Abstract Submitted
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Velocity-vorticity correlation structures in compressible turbulent boundary layer[1] JUN CHEN, SHI-YAO LI, ZHEN-SU SHE, Peking Univ. — A velocity-vorticity correlation structure (VVCS) analysis is applied to analyze data of 3-dimensional (3-D) direct numerical simulations (DNS), to investigate the quantitative properties of the most correlated vortex structures in compressible turbulent boundary layer (CTBL) at Mach numbers, $Ma = 2.25$ and 6.0. It is found that the geometry variation of the VVCS closely reflects the streamwise development of CTBL. In laminar region, the VVCS captures the instability wave number of the boundary layer. The transition region displays a distinct scaling change of the dimensions of VVCS. The developed turbulence region is characterized by a constant spatial extension of the VVCS. For various Mach numbers, the maximum correlation coefficient of the VVCS presents a clear multi-layer structure with the same scaling laws as a recent symmetry analysis proposed to quantifying the sublayer, the log-layer, and the wake flow. A surprising discovery is that the wall friction coefficient, C_f, holds a "-1"-power law of the wall normal distance of the VVCS, y_s. This validates the speculation that the wall friction is determined by the near-wall coherent structure, which clarifies the correlation between statistical structures and the near-wall dynamics.

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