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Investigation of the large-scale and statistical properties of Richtmyer-Meshkov instability-induced mixing

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The weighted essentially non-oscillatory method (Jiang & Shu 1996; Shu 1999) is applied to study the evolution of single- and two-mode Richtmyer-Meshkov instability-induced mixing. The numerical method is validated using two-dimensional simulations of the Mach 1.21 air/SF_6 shock tube experiments of Collins and Jacobs (2002) that include reshock of the evolving interface. The flow structure and perturbation amplitude growth obtained from the simulations are shown to be in very good agreement with the corresponding experimental data. The amplitude growth is also compared to the growth predicted by several nonlinear analytical models.

High-resolution, three-dimensional simulations are performed to study the spatial structure, spectra, and statistics in the Mach 1.5 air/SF_6 shock tube experiment of Vetter and Sturtevant (1995). The interfacial perturbation, including the embedded wire mesh, is modeled following the two-scale representation of Cohen et al. (2002). The mixing layer width is compared to the experimental data. The time-evolution of the kinetic energy spectra corresponding to velocity fluctuations in both the streamwise and spanwise directions and the density variance spectra are investigated. The balance of terms in the kinetic energy and enstrophy evolution equations is studied to provide insight into the baroclinic production and vortex stretching mechanisms that drive the instability and turbulence. Simulations using different orders of spatial accuracy are compared at different grid resolutions to investigate the dependence of quantities on the resolution.

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