Department of Applied and Computational Mathematics and Statistics Colloquium

Eric Lauga

Department of Mechanical and Aerospace Engineering
University of California, San Diego

will give a lecture entitled:

Optimality in Cellular Hydrodynamics

Abstract

Fluid mechanics plays a crucial role in many cellular processes. One example is the external fluid mechanics of motile cells, such as bacteria, spermatozoa, algae, and essentially half of the microorganisms on earth. The most commonly-studied organisms exploit the bending or rotation of a small number of flagella (short whip-like organelles, length scale from a few to tens of microns) to create fluid-based propulsion. Ciliated microorganisms swim by exploiting the coordinated surface beating of many cilia (which are short flagella) distributed along their surface. After a short introduction to the fundamentals of fluid-based locomotion on small scales, we pose four separate optimization problems addressing the optimal geometries and locomotion gaits of low-Reynolds-number swimmers. First, we characterize the optimal dynamics of simple flapping swimmers with two degrees of freedom. Second, we derive analytically and computationally the optimal waveform of an elastic flagellum, such as the one employed by eukaryotic cells for propulsion. Third, we investigate the optimal shapes of helical propellers and use our results to help rationalize the shape selection mechanism in bacterial flagella. Finally, we characterize the optimal locomotion by surface distortions of blunt swimmers and demonstrate the appearance of waves, reminiscent of the metachronal waves displayed by ciliated organisms.

Wednesday, April 27th, 2011
4:00 p.m. to 5:00 p.m.
129 Hayes-Healy Center