Center for Fluid Mechanics, Division of Applied Mathematics
Fluids and Thermal Systems Group, School of Engineering
Joint Seminar Series

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Optimization and Boundary Effects in Micro-scale Swimming

The swimming of microorganisms and synthetic 'nanoswimmers' takes place in a low Reynolds number fluid environment, in which viscous dissipation dominates inertial effects. In one of the most common means of low Reynolds number propulsion, bacteria propel themselves through fluids by passing either helical waves (typically prokaryotes) or planar waves (typically eukaryotes) along a slender flagellum. Both from a biological and an engineering perspective, it is of great interest to understand the role of the waveform shape in determining an organism's locomotive kinematics, as well as its hydrodynamic efficiency. We will begin by discussing polymorphism in bacterial flagella, and show by examination of experimental data and numerical simulation that fluid mechanical forces may have played a role in the evolution of the flagellum. For eukaryotic flagella, we will see how the optimal waveform is degenerate under the most common efficiency measure, and how that solution is regularized when energetic costs of internal bending and axonemal sliding are taken into account. Finally, we will study the hydrodynamic effects of nearby boundaries on swimming organisms from a generalized framework, through which a number of surprising and counter-intuitive behaviors can be seen even in very simple systems.

TUESDAY – OCTOBER 11, 2011
4:00 PM
Barus & Holley, Room 190