Tata Institute of Fundamental Research

Survey No. 36/P, Gopanpally Village, Serilingampally, Ranga Reddy Dist., Hyderabad – 500 046

Webinar

Simulations and Theory in Active Granular Matter: Nonequilibrium Phase Transitions and Nonreciprocal Interactions

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Vibrated monolayers of macroscopic grains show dramatic collective behaviours. They serve as valuable laboratories to test ideas on active matter, exploring the roles of confinement and obstacles. A mechanically agitated monolayer of elongated, tapered macroscopic particles provides a faithful imitation of motility, transducing the energy of vertical vibration into directed horizontal motion. In these systems, the constituent particles individually take up and dissipate energy, thus moving, interacting, and aligning collectively. In my talk, I will present collective and single-particle studies of macroscopic granular particles energised by mechanical vibration and discuss the analytical theory for the observed phenomena.

First, I will discuss the collective trapping phase transitions of active polar particles in the presence of a V-shape obstacle. We account theoretically for our observations as competition between motility induced phase separation and collective expulsion of smectic tilt-boundary structure that forms inside the wedge. Next, I will talk about the dynamics and pair interactions of two motile particles moving through a supported two-dimensional crystalline medium. Initially presenting experimental and simulation findings on tapered rods in bead medium and then introducing a theory of motile particles in a damped elastic medium. The theory confirms our results in terms of calculated fore-aft asymmetric elastic distortion and particles trajectories. The theory further implies a non-reciprocal pursuit-and-capture behaviour of pairs of rods that we confirm in our experiments and simulations. I will conclude by presenting the dynamical states of rods and beads and their structural properties in a rectangular box with periodic boundary conditions. At high concentrations of beads and rods, the homogeneous rods-beads mixture segregates into rods-rich and beads-rich regions in the steady-state. We account for the behaviour by writing down a hydrodynamic theory, considering the concentrations of rods and beads.

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11:00 AM