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Dynamics and propulsion of a rotating flexible helical rod near a no-slip rigid boundary MOHAMMAD JAWED, HUSSAIN KARIMI, PEDRO REIS, Massachusetts Institute of Technology — We study the effect of a no-slip rigid boundary on the locomotion of uni-flagellar bacteria in a viscous fluid at low Reynolds number conditions, through a combination of computer simulations and experiments. In our analogue model experiments, we exploit the prominence of geometry in this class of problems to rescale the original micron-scale system onto the desktop-scale. We manufacture elastomeric filaments with fully customizable geometric and material properties, and rotate them in a glycerin bath at a finite distance away from a rigid boundary. The experimental results are compared against numerical simulations that combine the Discrete Elastic Rods method in conjunction with Lighthill Slender Body Theory. The no-slip boundary condition on the wall is implemented by the method of images. We first show that the filament buckles above a critical rotation frequency due to fluid loading, and then quantify the dependence of this critical threshold on the distance from the boundary. Excellent agreement is found between experiments and simulations, with no fitting parameters. Moreover, we find that the generated propulsion force is strongly affected by the presence of a nearby boundary.

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