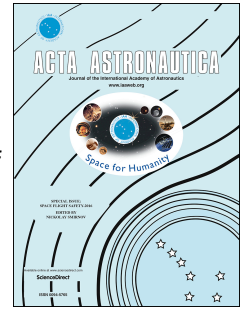


# Accepted Manuscript

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

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PII: S0094-5765(17)31225-0

DOI: [10.1016/j.actaastro.2017.12.010](https://doi.org/10.1016/j.actaastro.2017.12.010)

Reference: AA 6590

To appear in: *Acta Astronautica*

Received Date: 30 August 2017

Revised Date: 3 December 2017

Accepted Date: 7 December 2017

Please cite this article as: J. Tan, D. Zhang, H. Li, J. Hou, Detailed experimental investigations on flow behaviors and velocity field properties of a supersonic mixing layer, *Acta Astronautica* (2018), doi: 10.1016/j.actaastro.2017.12.010.

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# 1 Detailed experimental investigations on flow behaviors and 2 velocity field properties of a supersonic mixing layer

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6

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

23

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

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