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Velocity-vorticity correlation structure in turbulent channel flow JUN CHEN, JIE PEI, ZHEN-SU SHE, Peking Univ., FAZLE HUSSAIN, Univ. of Houston — A statistical structure – velocity-vorticity correlation structure (VVCS) – is defined by the amplitude distribution of a tensor field of correlation coefficicents. Applied to turbulent channel flow DNS database (at $Re_\tau = 180$), it captures most relevant features – qualitative and quantitative – of coherent structures near the wall, including streaks (Kline et al. 1967, JFM), inclined streamwise vortices (Jeong et al. 1997, JFM), and transverse vorticity (Jimenez & Moin 1991, JFM), etc. Associated with the streamwise velocity component (particularly $\langle u\omega_x \rangle$), VVCS reveals a change of topology with increasing y_r^+, providing a physical interpretation of multiple layers of wall-bounded turbulence. The statistical structure of $\langle u\omega_x \rangle$ depends on the y_r^+-location of u detection. When y_r^+ is near the wall, the structure resembles streamwise vortices. But when y_r^+ is close to the center, it becomes a blob-like structure, quite different from streamwise vortices in the near-wall region. We propose that the statistical structure is adequate in modeling of the mean flow field. This study raises some doubt about unique structures in turbulent flows: consideration of a set of statistical structures is unavoidable.

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