The Hydrodynamics of Microswimmers

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Abstract:
Both in soft matter and in biology, there are numerous examples of swimmers and self-propelled particles. With a typical size in the range of a several micro-meters, both low-Reynolds-number hydrodynamics and thermal fluctuations are essential to determine their dynamics [1,2]. Prominent examples are sperm cells which are propelled by a snake-like motion of their tail, bacteria like *E. coli* which move forward by a rotational motion of their spiral-shaped flagella, and synthetic bimetallic nanorods.
We have studied the behavior of sperm cell and self-propelled rods by performing multi-particle collision dynamics (MPC) simulations, a particle-based mesoscale hydrodynamics technique which captures the hydrodynamic behavior of a wide range of complex fluids very well [3,4]. We focus here on the cooperative behavior of swimming sperm [5], and on the dynamic properties of individual sperm cells and nanorods near surfaces [6,7]. In both cases, hydrodynamic interactions and the elongated shape of the microswimmer play an important role. As result, both sperm cells and self-propelled rods display a strong surface excess in confined geometries.

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