CPP 10: Active Matter 1 - organized by Carsten Beta (Potsdam), Andreas Menzel (Magdeburg) and Holger Stark (Berlin) (joint session DY/BP/CPP)

Time: Tuesday 9:30–10:30 Location: DYa

CPP 10.1 Tue 9:30 DYa

Swirl formation of active colloids near criticality — •Robert C. Löffler[1], Tobias Bäuerle[1], Mehran Kardar[2], Christian M. Rohwer[3], and Clemens Bechinger[1] — [1]FB Physik, Universität Konstanz, Germany — [2]Dep. Physics, MIT, Cambridge, MA, USA — [3]Dep. Mathematics, University of Cape Town, South Africa

Animal groups like flocks of birds or schools of fish normally show a high degree of order. Yet they are also responsive to external factors in order to optimize nutrition and avoid predation. Various observations of such responsiveness have let to the assumption that those systems represent a state of order close to a critical point.

In our experiments, we use light-responsive active Brownian particles (ABPs) to which we can apply individual torques in a feedback controlled system to study such behavioral rules. Through the variation of a single parameter in our interaction model based on information about a particles local neighbors, we observe a continuous phase transition in the collective motion of the group: The ABPs transition from a disordered swarm to a stable swirl (i.e. milling, vortex-like state). Being able to continuously change our control parameter we observe a critical point with explicit bifurcation dynamics in the rotational order parameter and critical slowing down, as well as hysteresis in the symmetry-breaking regime of the control parameter. Observation of such critical behavior in simple models not only allows for more insight in complex animal behavior but also helps with designing future rules for collective tasks in robotic or other autonomous systems.

Bäuerle *et al.*, Nat. Comm. **11**, 2547 (2020); Löffler *et al.* (in review).

CPP 10.2 Tue 9:50 DYa

A particle-field approach bridges phase separation and collective motion in active matter — •Robert Grossmann[1], Igor Aranson[2], and Fernando Peruani[3] — [1]Institute of Physics and Astronomy, University of Potsdam, Potsdam, Germany — [2]Department of Chemistry, Pennsylvania State University, University Park (PA), United States of America — [3]Laboratoire de Physique Théorique et Modélisation, CY Cergy Paris Université, Cergy-Pontoise, France

Linking seemingly disconnected realms of active matter – active phase-separation of repulsive discs and collective motion of self-propelled rods – is a major contemporary challenge. We present a theoretical framework based on the representation of active particles by smoothed continuum fields which brings the simplicity of alignment-based models, enabling an analytical analysis, together with more realistic models for self-propelled objects including their steric, repulsive interactions. We demonstrate on the basis of the collision kinetics how nonequilibrium stresses acting among self-driven, anisotropic objects hinder the emergence of motility-induced phase separation and facilitate orientational ordering. Moreover, we report that impenetrable, anisotropic rods are found to form polar, moving clusters, whereas large-scale nematic structures emerge for soft rods, notably separated by a bistable coexistence regime. Thus, the symmetry of the ordered state is not dictated by the symmetry of the interaction potential but is rather a dynamical, emergent property of active systems. This theoretical framework can represent a variety of active systems: cell tissues, bacterial colonies, cytoskeletal extracts or shaken granular media.

CPP 10.3 Tue 10:10 DYa

A Quantitative Kinetic Theory of Flocking in Dry Active Matter Including a Three Particle Closure — •Rüdiger Kürsten and Thomas Ihle — Institut für Physik, Universität Greifswald, Germany

We consider aligning self-propelled point particles in two dimensions. Their motion is given by generalized Langevin equations, however, the qualitative behavior is as for the famous Vicsek model. We develop a kinetic theory of flocking beyond mean field. In particular, we take into account the full pair correlation function. We find excellent quantitative agreement of those pair correlations with direct agent-based simulations within the disordered regime. Furthermore we use a closure relation to incorporate the spatial correlations of three particles. In that way we achieve good quantitative agreement of the onset of flocking with direct simulations. Compared to mean field theory, the flocking transition is shifted significantly towards lower noise because angular correlations favor disorder.