DEPARTMENT OF PHYSICS
INDIAN INSTITUTE OF TECHNOLOGY KANPUR

Physics Colloquium

Morphogenetic patterns: active mechanics, signaling, and geometry

Abstract

Living systems are maintained out of thermodynamic equilibrium by a continuous throughput of energy. At the hydrodynamic level, these nonequilibrium processes manifest as ``active stresses" that drive large-scale flows and deformations, shaping cells and tissues. Such morphogenetic patterns arise from a tight coupling between biochemical signaling, active mechanics, and dynamical geometry. The cellular cytoskeleton is a central component of this mechanochemical coupling. We will discuss minimal theoretical models for the emergence of mechanochemical patterns in active materials. We will then consider such patterns on dynamical geometries -- the geometrodynamics of active matter. Two examples illustrate this approach. First, a minimal hydrodynamic theory coupling chemical concentration fields to surface geometry leads to the spontaneous emergence of cell-division-like patterns. Its predictions quantitatively agree with experimental data. Second, a hydrodynamic model provides a unified framework for determinate, indeterminate, and proportionate growth in tissues. More broadly, these active deformable materials may offer a useful framework for understanding how biochemical signals generate shape and form in living systems.

Speaker



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ALL ARE CORDIALLY INVITED

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