PHYSICAL MATHEMATICS SEMINAR

Fluid-Structure Interactions at the Capillary Scale

DANIEL HARRIS

Brown University

ABSTRACT:

Studies of the motion of small bodies at an air-water interface has significant relevance for a range of natural systems and technological applications. In this talk, I will discuss two related systems presently under investigation in the Harris Lab at Brown.

In the first part of the talk, we explore the dynamics of millimetric superhydrophobic spheres impacting the surface of a quiescent water bath. It is known that small superhydrophobic particles impacting a water surface can rebound completely from the interface under certain conditions (Lee & Kim, Langmuir, 2008). We follow up on this striking finding, giving particular attention to the dependence of the normal coefficient of restitution and contact time on the impact velocity and relative density of the sphere. Our experimental observations are compared to the predictions of a fluid model derived from linearized Navier-Stokes under the assumption of a high Reynolds number regime (Galeano-Rios et al., JFM, 2017).

In the second part, we investigate the friction experienced by centimeter-sized bodies sliding on the surface of water. We demonstrate that their motion is dominated by skin friction due to the viscous boundary layer that forms in the fluid beneath the moving body. We develop a simple model that considers the boundary layer as quasi-steady, and is able to capture the experimental behavior for a range of body sizes, masses, shapes and fluid viscosities. Furthermore, we explore the influence of the body's shape as well as the topography of its bottom surface on the friction. Our results are thus significant for understanding the motion of small natural and artificial bodies at the air-water interface, and can inform the design of aerial-aquatic microrobots for environmental exploration and monitoring.

Future directions will be discussed.

TUESDAY, SEPTEMBER 11, 2018
2:30 pm
Building 2, Room 136

Reception following in Building 2, Room 290
(Math Dept. Common Room)

http://math.mit.edu/seminars/pms/

Massachusetts Institute of Technology