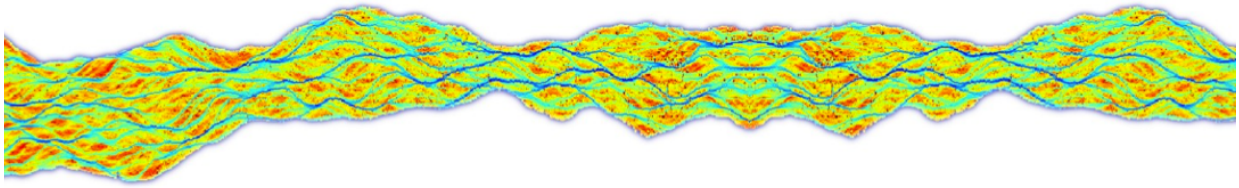
Intermittent avalanche dynamics of slow imbibition fronts



I will review our experimental study of the dynamics of a viscous wetting fluid interface forced to invade a disordered medium –a model open fracture– at constant flow rate.

Distortions of the advancing imbibition front produced by capillary pressure fluctuations (due to the heterogeneities of the medium) are damped by interfacial tension and fluid viscosity. The competition of those stabilizing and destabilizing forces operating at different length scales leads to a kinetic roughness process characterized by critical interfacial fluctuations and a collective avalanches dynamics.

Using fast and high-resolution imaging, we could show that the imbibition front motion takes place by localized bursts, whose lateral sizes, areas and durations are power-law distributed up to a cut-off scale, which diverges as the Capillary number of the displacement decreases Ca → 0, corresponding to the critical depinning transition. Those capillary bursts triggered from the smallest scale of the disorder up to the scale at which viscous dissipation becomes dominant lead to anomalous Gumbel-like fluctuations, and a strongly intermittent –turbulent-like– behavior of the global invasion process.