SFB 910 Symposium

“Self-Organization and Control of Active Matter”

Friday, 17th June 2022, 15:00 s.t.
H 3005 / via Zoom
For information on how to access the event, please contact:
henning.reinken@itp.tu-berlin.de

Technische Universität Berlin
Straße des 17. Juni 135, 10623 Berlin

15:00	**Launching a Microscopic Tug-of-war between Bacteria and Complex Liquid Crystal Emulsion Droplets** Jan Frederik Totz *(Massachusetts Institute of Technology, USA)*
15:50	Coffee Break
16:20	**Hierarchical self-organization in communicating polar active matter** Alexander Ziepke *(Ludwig-Maximilians-Universität München)*
16:50	**Controlling flow patterns in solutions of active rods** Arghavan Partovifard *(Technische Universität Berlin)*

Guests are welcome!

Sabine Klapp   Harald Engel   Andreas Knorr

http://www.itp.tu-berlin.de/sfb910/

Abstracts

Launching a Microscopic Tug-of-war between Bacteria and Complex Liquid Crystal Emulsion Droplets

Jan Frederik Totz *(MIT, USA)*

The development of rapidly deployable, point of care sensors for detecting bacteria is necessitated by the ever-present and serious public health threat they continue to pose. However, the ability to discern between dead and live populations or quantifying their viability remains a non-trivial challenge to address. We develop liquid crystal biphase-emulsion droplets that allow the pico-newton active forces of swimming bacteria to be conveniently read out optically. Here, bacteria are anchored to topological defect in the liquid crystal phase so that their random active motion is constrained to a spherical surface and opposed by the restoring gravitational torque of the droplet itself. We verify the viability of our approach by anchoring single Escherichia coli with decreasing metabolical levels and find good agreement of the resulting stochastic optical intensity fluctuations with simulations and theory of active particles on curved surfaces.

Hierarchical self-organization in communicating polar active matter

Alexander Ziepke *(Ludwig-Maximilians-Universität München)*, Ivan Maryshev, Igor Aranson, and Erwin Frey

Self-organization in self-propelled active matter plays an important role in various biological and artificial systems. In numerous cases, communication between the active agents is a key mechanism for the formation and localization of critical structures, such as the fruiting body in Dictyostelium discoideum or aggregation clusters in quorum-sensing bacteria. Despite its importance, the specific role of communication and its interplay with self-propulsion remains largely unexplored. We propose a model for communicating active matter that endows self-propelled polar agents with information processing and signal relaying capabilities. We show that information processing greatly enriches the ability of these systems to form complex structures, allowing them to self-organize through a range of different collective dynamical states at multiple hierarchical levels. This provides insights into the role of self-sustained signal processing for self-organization in biological systems and opens pathways for applications using chemically driven colloids or microrobots.

Controlling flow patterns in solutions of active rods

Arghavan Partovifard *(TU Berlin)*, Josua Grawitter, Holger Stark

Active fluids exhibit spontaneous, chaotic flows, which despite occurring at vanishing Reynolds numbers, resemble turbulence and hence are known as active turbulence [2]. One of the current challenges in active matter is controlling and harnessing these flow patterns for various aims, for example, to design spatial patterns and do extract work performance from them [1]. As a simple realization of active matter, we study a dilute suspension of rigid active rods through numerical solutions of the governing equations, which include momentum conservation and an equation for the liquid crystal alignment tensor. For a solution of extensile active rods, we identify a critical value of the activity beyond which the initially isotropic phase of rods develops nematic order together with continuously nucleating and annihilating topological defects and thus turbulent flow patterns. The nematic order of the system increases with the activity and the characteristic vortex size of turbulent flow patterns highly depends on the activity of the system. Recent advances in designing photoactivable particles make it possible to modulate the activity of systems as a function of space via light [3, 4]. We study how chaotically moving defects can be trapped by introducing confinement in which boundaries are formed by activity gradient. Indeed active-inactive boundaries behave like soft confinements that can cage topological defects. Depending on different sizes of confinement, the system exhibits different dynamics.

[1] Michael M. Norton et. al., Phys. Rev. Lett. 125, 178005 (2020).

[2] Henricus H. Wensink et. al., Proceedings of the national academy of sciences 109, 14308 (2012).

[3] Arlt, J., Martinez, V.A., Dawson, A. et al., Nat Commun 9, 768 (2018).

[4] Ross, T.D., Lee, H.J., Qu, Z. et al., Nature 572, 224 (2019).