The role of very large-scale motions in wall turbulence

Davide Gatti

Intitute of Fluid Mechanics, Karlsruhe Insitute of Technology, Karlsruhe, Germany

Our ability to model and control turbulent flows relies on the present understanding of the interactions between the wealth of vortical structures with different characteristic length scales that coexist in wall-bounded turbulence. They range from the small-scale eddies populating the near-wall turbulence cycle to very large-scale structures, which are much larger than the near-wall vortices (fig. 1).

In particular, the interaction between these extreme scales has been intensively investigated in the last decades, for being a potential target of drag-reducing control and due to its impact on the anomalous Reynolds-number scaling of even the simplest turbulent statistics.

In the seminar, we will briefly review the present knowledge and introduce some new results regarding the interaction between the very large scale motions and small-scale near-wall turbulence. The phenomena of large-scale superposition and modulation of wall turbulence will be discussed and revisited. We will also comment on the role of turbulent large-scale structures in comparing the global energy budgets of different wall-bounded flows.

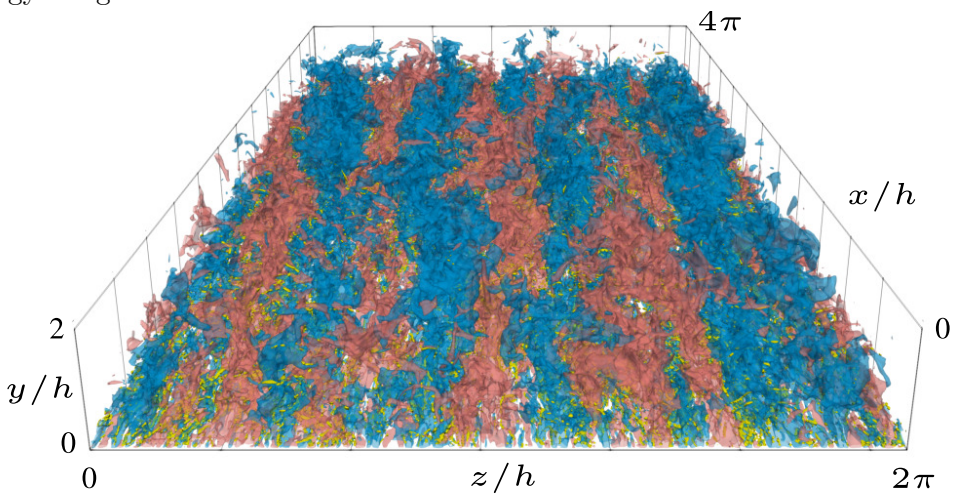

Figure 1: Visualisation of the largest turbulent motions, represented as isosurfaecs of weak positive (red) and negative (blue) instantaneous streamwise velocity fluctuation with intensity $u' = \pm 2u_\tau$, and the smallest turbulent motions (yellow), visualised as isosurfaces of $\lambda_2^+ = -0.02$, in the bottom half of a turbulent channel at $Re_\tau = 1000$.

Davide Gatti is currently a postdoctoral researcher and lecturer at the Institute of Fluid Mechanics of the Karlsruhe Institute of Technology in Germany, where he mainly works in the field of physics of turbulent flows and their control for turbulent drag reduction as well as modelling and simulation of complex fluids. He obtained a master degree in aeronautical engineering at Politenico di Milano in 2011 and his Ph.D. in mechanical engineering at the Technical University of Darmstadt in 2014.