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Swimming & Propulsion in Viscoelastic Media[1]

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Many microorganisms have evolved within complex fluids, which include soil, intestinal fluid, and mucus. The material properties or rheology of such fluids can strongly affect an organism's swimming behavior. A major challenge is to understand the mechanism of propulsion in media that exhibit both solid- and fluid-like behavior, such as viscoelastic fluids. In this talk, we present experiments that explore the swimming behavior of biological organisms and artificial particles in viscoelastic media. The organism is the nematode *Caenorhabditis elegans*, a roundworm widely used for biological research that swims by generating traveling waves along its body. Overall, we find that fluid elasticity hinders self-propulsion compared to Newtonian fluids due to the enhanced resistance to flow near hyperbolic points for viscoelastic fluids. As fluid elasticity increases, the nematode's propulsion speed decreases. These results are consistent with recent theoretical models for undulating sheets and cylinders. In order to gain further understanding on propulsion in viscoelastic media, we perform experiments with simple reciprocal artificial 'swimmers' (magnetic dumbbell particles) in polymeric and micellar solutions. We find that self-propulsion is possible in viscoelastic media even if the motion is reciprocal.

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