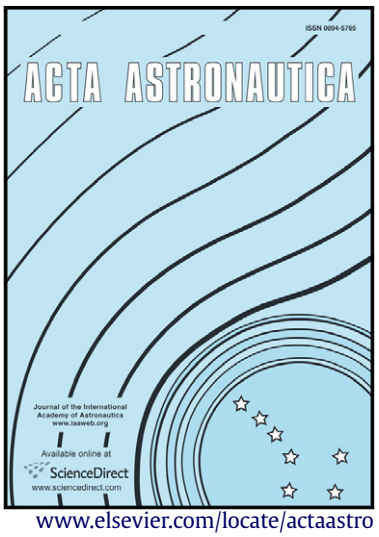

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Investigation of injectant molecular weight effect on the transverse jet characteristics in supersonic crossflow

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Abstract: The effect of injectant molecular weight on the transverse jet was investigated by the hybrid RANS/LES simulation, particle image velocimetry (PIV) and nanoparticle-based planar laser-scattering (NPLS) measurements with the nitrogen and helium jets at a constant jet-to-freestream momentum flux ratio involved. The recycling-rescaling procedure was applied to reproduce the turbulent boundary layer. Statistics obtained from the hybrid RANS/LES simulation with fine mesh shown good agreement with the experimental results. Two kinds of large-scale vortex structures are observed in the transverse jet of supersonic crossflow, namely leading edge vortices and hanging vortices, and they were previously noticed in the low speed transverse jet. The velocity gradient between jet and main flow is found to be the dominative factor determining the development of leading edge vortices in both nitrogen and helium jets. A larger velocity gradient in helium jet induces a quick breakup of the large-scale structures, and this produces small scale structures with small interval in jet plume. By contrast, a smaller velocity gradient in nitrogen jet induces a later breakup of the large-scale structures, and this produces large scale structures with large interval in jet plume. The development of large-scale vortices structures has also influenced the mixing and penetration height, with a better mixing achieved in helium jet and a higher penetration height in nitrogen jet.

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