



JOHNS HOPKINS
Center for Environmental
& Applied Fluid Mechanics

Special CEAFM Seminar: Fall 2012

Date: **Tuesday, October 9, 2012 [Special Date]**
Time: 12:00 p.m. [Special Time]
Location: Gilman 132 [Special Location]
Speaker: **Dr. Bin Liu** (Brown University)
Title: *"Synchronization of Chaos and the Smallest Turbulent Eddy"*

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.

Bin Liu received his B. S. in Physics from Fudan University in China and his M. S. and Ph. D. in Physics from New York University. His Ph. D. thesis covers two entirely different subjects: density functional theory on multi-fermion system and thermal convection interacting with free bodies. The major results were published in Physical Review Letters and Physical Review A. During his postdoctoral research at the Courant Institute of Mathematical Sciences (from 2007 to 2010), he explored his interests in fluid-structure interactions in Biological systems. Using both theoretical and experimental approaches, he worked on problems concerning animal flight, and motion in non-Newtonian fluids. These results have been published in Physical Review Letters and Journal of Fluid Mechanics. Bin Liu is currently a postdoctoral research associate in the School of Engineering at Brown University (from 2010), studying how microorganisms interact with complex fluid environments.