CPP 33: P5: Microswimmers, Active Liquids

Time: Tuesday 14:00–16:00 Location: Poster C

CPP 33.1 Tue 14:00 Poster C

Light-driven Microswimmers: Run-and-Tumble depend on the conditions — •Celia Lozano[1,2], Jannick Fischer[1], Felix Kümmel[1], and Clemens Bechinger[1,2] — [1]2. Physikalisches Institut, Universität Stuttgart — [2]Max-Planck-Institut für Intelligente Systeme, Stuttgart

Recently, notable improvements regarding the understanding of the dynamics of active particles have been obtained [1]. While their swimming motion under bulk conditions is rather well understood, only little is known about the dynamical properties of active particles under conditions where the Peclet (Pe) number various as a function of the particle position. We present an experimental study, where active motion is achieved by diffusiophoretic forces in a binary solvent and where the Pe number is controlled by the light intensity [2]. In the presence of one-dimensional periodic intensity patterns, we observe the accumulation/depletion of active particles in regions with low/high illumination, i.e. with small/large Pe numbers. We study the steady state particle density variations as a function of the ratio of the persistence length of active particles and the strip width of the intensity pattern and compare our results to numerical simulations. We expect, that our findings contribute to the understanding of pattern formation of chemotactic organisms in chemical gradients.

[1] B. ten Hagen, F. Kümmel, R. Wittkowski, D. Takagi, H. Löwen, and C. Bechinger Nature Comm. 5, 4829 (2014) [2] I. Buttinoni, G. Volpe, F. Kümmel, G. Volpe, and C. Bechinger J. Phys.: Cond. Mat. 24, 284129 (2012)

CPP 33.2 Tue 14:00 Poster C

Self-propulsion of Janus particles near a polymer functionalized surface — •Mojdeh Heidari and Regine von Klitzing — Stranski Laboratorium für Physikalische und Theoritische Chemie, Inst. für Chemie TU Berlin, Straße des 17. Juni, 10623 Berlin, Germany

Active colloidal suspensions are consisting of particles with dimensions ranging from hundreds of nanometer to tens of micrometer. These particles are able to move autonomously under out-of-equilibrium conditions by converting the energy of their environment into directed motion. So far, the motion of microswimmers has been investigated close to a glass slide, whereas the interactions between particles and the substrate are often neglected. However, these interactions are expected to play a significant role in the motion of microswimmers.

In this study we explore the motion of Janus-type microswimmers close to a glass slide which is functionalized with thermoresponsive PNIPAM brushes. Janus particles are polystyrene microbeads half coated with Au and undergo self-propulsion by taking advantage of thermophoretic effect under laser illumination. The remarkable advantage of such Janus particles is that their self-propelled motion can be switched on and off on demand by adjusting laser intensity. Structural properties of polymer brush layer on the substrate such as roughness, thickness and grafting density has been varied and the respective influence of such variations on the motion of microswimmers has been addressed.

CPP 33.3 Tue 14:00 Poster C

Active microrheology in colloidal soft-matter — •Robert Wulfert[1], Udo Seifert[1], and Thomas Speck[2] — [1]II. Institut für Theoretische Physik, Universität Stuttgart, Germany — [2]Institut für Physik, Johannes Gutenberg-Universität Mainz, Germany

Tracking the microscopic motion of a driven colloidal probe through a complex host medium delivers valuable insight regarding the system's dissipative behaviour in the non-linear response regime. The active forcing disturbs the equilibrium microstructure around the probe causing an excess of particles in front and a depopulated wake trailing it. This anisotropy in the pair-distribution corresponds to a frictional drag on the probe due to colloidal interactions, which can be interpreted in terms of an effective viscosity on the micron-scale. We calculate the pair-distribution function from the pair-Smoluchowski equation for hard-sphere colloids with additional long-range interactions. Furthermore, we discuss how the resulting velocity-force relations generalize in the case of dense and hence strongly interacting host suspensions and compare our results to Brownian dynamics simulations.

CPP 33.4 Tue 14:00 Poster C

From Single Artificial Self-Propelled Particles to Collective Motions — •Leonard Li[1], Ralf Seemann[1,2], and Jean-Baptiste Fleury[1] — [1]Saarland University, Experimental Physics, Saarbruecken, Germany — [2]Max Planck Institute for Dynamics and Self-Organization, Goettingen, Germany

Collective motions as manifestation of a coordinated behavior are commenly observed in living-organisms: from bacteria to birds, sheaps and fishs. Recently, identical type of behavior could be also observed with non-living system, i.e swarmming of self-propelled droplets dancing into a microfluidic chip. Based on this type of system, we study the conditions leading to the emergence of collective motion from the hydrodynamic interaction between individual self-propelled objects.

