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Contributed Talks 2: Erika Ortiz, Victor Valadao & Dipankar Roy,

Monday, 28 April 2025 16:30 (1h 30m)

Erika Ortiz. We implement numerically a model representing the 3D incompressible Navier-Stokes system with small-scale white noise on logarithmic lattices, i.e., 3D space lattices with logarithmi- cally spaced nodes. Our goal is the numerical analysis of spontaneous stochasticity in this system. For this, we consider decreasing sequences of viscosities and noise parameters and analyze the convergence of the corresponding probability densities, thereby, verifying numerically weak con- vergence in the inviscid and zero-noise limit. We will report the numerical results obtained in this direction. This is a join work with Ciro S. Campolina and Alexei A. Mailybaev.

Victor Valadao. The Surface Quasi-Geostrophic (SQG) equation is a two-dimensional model for flow dynamics at the surface of a rotating and stratified fluid. It is applied to geophysical con- texts such as the Earth's atmosphere at the tropopause, ocean surface dynamics, and Jupiter's atmosphere. Despite these applications, when SQG develops turbulence through forcing and dissipation, it shares statistical properties with three-dimensional (3D) turbulence, including an energy cascade with a Kolmogorov spectrum E(k) $\propto$ k^−5/3. The similarities between SQG and 3D turbulence motivate its exploration as a simplified model for understanding 3D turbulence. Our study focuses on the scaling properties of SQG turbulence, particularly the energy flux and spectrum, and Eulerian predictability through finite-time Lyapunov exponents (FTLE) in extensive numerical simulations over a wide range of Reynolds numbers (Re). We observe that Kolmogorov scaling emerges only at high Re, while at lower Re, the energy spectrum's exponent ξ(Re) is steeper than −5/3, indicating a non-constant energy flux. On the predictability side, we found that the Lyapunov exponent λ(Re) scales approximately as $\lambda \propto$ Re^0.7, deviating from the expected $\lambda \propto$ Re^1/2 scaling. It is worth emphasizing that this scaling holds even when $\xi < -5/3$. Similar deviations were observed in 3D turbulence, where $\lambda \propto$ Re^0.64, suggesting a fundamental mechanism common to both SQG and 3D turbulence that governs the separation of solutions in these systems despite their differences.

Dipankar Roy. We study one-dimensional stochastic models with two conservation laws. One of the models is the coupled continuum stochastic Burgers equations. In this model, each current is a sum of quadratic nonlinearities, linear diffusion, and spacetime white noise. The second model is a two-lane stochastic lattice gas. The two conserved densities are tuned so that the flux Jacobian, a 2×2 matrix, has the same eigenvalues. In the steady state, we investigate spacetime correlations of the conserved fields and the time-integrated currents at the origin. For a certain choice of couplings, we observe the dynamical exponent of 3/2. Moreover, at these couplings, we demonstrate that the coupled continuum stochastic Burgers equations and the lattice gas are in the same universality class. This presentation is based on the work reported in Dipankar Roy et al J. Stat. Mech. (2024) 033209.