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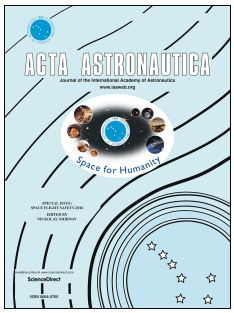

Detailed experimental investigations on flow behaviors and velocity field properties of a supersonic mixing layer

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Detailed experimental investigations on flow behaviors and velocity field properties of a supersonic mixing layer

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Abstract: The flow behaviors and mixing characteristics of a supersonic mixing layer with a convective Mach number of 0.2 have been experimentally investigated utilizing nanoparticle-based planar laser scattering and particle image velocimetry techniques. The full development and evolution process, including the formation of Kelvin-Helmholtz vortices, breakdown of large-scale structures and establishment of self-similar turbulence, is exhibited clearly in the experiments, which can give a qualitative graphically comparing for the DNS and LES results. The shocklets are first captured at this low convective Mach number, and their generation mechanisms are elaborated and analyzed. The convective velocity derived from two images with space-time correlations is well consistent with the theoretical result. The pairing and merging process of large-scale vortices in transition region is clearly revealed in the velocity vector field. The analysis of turbulent statistics indicates that in weakly compressible mixing layers, with the increase of convective Mach number, the peak values of streamwise turbulence intensity and Reynolds shear stress experience a sharp decrease, while the anisotropy ratio seems to keep quasi unchanged. The normalized growth rate of the present experiments shows a well agreement with former experimental and DNS data. The validation of present experimental results is important for that in the future the present work can be a reference for assessing the accuracy of numerical data.

Keywords: Aerospace propulsion system; Supersonic flow; Mixing characteristics; Shocklets; Compressibility effects

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