Program in Polymers and Soft Matter

SEMINAR

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Liquid Crystals: From Simple Self-Assembled Constructs, to Autonomous Materials

Polymeric materials comprising mechano-chemically active components are able to undergo spontaneous structural rearrangements that generate internal stresses and motion. These stresses can be particularly large in the case of liquid crystalline polymers, where elasticity plays an important role on the structure of the underlying materials. Understanding how internal activity leads to specific behaviors is important for design of autonomous materials systems capable of delivering desired functionalities. This lecture will focus on the relationship between structure, activity, and motion in lyotropic liquid crystalline polymeric systems. More specifically, results will be presented for actin and tubulin suspensions, where activity is generated by protein motors. A distinctive feature of these biopolymers is that characteristic contour lengths can range from hundreds of nanometers to tens of microns, thereby making them amenable for study by optical microscopy. By relying on molecular and meso-scale models, it is possible to arrive at a comprehensive description of these suspensions that helps explain the connections between molecular structure, the formation and shape of distinct topological defects, activity, and defect dynamics. One of the outcomes of such a description is the realization that hydrodynamic interactions can in some cases exacerbate or mitigate the elasticity of the underlying materials, leading to non-intuitive phenomena that do not arise at equilibrium. By balancing such effects, these findings raise the possibility of designing functional materials where specific, macroscopic dynamical responses are engineered into a system to create function.