TOR VERGATA
UNIVERSITÀ DEGLI STUDI DI ROMA

Dipartimento di Fisica

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Seminar

Tuesday, 9 September 2025 - h. 14:00

Sala Struttura della Materia (Dipartimento di Fisica)

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"Expressing turbulent kinetic energy as coarse-grained enstrophy or strain deformations"

Abstract

In turbulent flows, the fluid element gets deformed by chaotic motion due to the formation of sharp velocity gradients. A direct connection between the element of fluid stresses and the energy balance still remains elusive. In this work, an exact identity of incompressible turbulence is derived linking the velocity gradient norm across the scales with the mean kinetic energy. In the context of three-dimensional (3D) homogeneous turbulence, this relation can be specialized obtaining the expression of the mean kinetic energy decomposed either in terms of deformations due to strain motion or via the vorticity norm of the fluid element. Applied to data from direct numerical simulations (DNS) describing homogeneous and isotropic turbulence, the decomposition reveals that, beyond the scales dominated by the external forcing, extensional and contractile deformations account approximately for 40% and 55% of the kinetic energy of the associated scale while less than the remaining 5% is carried by the indefinite-type stresses. From these two identities, one can derive an exact expression for the kinetic energy spectrum which is based solely on real space quantities providing a characterization of the Kolmogorov constant as well. Numerical evidences show that this formulation of the energy spectrum is consistent with the Kolmogorov power-law spectral scaling.

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