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# DIRECT NUMERICAL SIMULATION OF THE TURBULENT MIXING IN RICHTMYER-MESHKOV INSTABILITY

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Accurate simulation of strong compressible turbulence, which is characterized by both broadband fluctuations and high gradients/discontinuities, remains a big challenge, especially when multi-material dynamics is involved. An effective in-house computational fluid dynamics (CFD) code (high-order turbulence solver, or HOTS) is developed based on the localized artificial diffusivity (LAD) method [1], which has been successfully applied to the numerical simulation of a variety of compressible flows. In HOTS, high-order compact finite difference schemes are employed for the entire computational domain, while the non-linear artificial dissipation is dynamically added according given criteria to capture the latent discontinuities such as shock wave, contact or material interface. The parallel efficiency is improved substantially utilizing a newly designed parallel tridiagonal solver in combination with the classical parallel diagonal dominant (PDD) algorithm [3].

We present results for the turbulent multi-material mixing from well-resolved direct numerical simulations (DNS) of Richtmyer-Meshkov instability (RMI) [2] in a shock tube. The celebrated Kolmogorov $-\frac{5}{3}$ spectrum can be observed in a long inertial subrange both before and after re-shock. It is noteworthy that there is a sudden rise in the total kinetic energy immediately after the re-shock. An insight is taken into the the underlying mechanism by evaluating the energy-budget equations. A posteriori analysis of the influence of subgrid scales on resolved motions also gives a consistent picture of energy transfer in RMI turbulence when reshock occurs. Moreover, subgrid-scale modeling for large-eddy simulation (LES) of turbulent mixing induced by RMI is also discussed. All the results addressed here also demonstrate that HOTS can serve as a solid tool in simulation of turbulent mixing in multi-material compressible flows in the presence of strong shock waves.

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