Abstract Submitted
for the DFD12 Meeting of
The American Physical Society

Propulsion with a Reciprocal Stroke Enabled by Nonlinear Rheology PAULO ARRATIA, XIAONING SHEN, NATHAN KEIM, University of Pennsylvania — In a fluid that is entirely viscous, a reciprocal swimming stroke results in no net displacement. However, complex fluids such as mucus or dense suspensions exhibit nonlinear rheology even at low Reynolds number. This nonlinear fluid response can lead to time-reversal symmetry breaking which can enable a reciprocal swimmer to move. Here we demonstrate this principle with a reciprocally-actuated artificial propeller in two viscoelastic fluids: a polymeric fluid with elasticity but negligible shear thinning, and a wormlike micellar fluid that exhibits shear thinning and shear-bands. Propulsion is absent in Newtonian fluid, and is strongest in the shear-thinning micellar fluid. We report on the role of elasticity (Deborah number) in setting the speed of propulsion, and of body shape and boundary conditions in setting its direction. This work is supported by the Army Research Office through award W911NF-11-1-0488.

Paulo Arratia
University of Pennsylvania

Date submitted: 09 Aug 2012 Electronic form version 1.4