

Seminar

Institute for Plasma Research

Title : Ratchet effects and Collective dynamics in passive and active systems

Speaker : Mrs. Anshika Chugh

Date: October 27, 2023

Time : 11:00 AM

Venue : Seminar Hall, IPR

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Abstract:

Inter cellular transport by tiny machines such as protein motors in a human body is a known phenomenon which works on the mechanism of converting chemical energy (free energy) into mechanical work. Despite the fact that noise and fluctuations become significant at such small scales and have a significant impact on the dynamics of the system, protein motors have perfected their motion[1].

Inspired by the working of protein motors in noisy background, in our study ,we explore the constructive role of noise which can be used to extract work in the form of directed motion. We employ ratchet mechanism to rectify noise into directed motion. Ratchets do not overcome poor conductivity with strong gradients, but rather use non-directional sources of energy like heat or chemical energy to power unidirectional transport, making the ratchet a ‘Maxwell’s demon’. In this work we use two distinct sources of non-directional energy: zero average time periodic external drive[3] and self-driven particles called active particles[4]. The work discusses the different parameter regimes of directed motion. In the second part of the work, we discuss the collective effects displayed by a collection of active particles and a mixture of active and passive particles. Several of the insights concerning the behavior of soft active particles[5] in confined spaces, as well as the possibilities for manipulating their structure via box geometry[6], and mixing fraction of passive particles[7] are also discussed.

Apart from being a problem of fundamental interest, our study has several implications for drug delivery, understanding cell movement through pores and veins in biological systems, designing artificial swimmers and separation of particles among others.

References:

- [1] RD Astumian et al, Physics Today 55 (11), 33–39 (2002)
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- [3] A Chugh, R Ganesh, Physica A 593 (2022) 126913
- [4] A Chugh, R Ganesh, Scientific Reports (2023) 13:16154
- [5] S D Karmakar, A Chugh, R Ganesh, Scientific Reports (2022) 12: 22563
- [6] A Chugh, S D Karmakar, R Ganesh, Manuscript under preparation
- [7] A Chugh, R Ganesh, Manuscript under preparation