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Polar and apolar active matter[1]

M. CRISTINA MARCHETTI, Syracuse University

Assemblies of interacting self-driven units form a new type of *active* soft matter with collective behavior qualitatively different from that of its individual constituents, nonequilibrium phase transitions, and unusual mechanical and rheological properties. Examples include cytoskeletal filaments crosslinked by motor proteins, bacterial colonies, migrating cells, and vibrated layers of granular rods. In this talk I will review our work on using nonequilibrium statistical physics to derive a continuum description of these systems from specific models of single particle dynamics. This approach aims at understanding the interplay between physical mechanisms (such as formation or loss of physical connections, excluded volume effects, directional forces) and biochemical or other processes in regulating the large-scale organization and function of active matter. I will contrast the behavior of units with a head and a tail that can exhibit a macroscopic polar state, where all organisms move coherently in a preferred direction, with that of units with head-tail symmetry, that can order in a nematic state, with no net motion on macroscopic scale. Finally, I will use a simple model of active rods on a substrate to discuss the interplay between equilibrium steric effects and self-propulsion in controlling order and fluctuations in active fluids.

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