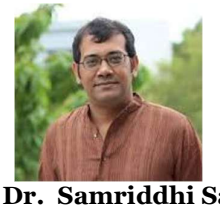
S N BOSE NATIONAL CENTRE
FOR BASIC SCIENCES
Block JD, Sector III, Salt Lake, Kolkata 700 106

DEPARTMENTAL SEMINAR

Physics of Complex Systems

21st May, 2025 **4.00 PM** **ONLINE / FERMION**

SPEAKER



Dr. Samriddhi Sankar Ray, Associate professor,
International Center for Theoretical Sciences (ICTS-TIFR),
Tata Institute of Fundamental Research, Bangalore, India

TITLE OF THE TALK

A high Reynolds number perspective on what makes dense, bacterial suspensions truly turbulent

ABSTRACT

Active turbulence has gathered great traction as an intriguing class of emergent, complex flows, occurring, e.g., in dense bacterial suspensions and whose understanding lies at the interface of non-equilibrium statistical physics and biology. However, are these low Reynolds number, living flows really turbulent or just chaotic with structural similarities with high Reynolds number (classical) inanimate turbulence? This is an intriguing question as fingerprints of classical turbulence — universality, scale-invariance, intermittency and multifractality — are often attributed to the largeness of the Reynolds number, making it unique amongst driven-dissipative systems.

In this talk we look for definitive answers to these questions. In particular, we show that unlike fully-developed turbulence for which we have no theory for a threshold Reynolds number beyond which flows turn turbulent, within the hydrodynamic model for dense bacterial suspension it is possible to estimate a critical activity beyond which such flows are truly turbulent. In particular, when such suspensions become extremely active, they show a universal scale-invariant spectral scaling, an emergent intermittency and multiscaling, and allow for biologically advantageous anomalous diffusion. If time permits, we end this talk with more recent results on suspensions which have spatially inhomogeneous activity — as commonly encountered in experimental set ups —leading to an emergent, turbulence-induced, fluctuating interface separating regions of high and low motilities.

For reference, this talk will build on work reported in the following papers:

1. Anomalous Diffusion and Levy Walks Distinguish Active Turbulence from Inertial Turbulence, S. Mukherjee, R. K. Singh, M. James and S. S. Ray, Physical Review Letters 127 118001 (2021). [Editors' Suggestion]
2. Lagrangian Manifestations of Anomalies in Active Turbulence R. K. Singh, S. Mukherjee and S. S. Ray, Physical Review Fluids 7 033101 (2022).
3. Intermittency, fluctuations and maximal chaos in an emergent universal state of active turbulence, S. Mukherjee, R. K. Singh, M. James and S. S. Ray, Nature Physics 19 891 (2023).
4. The Onset of Intermittency in Active Turbulence, K. V. Kiran, K. Kumar, A. Gupta, R. Pandit and S. S. Ray, Physical Review Letters 134 088302 (2025).
5. Turbulence-Induced Fluctuating Interfaces in Heterogeneously-Active Suspensions, S. Mukherjee, K. Kumar and Samriddhi Sankar Ray, ArXiv:2502.16443 (2025).

HOST FACULTY

Dr. Urna Basu, Associate Professor
DEPT. OF PHYSICS OF COMPLEX SYSTEMS

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