



Sommerfeld Theory Colloquium

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Chemomechanical self-organization across scales in living systems

A hallmark of living systems is their ability to generate and maintain order under constant fluctuations. In cells, such order often emerges from chemomechanical pattern formation, where proteins both sense and remodel the geometry of the cell. Here, I will discuss how theoretical modeling and simulations can capture this feedback across different spatial scales, using three example systems: on the macroscopic scale of individual cells, we used optogenetic control over a chemomechanical protein system to control the shape of starfish oocytes and induce self-organized surface contractions in these cells. On the mesoscopic scale of synthetic vesicles, I will discuss how protein patterns can drive the motility of synthetic liposomes, providing a minimal mechanism to transform chemical energy into motion without molecular motors. Finally, on the intracellular nanometer scale, I will present a mechanism for pattern formation without active energy consumption that relies on curvature sensitivity of membrane-binding proteins. Looking forward, I will discuss data-driven avenues for systematically analyzing biological self-organization, with particular focus on bringing experiments and simulations closer together.

Wednesday, 5 November 2025, 16:15h, Room A348, Theresienstr. 37/III

Prof. Erwin Frey