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Contributed Talks 1: Alexander Migdal & Jeremie Bec

Monday, 28 April 2025 11:30 (1 hour)

Alexander Migdal. Duality of Decaying Turbulence to a Solvable String Theory. We propose a novel analytical framework for incompressible Navier-Stokes (NS) turbulence, revealing a duality between classical fluid dynamics and one-dimensional nonlinear dynamics in loop space. This duality is an exact mathematical equivalence without any model assumptions or approximations. This reformulation of NS dynamics leads to a universal momentum loop equation, which excludes finite-time blow-ups, establishing a No Explosion Theorem for turbulent flows with finite initial noise. Decaying turbulence emerges as a solution to this equation and is interpreted as a solvable string theory with a discrete target space composed of regular star polygons. The derived decay spectrum exhibits excellent agreement with experimental data and direct numerical simulations (DNS), replacing classical Kolmogorov scaling laws with universal functions derived from number theory. These results suggest a deeper mathematical structure underlying turbulence, uniting fluid dynamics, quantum mechanics, and number theory.

Jeremie Bec. Eulerian vs. Lagrangian intermittency in turbulence. Bridging multifractal descriptions Intermittency in turbulence manifests as intense fluctuations in energy dissipation and anomalous scaling laws, which can be described within the multifractal cascade framework. While the Eulerian approach characterises these fluctuations through spatial fields, the Lagrangian perspective captures them along tracer particle trajectories. These complementary viewpoints require a unified theoretical framework. In this talk, we examine the statistical signatures of Eulerian and Lagrangian intermittency, emphasising the role of bridge relations in linking their respective fluctuations and exploring how causality constraints influence the temporal evolution of intermittency. By comparing theoretical predictions with numerical data, we highlight open challenges in reconciling these two descriptions of turbulence.