APPLIED MATHEMATICS COLLOQUIUM

The Mathematics and the Physics of the Moving Contact Line Problem

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Abstract:
When a fluid-air or fluid-fluid interface contacts a solid, such as a water surface contacting the walls of a half-full cup, the resulting dynamical system is a "moving contact-line problem," and represents one of the most controversial problems in fluid mechanics. The difficulty stems from the fact that the classical Navier-Stokes equation with no-slip boundary condition predicts a non-physical singularity at the contact line with an infinite rate of energy dissipation. Partly for this reason, mathematical and numerical studies of free boundary problems in fluids have so far avoided dealing with realistic solid boundaries. Many modified continuum models have been proposed to overcome this difficulty. They all succeed in removing the singularity, but they leave behind the question: which one of these models is faithful to the microscopic physics near the contact line region? This and related questions can be answered by using continuum theory, molecular dynamics and the more recently developed multiscale techniques. We will discuss how these techniques can be combined to give us a better understanding of the fundamental physics of the moving contact line and formulate simple and effective models, which not only give a faithful description of the physical process but also remove the singularities. We also illustrate how this model can be used to analyze hysteresis and other important physical problems for the moving contact line.

Joint work with Weiqing Ren at the Courant Institute.

Monday November 15th 2010
4:30 PM
Building 2, Room 105
Refreshments are available in Building 2, Room 290
(Math Common Room) between 3:30 – 4:30 PM

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