Biological Model Systems of Pattern Formation

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The emergence of collective motion and out-of-equilibrium patterns is characteristic for systems ranging from flocks of animals to self-propelled microorganisms to the cytoskeleton. Similarities in these self-organization phenomena suggest the existence of universal principles. Two important biological model systems are provided by *high-density motility assays* [1] and *spatially extended microbial communities* [2,3]. While actin filaments in motility assays are driven by the power-stroke of molecular motors, the dynamics of bacteria in biofilms ranges from Brownian motion to self-propulsion. We discuss several theoretical approaches to analyze the spatio-temporal patterns self-forming in the course of the stochastic time evolution, and analyze how these patterns emerge through the interplay between the dynamics of the individual agents and their interactions. Our findings and methods have important applications for understanding the formation of noisy patterns in a broad class of systems, e.g., in ecological and evolutionary contexts, and cytoskeletal systems.

[1] V. Schaller, C. Weber, C. Semmerich, E. Frey, & A.R. Bausch, *Polar Patterns of Driven Filaments*, Nature, in press (2010).
[2] T. Reichenbach, M. Mobilia, & E. Frey, *Mobility promotes and jeopardizes Biodiversity in Rock-Paper-Scissors Games*, Nature **448**, 1046 (2007).
[3] E. Frey, *Evolutionary Game Theory: Theoretical Concepts and Applications to Microbial Communities*, Physica A 389, 4265 – 4298 (2010).