CPP 33.5 Tue 14:00 Poster C

Quantifying random walk properties of Caenorhabditis elegans with the WormTracker — •Carsten Schade and Matthias Weiss — Universität Bayreuth

The locomotion pattern of C. elegans (a small transparent roundworm)is complex and depends on the visco-elastic properties of the environment. Here, we have used a custom-made worm imaging platform to monitor the random walks of individual worms in varying environments. As a result, we have observed that the probability distribution of spatial increments depends on the visco-elastic properties of the worm's environment. Moreover, these probability distributions Show signatures of Levy-stable distributions, hence suggesting near-optimal search strategies to explore the environment.

CPP 33.6 Tue 14:00 Poster C

Swimming Dynamics of *C. reinhardtii* in Confined Geometries — •Tanya Ostapenko, Christian Kreis, and Oliver Bäumchen — Max Planck Institute for Dynamics and Self-Organization (MPIDS), Am Fassberg 17, 37077 Göttingen, Germany

Chlamydomonas reinhardtii is a unicellular, biflagellated alga that has long been appreciated as a model organism in biology. Recently, their possibilities as a source of therapeutic proteins and renewable biofuels have attracted much interest. Previous research in the physics community to date has mainly focused on the propulsion mechanism of this microswimmer in bulk, as well as quasi-two-dimensional systems. Recently, the influence of interfaces on the dynamics has been recognized as an important factor. Additional studies showed that active swimmers affect the rheological (*e.g.* the effective viscosity) and transport properties of dense suspensions.

We report on the behavior of *C. reinhardtii* in two different, confined environments. First, we consider cells injected into a quasi-two-dimensional microfluidic chip, where we find that the geometric shape and dimensions in which the cells swim can affect their trajectories and wall interactions. Secondly, we investigate *C. reinhardtii* in an evaporating droplet, where the volume in which the cells may swim is time-dependent. We discuss possible explanations for any resulting pattern formations, as well as how the confined environment impacts the swimming dynamics.

CPP 33.7 Tue 14:00 Poster C

Bacterial swimming in narrow spaces — •Marius Hintsche, Michael Raatz, Marco Bahrs, Matthias Theves, and Carsten Beta — Institut für Physik und Astronomie, Universität Potsdam, Potsdam, Germany

The natural habitat of many bacterial swimmers is dominated by interfaces and narrow interstitial spacings. Thus, they will often interact with the fluid boundaries in their vicinity. To quantify these interactions, we investigated the swimming behavior of the soil bacterium Psudomonas putida in a variety of confined environments. We fabricated structured microchannels with different configurations of cylindrical obstacles as well as unstructured narrow chambers. In these environments we recorded swimming trajectories and measured key motility parameters for different obstacle densities and arrangements. Although the run-and-turn swimming pattern does not change, the shape of trajectories varies in different obstacle configurations. Motility parameters like speed, run times and turning angles depend strongly on the obstacle density. This is likely to be a combination of hydrodynamic wall effects and collisions with the obstacles.

CPP 33.8 Tue 14:00 Poster C

Modeling active systems on different length scales: a comparison of pattern phenomenology — •Jonas Denk, Lorenz Huber, Emanuel Reithmann, and Erwin Frey — Ludwig-Maximilians-Universität, München, Deutschland

Modeling complex biological systems always includes a level of coarse-graining in order to reduce the intricate functions of each microscopic constituent and their interplay to a comprehensive description. For active systems of self-propelled particles realizations of this coarsening procedure range from agent-based simulations on a single particle level to mean field descriptions on a hydrodynamic length scale. Because these two approaches are conceptually different it is important to ask whether they yield similar results especially with respect to the formation of macroscopic patterns. Motivated by recent *in vitro* experiments of membrane-bound FtsZ, a bacterial cell-division protein, we compare microscopic particle-based simulations to a coarse-grained kinetic Boltzmann approach for systems of chirally driven polymers. We discuss conceptual differences and identify observables, that are suited for each level of description. We find that both approaches exhibit the same phenomenology in terms of vortex structure and flocking states. Furthermore, we argue discrepancies between them and discuss possible applications in the field of self-propelled particle systems.