

LadHyX Seminar – October 22nd, 10:45 am

Yongyun Hwang
(Imperial College London)

Simplifying Wall Turbulence

Wall-bounded turbulence is one of the most complex dynamical systems encountered in classical physics, involving a vast range of interacting spatial and temporal scales. Yet many of its most important properties display remarkable simplicity. One notable example is the logarithmic mean velocity profile, which appears to be universal across a wide range of flow configurations and Reynolds numbers. This apparent contradiction raises a fundamental question: how much of turbulence is actually needed to explain its macroscopic behaviour? In this talk, I will discuss several approaches that seek to simplify wall turbulence while retaining its essential physics. I will first show how the logarithmic mean velocity profile motivates the idea of self-similar flow organisation and introduce Townsend's attached eddy hypothesis as a framework for understanding the statistical structure of high-Reynolds-number turbulence. I will then turn to a dynamical viewpoint based on exact coherent structures, highlighting our recent finding that self-similar nonlinear solutions may serve as dynamical building blocks of wall-bounded flows. Finally, I will discuss reduced-order models based on statistical state-space concepts, which provide a bridge between such elementary structures and the multiscale dynamics of realistic turbulence, offering a tractable description of complex turbulent motions.