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Special Biological Physics Seminar

Collective Microswimmer Motility in Complex Environments

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ABSTRACT

The behavior of microswimmers is strongly influenced by the interaction with their environ- ments which can be other microorganisms or confining walls. I will first report on the swimming behavior of the green alga Chlamydomonas reinhardtii in confinement where we find an increased probability of the cell swimming close to the confining wall. We discovered that the near-wall swimming probability scales with the local wall curvature. The model that we propose, consisting of an asymmetric dumbbell, describes the near-wall swimming accurately and does not require any fitting parameter. In fact, we found that the important ingredient to the curvature guided navigation is the torque stemming from the asymmetry of the organism.

Secondly, I will report on the influence of hydrodynamic interactions between microswimmers. We introduce a novel model for biological microswimmers that creates the flow field of the corresponding microswimmers, and takes into account the shape anisotropy of the swimmer's body and stroke-averaged flagella. By employing multiparticle collision dynamics, we directly couple the swimmer's dynamics to the fluid's. We characterize the nonequilibrium phase dia- gram, as the filling fraction and Péclet number are varied, and find density heterogeneities in the distribution of both pullers and pushers, due to hydrodynamic instabilities. We find a maximum degree of clustering at intermediate filling fractions and at large Péclet numbers resulting from a competition of hydrodynamic and steric interactions between the swimmers. We develop an analytical theory that supports these results. This maximum might represent an optimum for the microorganisms' colonization of their environment.