Supersonic multi-species flow with particle dispersion on a mixing layer

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Abstract: Particle-laden flows play an important role in high-speed technologies such as solid rocket propulsion systems and high-speed fuel combustors. The flow physics in such devices is very complex due to shock dynamics, turbulence and particle dispersion in mixing layers. Direct numerical simulation (DNS) has been successfully used for compressibility effects in the turbulent shear layer [1], single-phase and two-phase flows [2]. The particle dispersions in the mixing layers for the different Stokes numbers have been obtained in [3]. In spite of that there are a few investigations of a compressible multispecies shear layer flow with the dispersion of particles.

This work is our first stage of the simulation in a comprehensive study of the flow-particle interactions in a three-dimensional multispecies turbulent medium. The direct numerical simulations of the flowfield structures and the properties of the particle dispersion in the quasi-2D turbulent mixing layer (hydrogen-air) are performed by solving the time-dependent, compressible Euler equations. The 3D numerical code using the high-order essentially non-oscillatory (ENO) scheme is developed. The dispersion of the particles is studied by following their trajectories in the mixing layer with the Lagrangian method. In detail, the effect of the initial mass fraction of hydrogen and the number of particles on the growth of vortices and their thickness is studied. The simulation reveals that the capturing of the particles by the vortices essentially depends on the density of particles.

Keywords: supersonic shear flow, mixing layer, particle dispersion, multispecies flow, ENO-scheme.

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References

[1] Pantano, C. and Sarkar, S., "A study of compressibility effects in the high-speed turbulent shear layer using direct simulation", *Fluid Mechanics*, Vol. 451, pp.329–374, 2002.

[2] Moin, P. and Mahesh, K., "Direct numerical simulation: a tool in turbulence research", *Fluid Mechanics*, Vol.30, pp. 539-578, 1998.

[3] Zhiwei, Hu., Xiaoyu, Luo and Kai, H., Luo, "Numerical simulation of particle dispersion in a spatially developing mixing layer",*Theoret. Comput. Fluid Dynamics*, Vol. 15, pp. 403-420, 2002.