Seminar

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Institute for Plasma Research

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Title: Transport in turbulent fluids

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Date: 26th September 2024 (Thursday)

Time: 10.30 AM

Venue: Seminar Hall, IPR

Abstract

Fluid turbulence is a ubiquitous phenomenon observed in nature. In astrophysical scenarios, it mediates fundamental processes such as the generation of magnetic fields via dynamo action and star formation in galaxies. In geophysical scenarios, it influences atmospheric and ocean circulation, the understanding of which aids in predicting weather patterns and addressing ocean pollution (e.g., efficient waste disposal, oil spills). In tokamaks, turbulence hinders plasma confinement and device performance. Therefore, exploring turbulence and dynamical properties of fluids as a fundamental process is crucial to understanding and manipulating our natural world.

To this end, a particle solver has been developed, tested, and integrated with an already existing in-house developed GPU-based 2D fluid solver, GHD2D [1], for studying neutral fluids. This new particle code has been benchmarked against standard results from a 2D kinematic chaotic system. The transport properties of various kinds of Navier-Stokes 2D hydrodynamical (HD) turbulent systems (initiated by the Kelvin-Helmholtz instability and decaying freely) have been studied to observe the long-term behavior of test particles using this integrated code. The nature of the turbulence is varied by changing initial conditions, such as the packing fraction of the initial vortices supplied to the system. While the positive-only or negative-only circulation HD system resembles a non-neutral plasma system, the equal presence of both circulations resembles a typical neutral plasma system. The transport observed in 2DHD turbulence over long times is in general, found to be sub-diffusive. For a particular initial vortex packing, transport is greater in cases with mixed circulation than in those with similar circulation types, due to higher mixing. Several of these preliminary results will be discussed. This particle solver will be further developed to study higher-dimensional turbulent systems and electrically conducting fluids.

[1] S. Biswas, Turbulent dynamo action in a 3-dimensional magnetohydrodynamic plasma: A PhD Thesis (Institute for Plasma Research, India, 2024).