PHYSICAL MATHEMATICS SEMINAR

Nonequilibrium Physics of Multiphase Flow through Porous Media: Origin of Gravity Fingering During Water Infiltration into Dry Soil

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ABSTRACT:

The simultaneous flow of several fluid phases through a porous medium is a pervasive phenomenon in nature. It occurs, for instance, during infiltration of water into soil, and during the formation of methane hydrates in ocean sediments and permafrost. It is also central to many energy technologies, such as production of oil and gas reservoirs, CO2 injection into geologic formations, and water dropout in low-temperature fuel cells.

Yet—and unlike flows of a single fluid—our ability to model multiphase flow through porous media at the macroscopic (continuum) scale is still very incomplete. The traditional equations are unable to capture, and much less explain, the formation of the complex patterns observed in experiments. Work in my research group focuses on advancing our fundamental understanding and predictive capabilities of multiphase porous media flow.

In this talk, I will present a new mathematical framework to model multiphase flow through porous media. The new theory incorporates one basic feature—the system is out of thermodynamic equilibrium. I will present the application of the new theory to infiltration of water into soil, and answer a long-standing question in soil physics: why does the infiltration front lead to preferential flow paths, in the form of gravity fingers? This result directly impacts the prediction of travel times of contaminants through the vadose zone, the recharge rate of shallow aquifers, and has implications on the soil susceptibility to desertification.

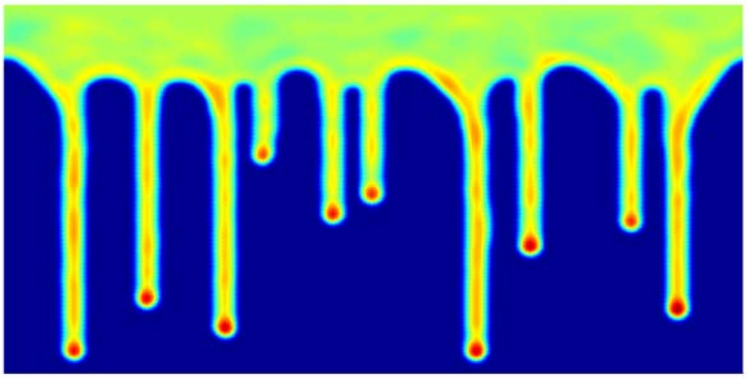

Figure caption: The infiltration of water into dry soil leads to preferential flow in the form of “gravity fingers”. Shown are results of our mathematical model, which reproduce the fingering instability, and the water pile-up at the tip of the fingers.

TUESDAY, OCTOBER 6, 2009
2:30 PM
Building 2, Room 105

Refreshments at 3:30 PM in Building 2, Room 290
(Math Department - Common Room)

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