Crackling dynamics during the failure of heterogeneous materials

-- Quake catalogs at the laboratory scale --

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The failure of heterogeneous materials is a complex process taking place on a very broad range of scales: from the separation of atomic bonds, to the nucleation and growth of micro and macro voids, and even up to larger geological scales during earthquakes and fault dynamics.

During the seminar, we will discuss a model experimental set-up that allowed us to access and characterize in all details such a complex spatio-temporal dynamics, also called “Crackling Noise”. Using both a high-resolution fast camera, and microphones, we could track the slow growth of a crack front along a weak heterogeneous plane of a Plexiglas block, and show that the fracture front dynamics displays an intermittent behavior driven by avalanches with very large size and velocity fluctuations. Such a crackling dynamics can be fully reproduced through a stochastic description derived from Linear Elastic Fracture Mechanics and extended to weakly disordered materials. In this approach, quasi-static failure of heterogeneous brittle materials can be interpreted as a dynamic phase transition and as such, exhibits universal scaling behaviors.