DY 36: Active Matter 3 - organized by Carsten Beta (Potsdam), Andreas Menzel (Magdeburg) and Holger Stark (Berlin) (joint session DY/BP)

Time: Wednesday 9:00–10:40 Location: DYb

DY 36.1 Wed 9:00 DYb

Localized States in active Phase-Field-Crystal models — •Max Philipp Holl[1], Lukas Ophaus[1,2], Svetlana Gurevich[1,2], and Uwe Thiele[1,2] — [1]Institut für Theoretische Physik, Münster, Germany — [2]Center for Nonlinear Science, Münster, Germany

The phase-field-crystal (PFC) model represents a gradient dynamics of a single order parameter field related to density and is able to describe crystallisation processes. The model describes a variety of spatially extended periodic and localized steady structures. In an active PFC model, encoding for instance the active motion of self-propelled colloidal particles, the PFC model's gradient dynamics structure is broken by a nonreciprocal coupling of density and an additional polarization field. Then, resting and traveling localized states exist with transitions characterized by parity-breaking drift bifurcations. We briefly review the snaking behavior of localized states in passive and active PFC models before discussing the bifurcation behaviour of localized states in systems of (i) two passive PFC with nonreciprocal coupling and (ii) coupled passive and active PFCs.

DY 36.2 Wed 9:20 DYb

Cooling by Heating in Inertial Active Brownian Particles — •Lukas Hecht and Benno Liebchen — Institut für Physik kondensierter Materie, Technische Universität Darmstadt, Hochschulstraße 8, D-64289 Darmstadt, Germany

The active Brownian particle (ABP) model is commonly used to model active matter consisting of particles which extract energy from their environment to generate directed motion. For both overdamped and inertial ABPs, motility-induced phase separation occurs in a certain parameter regime. Remarkably, inertial ABPs show a coexistence of different effective temperatures of the dilute and the dense phase whereas overdamped ABPs have a uniform effective temperature even in the phase-separated state [1].

The coexistence of different temperatures brings us to the cooling-by-heating idea: Increasing the self-propulsion speed locally could lead to a locally decreased temperature. We investigate the cooling-by-heating idea with numerical simulations of ABPs with translational and rotational inertia. Since a locally increased self-propulsion speed causes a decrease of the local particle density, detailed knowledge about the phase diagram is essential to determine appropriate parameters for which cooling by heating is possible. Therefore, we analyze the phase transition behavior of inertial ABPs and the corresponding phase diagram.

[1] S. Mandal, B. Liebchen, and H. Löwen, “Motility-Induced Temperature Difference in Coexisting Phases”, Phys. Rev. Lett. 123, 228001 (2019).

DY 36.3 Wed 9:40 DYb

Active dynamics of microalgae in an anisotropic porous environment — •Florian von Rüling and Alexey Eremin — Otto von Guericke University Magdeburg

Understanding the motion of active colloids in porous media is essential for fundamental physics and a wide range of biological and medical applications. Cell growth and motion is often restricted by complex environments such as the cytoskeleton. Here, we report experimental studies on the motion of the unicellular microalgae Chlamydomonas reinhardtii through a flexible anisotropic lattice of chains formed by magnetic particles. In a thin cell or capillary, the microalgae interact with chain-like aggregates that form in a magnetic field. Shape-anisotropic structures guide the swimmers or initiate tumbling. They affect the persistence time of the microswimmer's motion. As the chains of magnetic particles disintegrate quickly after turning off the magnetic field, the system transforms into an unperturbed state. We investigate the effect of the chains on the orientational velocity correlations in the active dynamics of the algae.

DY 36.4 Wed 10:00 DYb

Effective Langevin equations for a polar tracer in an active bath — •Milos Knezevic and Holger Stark — Institut für Theoretische Physik, Technische Universität Berlin, Hardenbergstraße 36, D-10623 Berlin, Germany

We study the motion of a polar tracer, having a concave surface, immersed in a two-dimensional suspension of active particles. Using Brownian dynamics simulations, we measure the distributions and auto-correlation functions of force and torque exerted by active particles on the tracer.The tracer experiences a finite average force along its polar axis, while all the correlation functions show exponential decay in time. Using these insights we construct the full coarse-grained Langevin description for tracer position and orientation, where the active particles are subsumed into an effective self-propulsion force and exponentially correlated noise for both translations and rotations. The ensuing mesoscopic dynamics can be described in terms of five dimensionless parameters. We perform a thorough parameter study of the mean squared displacement, which illustrates how the different parameters influence the tracer dynamics, which crosses over from a ballistic to diffusive motion. We also demonstrate that the distribution of tracer displacements evolves from a non-Gaussian shape at early stages to a Gaussian behavior for sufficiently long times. Finally, for a given set of microscopic parameters, we establish a procedure to estimate the matching parameters of our effective model, and show that the resulting dynamics is in a very good quantitative agreement with the one obtained in Brownian dynamics simulations.

DY 36.5 Wed 10:20 DYb

Collective behaviour of self-propelled elliptical particles — •Ashreya Jayaram, Andreas Fischer, and Thomas Speck — Institute of Physics, Johannes Gutenberg University Mainz, Staudingerweg 7-9, 55128 Mainz, Germany

Ensembles of anisotropic self-propelled particles exhibit a rich variety of emergent phases. A combination of short-ranged excluded volume interactions, which induce inter-particle forces and torques, and self-propulsion determines the resulting macroscopic structure. Starting from a point in parameter-space which displays motility-induced phase separation (MIPS) for isotropic particles, we systematically increase the aspect ratio of the constituent ellipses. On doing so, first, MIPS breaks down paving way to a spatially homogeneous state comprising polar domains. Secondly, at sufficiently large aspect ratios, particles aggregate into polar bands. We rationalize these observations from simulations by extracting two effective parameters, *viz.*, the force imbalance coefficient and the coupling to the local polarization, that enter the mean-field description of the system.