Experimental Investigation of Velocity Evolution in the Richtmyer-Meshkov Instability

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Abstract

The present work describes the evolution of the Richtmyer-Meshkov instability through a focus on the development of the structure and distribution of velocity fluctuations. In the Wisconsin Shock Tube Laboratory at the University of Wisconsin, a broadband, shear-layer initial condition is created at the interface between helium and argon. This shear layer is seeded with particulate TiO_2, diameter 300 nm, which is used to track the flow and allow for the Mie scattering of light. Once impulsively accelerated by a M=1.4 shock wave, the interface is imaged twice in close succession using planar laser imaging to create particle image pairs. Velocity fields are obtained from these particle images using the Insight 4G software package from TSI Inc. This process is repeated, capturing a total of five different times in the development of the instability, allowing for the study of the evolution of velocity fluctuations in the RMI. For each post-shock time, the velocity field structure is investigated, and probability density functions showing the distribution of velocty fluctuations are compared. Using known length scales from previous studies (Weber *et al.*, 2014), these newfound RMS velocity values are used to give an estimate of the Reynolds number. Vorticity is also extracted from experimental measurements of velocity fluctuations, shedding light on the evolution of vortical structures as well as the distribution of this vorticity. Experimental velocity fields also allow for the calculation of the planar turbulent kinetic energy (TKE) spectrum at each of the five times in the development of the instability. Measurements of higher-order statistics have been obtained, showing a power law relation between skewness and kurtosis dependant on velocity direction. Sample particle images, velocity fluctions, and vorticity fields are shown at three times in Fig. 1.

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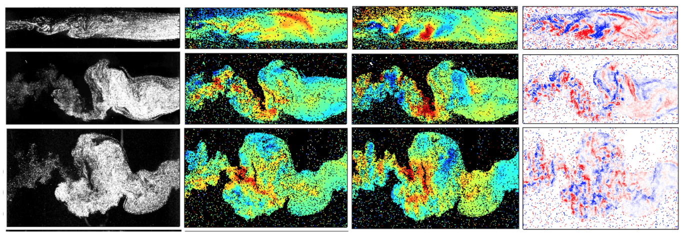

Figure 1: Left to right: particle images, transverse velocity fluctuations, streamwise velocity fluctuations, and vorticity fields showing the evolution of the RMI. Top to bottom: t=0.14 ms, t=0.88 ms, t=2.16 ms after shock-acceleration.

References

Weber, C., Haehn, N., Oakley, J., Rothamer, D., Bonazza, R. 2014 An experimental investigation of the turbulent mixing transition in the Richtmyer-Meshkov instability. *J. Fluid Mech.* **748**, pp 457-487.