Abstract Submitted
for the DFD11 Meeting of
The American Physical Society

Force-free swimming of a model helical flagellum in viscoelastic fluids BIN LIU, THOMAS POWERS, KENNETH BREUER, School of Engineering, Brown University — Many bacteria swim by rotating helical flagella. These cells often live in polymer suspensions, which are viscoelastic. Recently there have been several theoretical and experimental studies showing that viscoelasticity can either enhance or suppress propulsion, depending on the details of the microswimmer. To help clarify this situation, we study experimentally the motility of the flagellum using a scaled-up model system - a motorized helical coil that rotates along its axial direction. The rotating helix is tethered on a linear stage that advances at prescribed speeds along the axial direction. A free-swimming speed is obtained when the net force on the helix is zero. In the Newtonian case, the free-swimming speed of the helix matches the predictions from the slender body theory and the boundary element method, with increasing order of agreement as the numerical strategy improves. When the helix is immersed in a viscoelastic (Boger) fluid, we find an increase in the force-free swimming speed. The enhancement is maximized at a Deborah number of approximately one, and the magnitude depends not only on the elasticity of the fluid but also on the geometry of the helix.

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Date submitted: 12 Sep 2011 Electronic form version 1.4