The Physics of Soft and Biological Matter

Microswimmer motility in rigid and elastic confinement

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Microscopic swimmers moving in rigid and elastic confined environments are a common feature of biological systems [1]. Microswimmers, ranging from molecular motors to single and multicellular self-propelled organisms, are often faced with a world crowded by passive and active, permeable and impermeable, boundaries, such as viscoelastic gels, microtubules or cell walls. These can act as barriers or defence mechanisms against microorganisms and it has also been suggested that they can be exploited by the swimmers to enhance their motility [1].

In this work [2] we analyse the effect of confining rigid and elastic boundaries on the motility of a model dipolar microswimmer within the framework of low-Reynolds number hydrodynamics. Our model consists of a simple bead-spring dipolar swimmer confined in a mesh tube of variable bending and stretching rigidity. Numerical results show that flexible boundaries are deformed by the velocity field of the swimmer in such a way that the motility of both extensile and contractile swimmers is enhanced. The magnitude of the increase in swimming velocity is controlled by the ratio of the swimmer-advection and elastic timescales, and the dipole moment of the swimmer. We explain our results analytically by considering swimming between inclined rigid boundaries.

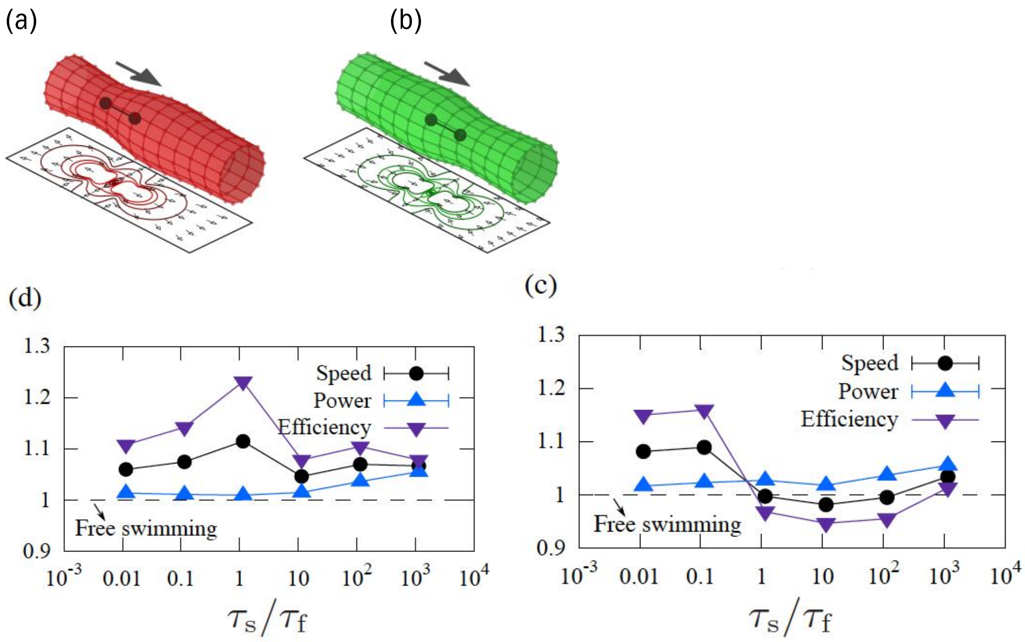

FIG. 1. (a) and (b) Numerical simulations of extensile and contractile dipolar swimmers in an elastic tube. (c) and (d) Effect of the interaction with the tube on the swimmer motility. The amplitude of the response in the swimmer speed and swimming efficiency depends on the ratio between swimmer and elastic timescales, τ_s/τ_f

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