ABSTRACT:

Biofilm formation, mammalian reproduction, and infection typically occur in environments where surrounding fluids comprise suspensions of polymers. These polymeric suspensions possess non-Newtonian rheological properties, such as rate-dependent viscosity and viscoelasticity, and present numerous experimental and modeling challenges. Using well-studied polymeric fluids, we aim to systematically investigate the effects of generalized Newtonian (rate-dependent) fluids on locomotion.

In this talk, I will discuss the effect of rate-dependent viscosity on (i) the swimming behavior of the nematode *Caenorhabditis elegans* and (ii) the rheology of active kinesin-driven microtubule suspensions. First, we investigate the swimming behavior of the low Reynolds number swimmer *C. elegans* using tracking methods and flow velocity measurements. With knowledge of the local flow behavior, we then address the important question of whether rate-dependent viscosity modifies the nematode’s cost of swimming. We find the cost of swimming in shear-thinning fluids is less than or equal to the cost of swimming in Newtonian fluids of the same zero-shear viscosity; furthermore, the cost of swimming in shear-thinning fluids scales with a fluid’s effective or average viscosity and can be predicted using rheological properties and simple swimming kinematics.

Second, we explore the rheology and dynamics of an active suspension of microtubules and kinesin motors in a dilute polymeric suspension using a confocal rheometer, which provides both rheological measurements and fluorescent imaging of microscale dynamics. We find the activity of microtubules enhances both the zero-shear viscosity and the shear-thinning behavior of the suspension. Using velocimetry techniques, we examine local mesoscale flow dynamics for insight into the underlying mechanisms responsible for this macroscale rheological behavior.