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Roughness Induced transition in supersonic boundary layers[1]
SUMAN MUPPIDI, KRISHNAN MAHESH, University of Minnesota — Laminar-to-turbulent transition at high speeds can significantly alter aerodynamic drag and heat transfer. The present study uses Direct Numerical Simulations to study transition of a Mach 2.9 boundary layer due to distributed surface roughness. Roughness causes the near-wall fluid to slow down and generates a strong shear layer over the roughness elements. Roughness surface also exerts an upward impulse on the fluid, generating counter-rotating pairs of streamwise vortices underneath the shear layer. As they move downstream, these vortices rise toward the shear layer, and their mutual interaction results in the break down of the shear layer, followed closely by transition to turbulence. The mean flow in the turbulent region shows a good agreement with available data for fully turbulent boundary layers. Simulations under varying conditions show that where the shear layer is not as strong, and the streamwise vortices are not as coherent, the flow remains laminar.

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