Graduate School Event

Thesis Defense: Geometry-driven self-organization of migrating cells and chiral filaments

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Host: Carrie Bernecky

How is self-organization in biological systems shaped by the geometry of individual units and the structure of their environment? In this thesis, we combine minimal active-matter models with bottom-up in vitro experiments to uncover physical principles underlying emergent biological behavior across scales. At the subcellular scale, we show how the shape and mechanics of treadmilling FtsZ filaments control large-scale pattern formation, which is relevant for bacterial cytokinesis. We find that filament flexibility and activity-driven straightening cause a shift from chiral to nematic-like self-organization. At the cellular scale, we investigate how cancer cells migrate through complex microenvironments. Strikingly, we find that geometric disorder alone can induce a transition from collective to single-cell invasion and shift the universality class of interface dynamics. Finally, we study how cell-intrinsic geometry and chirality influence collective motion. Using a minimal model of rotating motile cells, we show that confinement can promote chiral flows, while in dense unconfined systems chirality becomes masked even before the onset of jamming transition. Overall, this work uncovers how geometric constraints - embedded in the intrinsic architecture of an active filament or encoded in the complexity of a microenvironment - couple to active forces to generate different classes of complex behaviors.

Monday, February 9, 2026 02:00pm - 03:00pm
Central Bldg / O1 / Mondi 3 (I01.O1.010)

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https://ista.ac.at/en/campus/how-to-get-here/ The ISTA Shuttle bus is marked ISTA Shuttle (#142) and has the Institute Logo printed on the side.