Abstract Submitted
for the DFD15 Meeting of
The American Physical Society

Propulsion of flexible helical flagella near a rigid boundary MOHAMMAD JAWED, PEDRO REIS, Massachusetts Institute of Technology — We study the locomotion of uni-flagellar bacteria in a viscous fluid at low Reynolds number near a rigid boundary, through a combination of computer simulations and experiments. In our analogue model experiments, we exploit the prominence of geometry of 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 employ the Discrete Elastic Rods method in conjunction with Lighthill Slender Body Theory. The non-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, both experimentally and numerically. Excellent agreement is found between the two, with no fitting parameters. We then make use of our numerics to systematically investigate the change in the generated propulsion due to presence of a nearby boundary. We find that the propulsion depends strongly on the location of the boundary.

Mohammad Jawed
Massachusetts Institute of Technology

Date submitted: 30 Jul 2015 Electronic form version 1.4