Physical Math Seminar

Capillary rise, thin films near edges, and surfactant spreading: New insights from self-similarity

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ABSTRACT:

Traditional similarity solutions in course work and research typically involve nonlinear equations with two independent variables. First, I will illustrate one “typical” problem that concerns capillary rise, which has been described in the literature as a "universal" solution, and show that, in fact, the solution is "almost universal." Second, I will describe an unusual case involving three independent variables and show that there is a similarity solution such that a nonlinear ODE results. These two cases are each illustrated by an experiment and rationalized with an analysis of the appropriate thin film equation. Finally, I will consider the rate of spreading through Marangoni flow of an insoluble surfactant on the surface of a deep layer of viscous fluid: there is a non-local relationship between the interfacial velocity and the surfactant concentration, yet it has been shown in recent years that it is possible to convert the nonlocal problem to a complex-valued Burgers equation. We provide a wide class of self-similar solutions to this problem.

*Joint work with Camille Duprat, Fernando Temprano-Coleto, Katie Wu, and Nan Xue.

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Building 2, Room 449

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