MPIDS Seminar

Navigation of active colloids in confinement and external fields

Dr. William E. Uspal

Max Planck Institute for Intelligent Systems, Stuttgart, Germany, and
IV. Institut für Theoretische Physik, Universität Stuttgart, Germany

Synthetic active colloids can self-propel through an aqueous solution by catalytic decomposition of chemical "fuel" available in the solution. Consequently, they generate hydrodynamic and chemical fields that extend into, and are modified by, the surrounding environment, coupling back to the motion of the particle. This feedback loop between "sensing" and motility could be harnessed to design particles that can autonomously navigate through complex (e.g., confined and time-varying) environments.

As a paradigm instance of geometric confinement, we consider a chemically active colloid near a solid planar wall. We show that certain designs of particle can sense, bind to, and swim along the wall, owing to hydrodynamic and chemical interactions between the particle and the wall. This tendency to bind to surfaces provides a novel basis for realizing "tactic" response of active colloids to ambient fields. As an example, we consider the effect of introducing external flow into the particle/wall system. We show that a robust directional response of the particle can emerge from the interplay of flow and near-surface swimming activity. Depending on the flow strength and the design of the particle, the particle can align against the flow direction ("upstream rheotaxis") or nearly perpendicular to it ("planar alignment"). We present experimental observations of the latter behavior, which causes particles to migrate across streamlines of the external flow. A comparison between the experimental and theoretical findings yields insight into the nature of the propulsive activity of the particles.

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Max Planck Institute for Dynamics and Self-Organization
Department of Living Matter Physics
Prof. Dr. Ramin Golestanian
Email: ramin.golestanian@ds.mpg.de, Phone: +49-(0)551/5176-100
Am Faßberg 17, 37077 Göttingen, Germany