Forces on Capillary Disks

By

Dr. Daniel M. Harris
School of Engineering
Brown University

Understanding the forces on small bodies at a fluid interface has significant relevance to a range of natural and artificial systems. In this talk, I will discuss two recent investigations in my lab where we’ve developed custom experiments to explore different forces on “capillary disks”: centimeter-scale hydrophobic disks trapped at an air-water interface.

In the first part, we investigate the friction experienced a capillary disk sliding along the interface. We demonstrate that the 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 that is able to capture the experimental behavior for a range of disk radii, masses, 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.

In the second part, we present direct measurements of the attractive force between capillary disks. It is well known that objects at a fluid interface may interact due to the mutual deformation they induce on the free surface, however very few direct measurements of such forces have been reported. In the present work, we characterize how the attraction force depends on the disk radius, mass, and relative spacing. The magnitudes of the measured forces are rationalized with a simple scaling argument and compared directly to theoretical predictions.

Future directions in this area will also be discussed, in particular, we are beginning to investigate the motion and interactions of “active” capillary disks at the interface.

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