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Models and simulations of micro-swimmer motion in complex confinement

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Many micro-swimmers (e.g.bacteria, algae, spermatozoa, active colloids) live and move in liquids contained in spaces with non-trivial geometry and boundaries. Examples include porous media, liquids containing impurities and obstacles, as well as micro-fluidic devices in experiments. Interactions between the micro-swimmers, the immersing fluid and the solid boundaries play an important role in many biological and technological processes, and as such are an active area of study in biomechanics. The challenges are two-fold: (1) building appropriate swimmer models that include hydrodynamic interactions with each-other and boundaries, and (2) devising computational methods that can capture the complex dynamics with relative efficiency and speed. I will discuss recent approaches in modeling and simulations that aim to understand the individual and collective motion of micro-swimmers in various confinements or structured environments. Our results highlight how the complex interactions between the individuals and the boundaries give rise to the non-trivial behavior, but also how tailored models and fast computations can be utilized to explore and understand the emerging phenomena.