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LES of an inclined jet into a supersonic cross-flow at Mach 3.6

A. FERRANTE, California Institute of Technology, C. PANTANO, University of Illinois at Urbana-Champaign, G. MATHEOU, P. DIMOTAKIS, California Institute of Technology — The objective of this work is to capture the main flow physics of an inclined jet (He, $M = 1.0$) into a supersonic cross-flow (Air, $M = 3.6$) using LES. The jet to free-stream momentum flux ratio is $\overline{q} = 1.75$. The flow parameters are the same of the experimental study of Maddalena *et al.* (*J. of Prop. and Power 2006*). Large-eddy simulation with sub-grid scale was performed using the stretched vortex model of turbulent and scalar transport developed by Pullin and co-workers. The governing equations are solved on a Cartesian mesh with adaptive mesh refinement (AMR). The level-set approach with the ghost-fluid method is used to treat the complex boundary where no-slip and adiabatic-wall conditions are applied. The numerical method is a hybrid approach with low numerical dissipation that uses tuned centered finite differences (TCD), and weighted essentially non-oscillatory (WENO) scheme around discontinuities, ghost-fluid boundaries (Hill & Pullin, *J. Comput. Phys. 2004*; Pantano *et al., J. Comput. Phys. 2007*), and low pressure regions ($<$ 2000Pa). The results show that the main flow features are well captured: bow shock, barrel shock, Mach disk, shear layers, counter-rotating vortices, and large-scale structures.

Antonino Ferrante
California Institute of Technology

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