PHYSICAL MATHEMATICS SEMINAR

GEOMETRICAL OPTIMIZATION AND SURPRISING BEHAVIORS IN SWIMMING AND FLYING

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ABSTRACT:

The swimming of microorganisms 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 will compare experimentally measured biological data on swimming bacteria to optimization results from highly accurate numerical simulations. For eukaryotic flagella, it will be shown how the optimal sawtoothed solution due to Lighthill is regularized when energetic costs of internal bending and axonemal sliding are included in a classical efficiency measure. Finally, the locomotive dynamics of bodies at intermediate Reynolds numbers will be discussed (where inertia and viscous dissipation are both important), for which a number of surprising and counter-intuitive behaviors can be seen even in very simple systems.

TUESDAY, FEBRUARY 1, 2011
2:30 PM
Building 2, Room 105

Refreshments at 3:30 PM in Building 2, Room 290

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