Getting Out of a Tight Spot: Heterogeneous Transport in Porous Media

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Maeder Hall, ACEE

Filtering water and brewing coffee are familiar processes that rely on transport in a porous medium. This process also underlies many technological applications, including oil recovery, groundwater remediation, and drying of coatings. When sufficiently slow, transport is typically modeled using a simple continuum approach. However, while appealing, such an approach neglects heterogeneities in transport that can strongly impact bulk behavior. In this talk, I will describe two different examples of how we investigate heterogeneous transport, and its implications, in porous media. First, I will describe how we visualize the flow of multiple immiscible fluids within a disordered porous medium, in 3D, over length scales ranging from smaller than a pore to that of the entire medium. This capability enables us to elucidate the physics underlying the mobilization of a trapped non-wetting fluid. Surprisingly, we find that addition of a surfactant does not enhance mobilization through a simple decrease of fluid interfacial tension; instead, it appears to enable a new mechanism of oil mobilization. Second, I will describe how we combine experiments and simulations to investigate the drying of a soft, shrinkable porous medium. In some cases, the capillary stresses that develop in the drying fluid cause the medium to fracture. We show how fracture evolution is sensitive to spatial heterogeneities in the drying profile, suggesting a way to control material behavior in this complex system. Ultimately, this research stimulates new findings and questions at the interface of Engineering, Physics, and Materials Science.

Prof. Sujit Datta is an Assistant Professor of Chemical and Biological Engineering at Princeton University. He is also an Affiliated Faculty at the Andlinger Center for Energy and the Environment and the Princeton Institute for the Science and Technology of Materials. He earned a BA in Mathematics and Physics and an MS in Physics in 2008 from the University of Pennsylvania, where he studied nanomaterials like graphene and carbon nanotubes. He earned his PhD in Physics in 2013 from Harvard, where he studied fluid dynamics and instabilities in porous media and colloidal microcapsules. His postdoctoral training was in Chemical Engineering at Caltech, where he studied microbial biophysics of the gut. He joined Princeton in 2017, where his lab seeks to understand and control the interactions between soft materials and their complex environments, motivated by applications like oil/gas recovery, water remediation, and drug delivery. Prof. Datta is the recipient of the LeRoy Apker Award for outstanding achievements in Physics and the Andreas Acrivos Award in Fluid Dynamics from the American Physical Society.

Social after the seminar outside of Maeder Hall
All are welcome

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