Mechanical Engineering Department Seminar

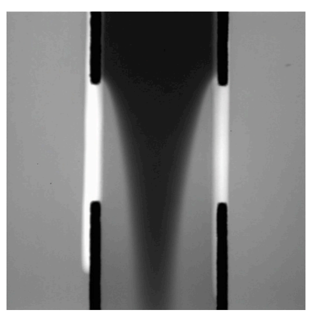
3:35pm April 22, 2015
1130 Mechanical Engineering
111 Church Street SE, Minneapolis, MN 55455

Sculpting and Visualizing Chemical Concentration Fields in Space and Time, and Gradient-Driven Colloidal Migration

Todd Squires

Professor and Vice Chair, Department of Chemical Engineering; University of California – Santa Barbara

Microfabricated fluidic systems offer exquisite control over the physical and chemical phenomena that occur within an experiment. Here, we highlight new capabilities we have developed to actively "sculpt" chemical concentration fields in microfluidic systems, a label-free method to directly visualize these evolving solution profiles, and a first-of-its-kind visualization and measurement of the (solution-dependent) diffusiophoretic migration of suspended colloids under imposed, non-equilibrium chemical fluxes. Such migration under chemical gradients have been known since the time of Deryaguin, who sought explanations for how latex films could grow on metal surfaces more quickly than diffusion would allow. Because any surface that reacts (or equilibrates) with a solution drives such a flux through that solution, diffusiophoresis would seem to be an almost ubiquitous phenomenon. Nonetheless, diffusiophoresis has remained stubbornly difficult to observe or characterize directly. We will discuss the physico-chemical phenomena that underlie diffusiophoresis, and therefore how to intuitively design particles that exhibit desired diffusiophoretic properties. We will describe direct measurements under both solute and solvent gradients, and how these might be understood from a fundamental standpoint. We will present some qualitative surprises that we have observed, and how they might be understood, and ideas for the conceptual design and rational engineering of particles and solutions that establish or exploit chemical gradients to drive suspension behavior.



Bio: Todd Squires is Professor and Vice Chair of Chemical Engineering at the University of California, Santa Barbara. He earned dual B.S./B.A. degrees in Physics and Russian Literature at UCLA in 1995, then earned a distinction in Part III of the mathematics tripos in DAMTP as a Churchill Scholar at Cambridge University. He earned his Ph.D. in Physics from Harvard University in 2002 with Michael Brenner and Howard Stone, on problems in colloidal hydrodynamics and electrokinetics. He then spent three years as a Lee A. Dubridge Prize Postdoctoral Fellow and NSF Mathematical Sciences Postdoctoral Fellow at Caltech, where he continued theoretical work in electrokinetics and microfluidics, and initiated new studies of nonlinear microrheology with John Brady. His group focuses on the physicochemical processes that occur in soft matter, both experimentally and theoretically. Specific areas of interest include microrheology (linear, nonlinear and interfacial), dynamic processes at surfactant interfaces, and the manipulation of dispersed particles, solutes, and flows in micro-chemical environments. Honors include the APS Early Career Award from the Soft Matter Topical Group, the NSF CAREER Award, the 2008 Beckman Young Investigator Award, the 2009 Camille Dreyfus Teacher-Scholar Award, the 2009 Francois Frenkiel Award from the APS Division of Fluid Mechanics, the 2013 Mid-Career award from the American Electrophoresis Society, and the 2010 Allan P. Colburn and 2012 Dudley Saville Memorial Lectureships, the 2015 Stanley Corrsin Memorial Lecture and the inaugural 2015 GSOFT Early Career Award from the APS.