PHYSICAL MATHEMATICS SEMINAR

Helical Swimming in Complex Fluid Media

BIN LIU

Brown University

ABSTRACT:

Many bacteria swim by rotating helical flagella. In Nature, these cells often live in a complex fluid environment, such as suspensions of polymers and other micro-scale structures. To explore the physics on how such complex environments affect the bacterial motility, the helical swimmer is simulated by a model system - a motorized helical coil that rotates along its axial direction. When the helix is immersed in a viscoelastic fluid, a model fluid of polymer suspensions, there is an increase in the swimming speed as compared with the Newtonian case. The enhancement is maximized when the rotation rate of the helix matches the relaxation time of the fluid. The magnitude of enhancement depends not only on the elasticity of the fluid but also on the geometry of the helix. In the second part of my talk, I will discuss on how such helical swimming is affected by spatial confinement of micro scales, such as a porous medium. As a reduced order model, the porous media is regarded as cylindrical cavities with solid walls. A modified boundary element method is introduced here to make full use of the helical symmetry. This method allows us to investigate a situation that the flagella are tightly confined by solid wall. To our surprise, at fixed power consumption, a highly coiled swimmer swims faster in a narrower confinement, while an elongated one swims faster in a cavity with a wider opening. These phenomena are explained with simple physical picture.

TUESDAY, APRIL 10, 2012
2:30 PM
Building 2, Room 105

Reception at 3:30 PM in Building 2, Room 290
(Math Dept. Common Room)

http://math.mit.edu/pms

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