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Velocity-Vorticity Correlation Structure (VVCS) in Transitional Compressible Turbulent Boundary Layer[1] JUN CHEN, SHI-YAO LI, ZHEN-SU SHE, State Key Lab. for Turb. & Complex Sys., FAZLE HUSSAIN, Dept. Mech. Engg., Texas Tech. Univ. — Velocity-vorticity correlation structure (VVCS) is used to measure the geometry of vortices in the numerically simulated compressible boundary layer (BL) at Ma=2.25, 4.5, and 6.0. Wall normal vorticity represented by $VVCS_{12}$ corresponds to the low-speed streaks, flanked by counter-rotating streamwise vortices identified by $VVCS_{11}$. The ratio of spanwise size to spanwise spacing of $VVCS_{12}$ decreases from 3 to unity during transition to turbulence, indicating low-speed streaks gradually populating in x. During transition, correlation coefficient, R_{ij} near the wall decreases at first then increases up to 0.55, indicating that the well-arranged hairpins break up into streamwise vortices, as observed in visualization of this region. At each y, the length of spanwise vortices identified by $VVCS_{13}$ decreases fast during transition at all Mas, indicating thickening of BL, while becoming nearly invariant in x in the well-developed region, consistent with a self-similar turbulent BL predicted by our theory (She2018JFM). For both $VVCS_{11}$ and $VVCS_{12}$ the spanwise size equals the transverse size in the developed flow region. These results affirm the predominant role of the multi-layered structure and suggest new possibilities for control of turbulent flow.

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