BP 51: Microswimmers III (Joint Session BP/DY)

Time: Thursday 11:15–12:45 Location: ZEU 250

BP 51.1 Thu 11:15 ZEU 250

A single squirmer under gravity — •Felix Rühle and Holger Stark — Inst. für Theor. Physik, TU Berlin, 10623 Berlin

A simple yet versatile model for many microswimmers is the widely studied spherical squirmer [1]. In this contribution we include a gravitational force acting on a single swimmer. In experiments this setup has yielded fascinating non-equilibrium structure formation such as floating rafts formed by active emulsion droplets [2] or dancing *Volvox* algae [3]. While theoretical and numerical studies for microswimmers under gravity do exist [4,5], they usually do not account for full hydrodynamics, which need to be included in the presence of surfaces.

In our study we observe a rich phenomenology depending on gravitational strength and on squirmer type: Swimmers are caught at the wall or completely escape from its influence, or they float at a finite distance from the bottom wall, both permanently and recurrently. We reproduce and explain these findings, which we obtained in MPCD simulations, using analytical calculations, which include wall-induced linear and angular velocities in the near and far field [6].

[1] J. R. Blake, *J. Fluid Mech.* **46**, 199 (1971).
[2] C. Krüger et al., *EPJE* **39**, 64 (2016).
[3] K. Drescher et al., *Phys. Rev. Lett.* **102**, 168101 (2009).
[4] M. Enculescu and H. Stark, *Phys. Rev. Lett.* **107**, 058301 (2011); K. Wolff, A. M. Hahn and H. Stark, *EPJE* **36**(4), 1 (2013).
[5] B. ten Hagen et al. *Nat. Comm.* **5**, 4829 (2014).
[6] J. S. Lintuvuori et al., *Soft Matter* **12**, 7959 (2016)

BP 51.2 Thu 11:30 ZEU 250

Chemotaxis in external fields: magnetotactic bacteria behavior — •Agnese Codutti[1], Stefan Klumpp[2], and Damien Faivre[1] — [1]Max Planck Institute of Colloids and Interfaces, Research Campus Golm, 14476 Potsdam, Germany — [2]Georg-August-Universität Göttingen, Friedrich-Hund-Platz 1, 37077 Göttingen, Germany

Microswimmers such as bacteria, algae and artificial swimmers can be described with a three dimensional active brownian particle model. Here, we modify this simple model to better describe bacterial motility. First of all, different states of motion are included: the bacteria can run straight or actively change direction of motion through tumble or reverse. Second, chemotaxis is added to generate a bias towards the preferred concentration of some substance. Finally, the swimmer may be subject to external forces and torques. We show how this modified model can be applied to various scenarios, including the run and tumble chemotactic motion of *E. Coli* and the motion of magnetotactic bacteria in a magnetic field. Magnetotactic bacteria produce an intracellular chain of magnetic nanoparticles that acts like a compass and passively orients the bacterium in the external magnetic field of the earth. The orientation provides an advantage to the bacteria, since it improves chemotaxis. Therefore we explore the interaction between chemotaxis and an external magnetic field. We show that reversing is more advantageous then tumbling, when a magnetic torque is included.

BP 51.3 Thu 11:45 ZEU 250

A microscopic field theoretical approach for active systems — •Francesco Alaimo[1,2], Simon Praetorius[1], and Axel Voigt[1,2,3] — [1]Institut für Wissenschaftliches Rechnen, TU Dresden, Dresden, Germany — [2]Dresden Center for Computational Materials Science (DCMS), TU Dresden, Dresden, Germany — [3]Center for Systems Biology Dresden (CSBD), Dresden, Germany

We consider a microscopic modeling approach for active systems. The approach extends the phase field crystal (PFC) model and allows us to describe generic properties of active systems within a continuum model. The approach is validated by reproducing results obtained with corresponding agent-based and microscopic phase field models. We consider binary collisions, collective motion and vortex formation. For larger numbers of particles we analyze the coarsening process in active crystals and identify giant number fluctuation in a cluster formation process.

