PHYSICAL MATHEMATICS SEMINAR

Universal growing behavior and frozen pattern formation in disordered reaction front propagation

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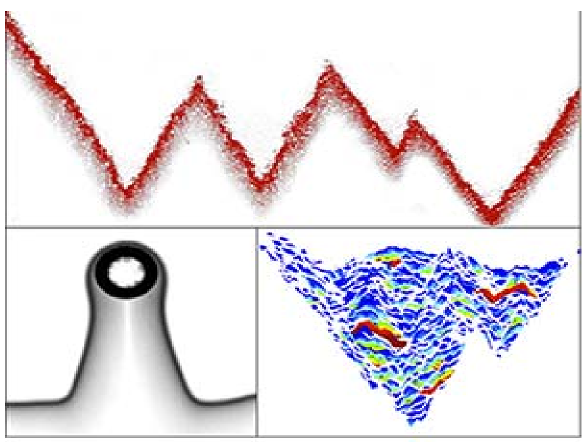
ABSTRACT:

The effect of fluid flows on active interface motion are relevant to a wide variety of dynamical processes such as interface growth in liquids, population dynamics, flame propagation in combustion or marine ecology. The emergence of scale invariant behavior is ubiquitous in growth phenomena and raises the question of universality in this context.

In this talk, we will show that chemical waves propagation provides a suitable system to study universal growing behavior in fluids. Resulting from the balance between molecular diffusion and nonlinear chemical kinetics, self-sustained reactions can generate traveling reaction waves. When coupled to a heterogeneous flow field, these fronts show a complex behavior with distinct dynamical regimes. We have performed experiments in a disordered Hele-Shaw cell, filled with an immersed granular bed. In this configuration, the reaction fronts become self-affine, and intriguingly, can exhibit frozen steady states for a certain range of flow rate. The front displays sawtooth shape patterns and two distinct depinning transitions, driven by the mean flow velocity, are observed.

We show that by tuning a single parameter, the mean flow velocity, the measured spatial and temporal fluctuations are consistent with three distinct universality classes in d=1+1. Fast advancing or receding fronts display the Kardar-Parisi-Zhang class scaling laws, while slowly propagating fronts exhibit an intermittent behavior and are characterized by the positive or negative quenched Kardar-Parisi-Zhang class.



TUESDAY, SEPTEMBER 23, 2014
2:30 PM
Building E17, Room 122

Reception following in Building E17, Room 401A
(Math Dept. Common Room)

http://math.mit.edu/pms/

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