Weekly CEAFM Seminar: Spring 2018

JOHNS HOPKINS
Center for Environmental
& Applied Fluid Mechanics

Date: **Friday, March 2, 2018**

Time: 11:00 AM

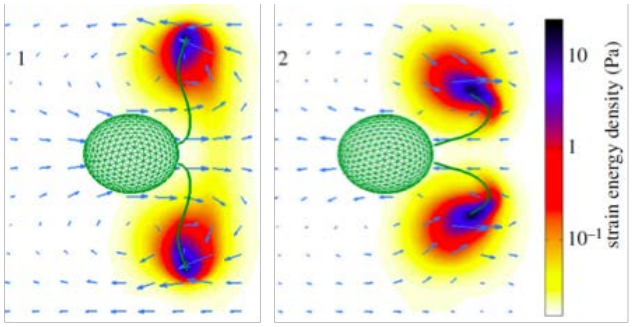
Location: Hodson Hall # 211

Speaker: **Prof. Paulo E. Arratia** (University of Pennsylvania)

Title: *"Life in Complex Fluids"*

Abstract

Many microorganisms (e.g. bacteria, algae, sperm cells) move in fluids or liquids that contain (bio)-polymers and/or solids. Examples include human cervical mucus, intestinal fluid, wet soil, and tissues. These so-called complex fluids often exhibit non-Newtonian rheological behavior due to the non-trivial interaction between the fluid microstructure and the applied stresses. In this talk, I will show how the presence of *particles* and *polymers* in the fluid medium can strongly affect the motility (i.e. swimming) behavior of microorganisms such as the bacterium *E. coli*. For bacteria moving in particle suspensions of different (particle) sizes, we find a regime in which larger (passive) particles can diffuse faster than smaller particles: the particle long-time effective diffusivity exhibits a peak in particle size, which is a deviation from classical thermal diffusion. A minimal model qualitatively explains the existence of the effective diffusivity peak and its dependence on bacterial concentration. These results have broad implications on characterizing active fluids using concepts drawn from classical thermodynamics. For swimmers (*E. coli* and *C. reinhardtii*) moving in polymeric liquids, we find that fluid elasticity can significantly affect the run-and-tumble mechanism characteristic of *E. coli*, for example, as well as the swimming speed and kinematics of both pushers and pullers. These results demonstrate the intimate link between swimming kinematics and fluid rheology and that one can control the spreading and motility of microorganisms by tuning fluid properties.



Simulations of *C. reinharditti* (puller) swimming in a viscoelastic fluid showing (1) power and (2) recovery strokes. Color bar represents polymer stresses.
(Li, et al. J. Royal Soc. Interface, 2017)