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Dynamics and Emergent Structures in Active Fluids[1]

APARNA BASKARAN, Brandeis University

In this talk, we consider an active fluid of colloidal sized particles, with the primary manifestation of activity being a self-replenishing velocity along one body axis of the particle. This is a minimal model for varied systems such as bacterial colonies, cytoskeletal filament motility assays vibrated granular particles and self propelled diffusophoretic colloids, depending on the nature of interaction among the particles. Using microscopic Brownian dynamics simulations, coarse-graining using the tools of non-equilibrium statistical mechanics and analysis of macroscopic hydrodynamic theories, we characterize emergent structures seen in these systems, which are determined by the symmetry of the interactions among the active units, such as propagating density waves, dense stationary bands, asters and phase separated isotropic clusters. We identify a universal mechanism, termed "self-regulation," as the underlying physics that leads to these structures in diverse systems.

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