PHYSICAL MATH SEMINAR

Spontaneous Flow and Non-singular Topological Defects in Confined Active Nematics

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ABSTRACT:

Emergence of chirality is a significant characteristic of biological systems across scales, but it is perhaps surprising that even completely achiral active constituents can spontaneously break the chiral symmetry. We study the fundamental instability in 3D confined active nematics with normal anchoring, which gives rise to degenerate left- and right-handed flow states. This spontaneous symmetry breaking yields key signatures of umbilic defects and domain walls separating chiral domains of opposite handedness. Topologically, these belong to a class of non-singular topological defects. We show that domains in this system can be characterised by an effective anisotropic Model A field theory, where anisotropy affects not only the shape but also drastically modifies the coarsening timescales. Umbilics, on the other hand, are unstable in open systems, but become preferred once the active system is entirely closed, resulting in flows similar to convective rolls. Our predictions can be useful across several experimental systems, including gravitactic bacteria, mixtures of molecular motors and microtubules, and tissues. Furthermore, anisotropy shapes dynamics even at the scale of individual active swimmers in complex environments. The same broken symmetries that were narrating emergent collective phenomena can convert even reciprocal swimming strokes into net motion, circumventing the classical constraints of Purcell's Scallop Theorem.

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2:30 PM – 3:30 PM

Building 2, Room 449

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