On the organization of coherent structures in turbulent Couette-Poiseuille transition channels

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An understanding of the mechanism of momentum transfer in wall turbulence is crucial in order to predict drag in wall-bounded turbulent flows. Such mechanism is often explained through the analysis of intense coherent structures that carry most of the wall-normal momentum flux from the buffer to the logarithmic and outer layers. Coherent structures shall either extract energy from the flow (e.g., mean shear) or hold energy long enough to be important on the energy budget. That is, they shall have a role in energy transport. Furthermore, coherent structures shall remain consistent in time, so time-averaging their properties (e.g., length, volume, intensity) produces suitable data.

Two types of coherent structures are analyzed in this study: streamwise streaks and bursts. Streamwise streaks are defined as regions of slowly moving fluid elongated in the direction of the mean flow. Bursting, in the form of ejections and sweeps (i.e. Q4-events), is composed of structures of intense Reynolds stress. They play important roles in most of the structural models proposed to explain how turbulent kinetic energy and momentum are redistributed in wall-bounded turbulence. The study of bursting in the form of coherent structures is limited to the recent decade.

In the present article, the topology (e.g. length, width, height, volume), the intensity of the above-mentioned coherent structures, and the interaction among them is studied in turbulent channels with diverse Couette-Poiseuille (C-P) configurations at $Re_\tau = 250$. The simulation dataset goes from a pure Poiseuille flow to a pure Couette flow covering intermediate configurations, where such configurations are achieved by controlling the velocity of the moving wall.

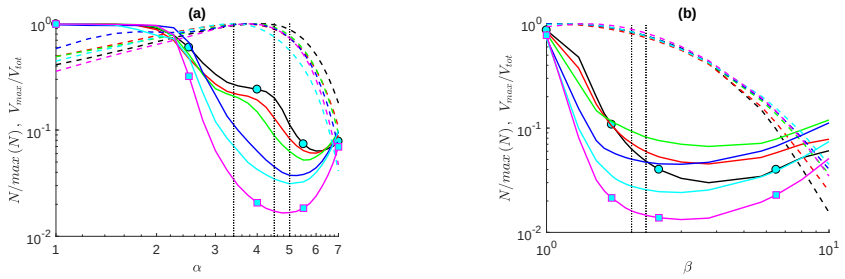

Figure 1: Percolation study for the identification of (left) streaks and (right) uv-structures. Solid lines: largest identified object against the volume of all identified objects. Dashed lines: number of identified objects against the maximum number of objects.

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