Center for Fluid Mechanics, Division of Applied Mathematics
Fluids, Thermal and Chemical Processes Group, School of Engineering
Joint Seminar Series

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Caught between a Drop and a Soft Place: The Deformation of an Elastic Substrate by a Three-Phase Contact Line

Young's classic analysis of the equilibrium of a three-phase contact line ignores the out-of-plane component of the liquid-vapor surface tension. While it has long been appreciated that this unresolved force must be balanced by elastic deformation of the solid substrate, a definitive analysis has remained elusive because conventional idealizations of the substrate imply a divergence of stress at the contact line. While a number of theories have been presented to cut off the divergence, none of them have provided reasonable agreement with experimental data. We measure surface and bulk deformation of a thin elastic film near a three-phase contact line using fluorescence confocal microscopy. The out-of-plane deformation is well fit by a linear elastic theory incorporating an out-of-plane restoring force due to the surface tension of the gel. This theory predicts that the deformation profile near the contact line is scale-free and independent of the substrate elastic modulus.

Time permitting, I will discuss another problem at the interface of fluid and solid mechanics: the fracture and delamination of colloidal coatings. Here, we observe the deformation of the underlying substrate to infer spatially-resolved interfacial and internal stresses near cracks in a fluid-filled brittle solid.

TUESDAY – May 3, 2011

3:00 PM

Barus & Holley, Room 190