Hrvatsko biofizičko društvo

NASTUPNO PREDAVANJE
nakon kojeg slijedi
BOŽIĆNO DRUŽENJE

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“ORDER AND DISORDER IN LIVING SYSTEMS”

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Animal morphogenesis is one of the most beautiful examples of pattern formation in nature. The functional form of a mature animal arises from the complex interplay of multiple biophysical and biochemical processes that span a broad range of scales, from biochemical reactions at the molecular scale to symmetry-breaking processes at the tissue level. Understanding how all these processes are integrated to robustly form a functional animal is an outstanding challenge. In this seminar, I will present our past and current work that aims to understand how order arises in biological tissues and how biologically relevant mesoscopic structures can emerge through mechano-chemical interactions. Seminar will consist of two parts, the first part on regeneration of *Hydra*, and the second part on crystallization of the fruit fly wing.

Hydra is a small freshwater animal famous for its extraordinary regeneration capabilities. *Hydra* tissue contains supracellular actomyosin fibers that can contract upon activation, allowing the animal to move and feed. We study how Hydra regenerates from a small fragment excised from an adult, and in particular, how the actomyosin fibers form the characteristic radial pattern at the location where the head will regenerate. Viewed as a physical problem, *Hydra* regeneration can be viewed as a self-organized formation of a +1 topological defect of the nematic field representing the fibers. We propose and explore a mechano-chemical feedback loop, connecting fiber contractions and biochemical signaling, as the underlying mechanism that allows for robust and flexible regeneration of the *Hydra* head.

Epithelial tissue of the fruit fly wing exhibits a crystallization during pupal development as the cells organise in a honeycomb lattice. While previous studies proposed that tissue shear flow leads to ordering of the cell packing in the fly wing, we instead reveal that the cell size polydispersity can play a role of the control parameter. Indeed, we show that even when tissue shear is inhibited, cell packings in the fruit fly wing epithelium transition from disordered to ordered packing. We use the vertex model of epithelial tissues to explore the phase diagram of tissue crystallization in the space of cell size polydispersity and mechanical noise magnitude. Finally, we propose that tissue shear enhances the ordering kinetics and compare dynamical simulations with experimental data.