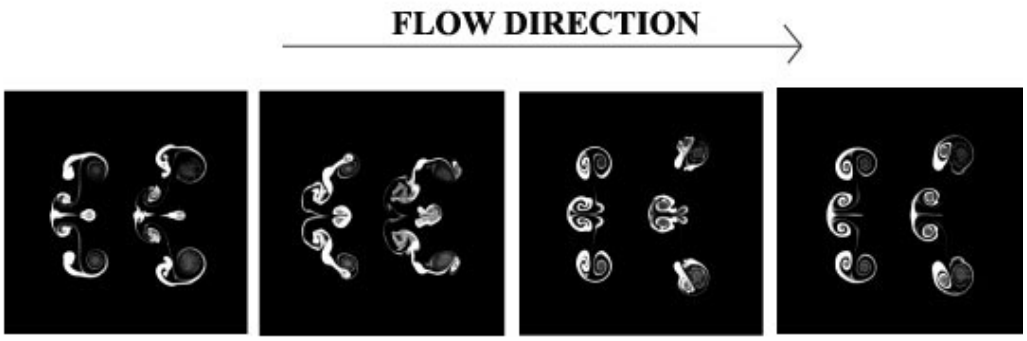

Figure 1. Distinct flow morphologies (PLIF images).