COHERENT STRUCTURES IN WALL-BOUNDED TURBULENCE

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The statistical evidence for the existence and properties of coherent structures in wall-bounded turbulent flow is reviewed. It is found that there are at least three kinds of structures, which can be distinguished by their correlations and by their propagation velocity. The best known are the near-wall streaks of the streamwise velocity, and their associated vortices. They can be described as relatively long-lived permanent waves, and do not extend beyond $y^+ \approx 80$. They form dispersive wave packets, because they are modulated by larger outer scales that travel at different speed. Similar to them, but larger ($L_x \geq 0.5\delta$), and internally turbulent, are the outer streaks. They scale in outer units, and can also be described as 'permanent' and dispersive. Streaks carry most of the kinetic energy at their respective wall distances. Thirdly, there is a self-similar family of shorter (v, w) structures. They are closely coupled to the shear, which tilts them forwards and determines their lifetime. Their conditional flow field can be described as an inclined large-scale 'roller' associated with a kink in the streak [1]. They are responsible for most of the Reynolds stresses. All these structures are essentially independent of the wall, because they exist as both attached and detached eddies in wall-bounded flows, and in wall-less homogeneous shear turbulence (see figure)

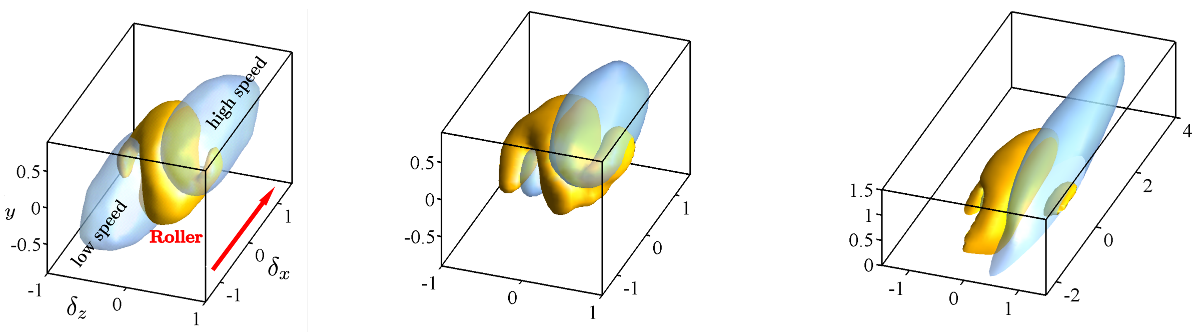

Figure 1: Conditional flow around 'large' ejections. The central opaque S-shaped object is the isosurface of the magnitude of the conditional perturbation vorticity. The two translucent ones are isosurfaces of the conditional perturbation streamwise velocity. (Left) homogeneous shear turbulence. (Centre) detached ejection in a channel. (Right) attached ejection in a channel. In all cases, $Re_\lambda \approx 100$. Adapted from [1].

References

[1] S. Dong, A. Lozano-Durán, A. Sekimoto, and J. Jiménez, *J. Fluid Mech.*, **816**, 167–208, 2017.

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