

# How Water Meets a Hydrophobic Surface

Steve Granick

Departments of Materials Science, of Chemistry, and of Physics

University of Illinois, Urbana IL 61801

sgranick@uiuc.edu

This talk will present several vignettes revolving around the theme of hydrophobicity:

- a) water at a single hydrophobic surface;
- b) water confined between a hydrophobic surface on one side, a hydrophilic surface on the other (a Janus interface);
- c) using the hydrophobic interaction to cause Janus colloidal particles, hydrophobic on one side and hydrophilic on the other side, to self-assemble into clusters.

First, I will report studies in which synchrotron x-ray reflectivity measurements of the interface between water and methyl-terminated octadecylsilane monolayers with stable contact angle  $>100^\circ$  conclusively show a depletion layer, whether the water is degassed or not. The thickness is of order one water molecule: 2-4 Ångstroms with electron density  $<40\%$  that of bulk water. Considerations of coherent and incoherent averaging of lateral inhomogeneities show that the data cannot be explained by 'nanobubbles'. When the contact angle is lower, unstable in time, or when monolayers fail to be sufficiently smooth over the footprint of the x-ray beam, there is no recognizable depletion.

Next, I will report studies in which water confined between adjoining hydrophobic and hydrophilic surfaces (a Janus interface) is found to form stable films of nanometer thickness whose responses to shear deformations are extraordinarily noisy. The power spectrum of this noise is quantified. In addition the frequency dependence of the complex shear modulus is a power law with slope one-half, indicating a distribution of relaxation processes rather than any dominant one. The physical picture emerges that while surface energetics encourages water to dewet the hydrophobic side of the interface, the hydrophilic side constrains water to be present, resulting in a flickering, fluctuating complex.

Finally, I will report the assembly of spherical particles with one hydrophobic hemisphere and large electric charge on the second hemisphere, in the case that the particle diameter exceeds the electrostatic screening length. Clusters result, not strings. The cluster shapes are analyzed by combined epifluorescence microscopy and Monte Carlo computer simulations with excellent agreement, indicating that the particles assemble in aqueous suspension to form equilibrated aggregates.