BP 51.4 Thu 12:00 ZEU 250

Interface-Controlled Motility of Photoactive Microalgae in Confinement — •Tanya Ostapenko, Christian T. Kreis, and Oliver Bäumchen — Max Planck Institute for Dynamics and Self-Organization (MPIDS), Am Fassberg 17, 37077 Göttingen, Germany

The natural habitats of many biological microorganisms include complex interfaces and varying environmental conditions. For flagellated microalgae swimming in an aqueous medium, we showed that the curvature of the compartment wall governs their motility in geometric confinement [1]. This curvature-guided motility results in long detention times towards highly curved interfaces. We determined this from the analysis of individual cell trajectories, the results of which are supported by simulations and analytics. For puller-type microswimmers, the precise nature of their flagella-surface interactions are important and remain debated to this day. We discovered that the flagella adhesiveness for photoactive microalgae can be controlled by light [2]. Here, we report on the swimming dynamics of single *Chlamydomonas* cells isolated in two-dimensional microfluidic chambers under different light conditions. We find that the cell's motility in confinement can be switched reversibly by light, which could be exploited for application in biological optical traps and wastewater decontamination. [1] T. Ostapenko, et al. (arXiv:1608.00363, 2016), [2] C. T. Kreis, et al. (in review, 2016).

BP 51.5 Thu 12:15 ZEU 250

Dynamics of spheroidal squirmers in Poiseuille flow — •Hemalatha Annepu, Mario Theers, Gerhard Gompper, and Roland G. Winkler — Theoretical Soft Matter and Biophysics, Institute for Advanced Simulation and Institute of Complex Systems, Forschungszentrum Jülich, 52425 Jülich, Germany

Bacteria such as *E. coli* exhibit a remarkable rheological behavior. On the one hand, the viscosity exhibits a Newtonian plateau at low shear rates, which decreases with increasing concentration. On the other hand, the bacteria exhibit positive rheotaxis, i.e., they swim preferentially upstream next to surfaces. This points toward an intriguing interplay between the swimmer flow field with the surface. To analyze the properties of microswimmers in channel flows, we consider spheriodal squirmers with a rotlet dipole embedded in a MPC fluid and study their flow-induced structure and dynamics. The no-slip boundary condition at a surface combined with the swimmer characteristics (puller, pusher) leads to a preferential alignment parallel (pusher) or perpendicular (puller) to the wall. This applies to both, spherical as well as spheroidal squirmers as long as they are not to close to a surface and the hydrodynamics is determined by the far field. We want to shed light on the influence of near-field hydrodynamic interactions on the swimming behavior of spheroidal squirmers close to surfaces. Our simulations reveal a dependence of the swimming behavior under flow on the shape of the microswimmer. We find positive rheotaxis for spheroidal pushers in narrow channels, which disappears in the limit of zero rotlet dipole strength.

BP 51.6 Thu 12:30 ZEU 250

Interaction of 3D amoeboid swimmer with a wall — •Mohd Suhail Rizvi, Alexandr Farutin, and Chaouqi Misbah — Université Grenoble Alpes, LIPHY, CNRS, F-38000 Grenoble, France

Several micro-organisms and eukaryotic cells, including those of immune system, are known to migrate in fluids with the help of the appendages (flagella or cilia) or by deforming their body, known as amoeboid swimming. We performed a numerical study of the interaction of a three dimensional amoeboid swimmer with a plane boundary using boundary integral method. Expectedly, for purely hydrodynamic interactions, the swimmer nature is dependent on its separation and orientation relative to the wall but shows two contrasting behaviors as it either gets attracted towards the wall or moves away from it depending on its configuration. We identify the regions in the phase space associated with these two contrasting behaviors and demonstrate that the navigational motion of an amoeboid swimmer in a confined region observed in 2D also persist in 3D. In the presence of the adhesive interaction (modeled using Lennard-Jones potential) between swimmer and the wall along with hydrodynamic, the swimmer velocity demonstrates a non-monotonic relationship with the adhesion strength by demonstrating fastest migration at moderate adhesion and thus recapitulates experimental observations.