DY 12: Active Matter (joint session DY/BP/CPP)

Time: Thursday 11:45–13:00 Location: H2

DY 12.1 Thu 11:45 H2

Orientation-dependent propulsion of active Brownian spheres: from advection to polygonal clusters* — •Jens Bickmann[1], Stephan Bröker[1], Michael E. Cates[2], and Raphael Wittkowski[1] — [1]Institut für Theoretische Physik, Center for Soft Nanoscience, Westfälische Wilhelms-Universität Münster, D-48149 Münster, Germany — [2]DAMTP, Centre for Mathematical Sciences, University of Cambridge, Cambridge CB3 0WA, United Kingdom

Controllability of the collective dynamics of active Brownian particles is much desired for numerous potential future applications. In addition to the regular way of achieving control via external interventions, e.g., by traps, internal interventions in the dynamics of active Brownian particles become increasingly popular. Most often, internal intervention is achieved by a propulsion of the particles that depends on space, time, or orientation. Using field-theoretical modeling and particle-based simulations, we investigate systems of interacting active Brownian spheres in two spatial dimensions with an orientation-dependent propulsion. We show that different forms of orientation-dependent propulsion can give rise to advection, anomalous diffusion, and even the emergence of polygon-shaped clusters. *Funded by the Deutsche Forschungsgemeinschaft (DFG) – WI 4170/3-1*

DY 12.2 Thu 12:00 H2

The Anomalous Transport of Tracers in Active Baths — •Omer Granek[1], Yariv Kafri[1], and Julien Tailleur[2] — [1]Department of Physics, Technion-Israel Institute of Technology, Haifa, 3200003, Israel — [2]Université de Paris, Laboratoire Matière et Systèmes Complexes (MSC), UMR 7057 CNRS, F-75205 Paris, France

We derive the exact long-time dynamics of a tracer immersed in a one-dimensional active bath. In contrast to previous studies, we find that the damping and noise correlations possess long-time tails with exponents that depend on the tracer symmetry. For an asymmetric tracer, the tails lead to superdiffusion and friction that grows with time when the tracer is dragged at a constant speed. For a symmetric tracer, we recover normal diffusion and finite friction. However, when the symmetric tracer is small compared to the active-particle persistence length, the noise becomes anticorrelated at late times and the active contribution to the friction becomes negative: active particles then enhance motion rather than opposing it.

DY 12.3 Thu 12:15 H2

Forces on objects immersed in active fluids — Thomas Speck and •Ashreya Jayaram — Institute of Physics, Johannes Gutenberg University Mainz, Staudingerweg 7-9, 55128 Mainz, Germany

Depending on their shape, objects immersed in active fluids may be subjected to a net force or net torque. We show that in a finite, periodic system, the force/torque on such an object is determined by the vorticity of the polarization of the surrounding active fluid which in turn is localized to regions close to the object where its curvature changes. We find that the system size L has a colossal influence on the magnitude of the force which grows as L^2 before saturating to a constant. We relate this force to the current away from the body and substantiate our theoretical results with numerical simulations of active Brownian particles.

DY 12.4 Thu 12:30 H2

Active Cooling in Inertial Active Matter — •Lukas Hecht[1], Suvendu Mandal[2], Hartmut Löwen[2], and Benno Liebchen[1] — [1]Institut für Physik kondensierter Materie, Technische Universität Darmstadt, Hochschulstraße 8, D-64289 Darmstadt, Germany — [2]Institut für Theoretische Physik II - Soft Matter, Heinrich-Heine-Universität Düsseldorf, Universitätsstraße 1, D-40225 Düsseldorf, Germany

To cool down a target domain of an equilibrium system, the system must be coupled to an external bath to which heat can be transferred. However, active matter is intrinsically out of equilibrium and the active particles themselves do not obey the second law of thermodynamics. Therefore, we ask the question if we can actively cool down active particles in a target domain without transferring a significant amount of heat to particles in the environment.

In this work, we use the active Brownian particle (ABP) model with inertia to develop a route to cool down ABPs in a target domain without the need of an external bath. Such an active cooling requires two ingredients: First, we need the feature of inertial ABPs to undergo motility-induced phase separation into coexisting phases with different effective temperatures [1]. Second, a mechanism that localizes the phase-separated region in the target domain is required. We show several realizations of active cooling demonstrating how inertial effects in active matter can be utilized to actively cool down a target domain.

[1] S. Mandal, B. Liebchen, and H. Löwen, Phys. Rev. Lett. 123, 228001 (2019).

DY 12.5 Thu 12:45 H2

Arrested phase separation in nonreciprocally interacting colloids — •Sebastian Fehlinger and Benno Liebchen — Institut für Physik kondensierter Materie, Technische Universität Darmstadt, Hochschulstraße 8, D-64289 Darmstadt, Germany

Non-reciprocal interactions are wide spread in nature and can lead to a huge variety of phenomenons in many physical systems. For the specific case of a binary mixture of passive particles, the breaking of the action reaction principle can lead to formation of self-propelled dimers and other active molecules. For a small system size, these active molecules have already been realized in experiments based on phoretically interacting binary colloidal mixtures [1].

This work focuses on the numerical simulation of the Langevin equations describing many noninteracting colloids which we complement with a continuum theory. We find that the nonreciprocal attractions destabilize the uniform disordered phase and lead to clusters which grow in the course of the time. Surprisingly, for a wide parameter range, the clusters only grow up to a certain size such that coarsening is arrested. We attribute this to the spatiotemporal organization of the composition of the binary mixture within the cluster which essentially screens the phoretic attractions.

[1] F. Schmidt, B. Liebchen, H. Löwen, G. Volpe, J. Chem. Phys. 150, 094905 (2019).