Discussion of

Stefano Zapperi's presentation on Plasticity and fracture in glasses and crystals

Gilles Tarjus (LPTMC, CNRS-UPMC)

Paris_yielding_2018

Brief recap

- **Amorphous plasticity:**
  - ✳ **Tensorial elasto-plastic model (*2D* and *3D*)**
  - ✳ **Also: Expts on colloids + atomistic simulations**

➡ Universal non-MF depinning avalanche properties, singular excitation spectra (marginal stability), yielding as a percolation transition.

- **Micron-scale plasticity of crystals:**
  - ✳ **Dislocation dynamics (*2D* and *3D*)**

➡ Common behavior with amorphous plasticity: scale-free avalanches, yielding is not MF depinning, singular excitation spectra (marginal stability).

- **Brittle failure of bond-forming glasses:**
  - ✳ **Atomistic simulation of SiO_2 glass pillars**
  - ✳ ***2D* random fuse model**

➡ System-size dependent brittle-ductile transition, percolation versus crack nucleation.

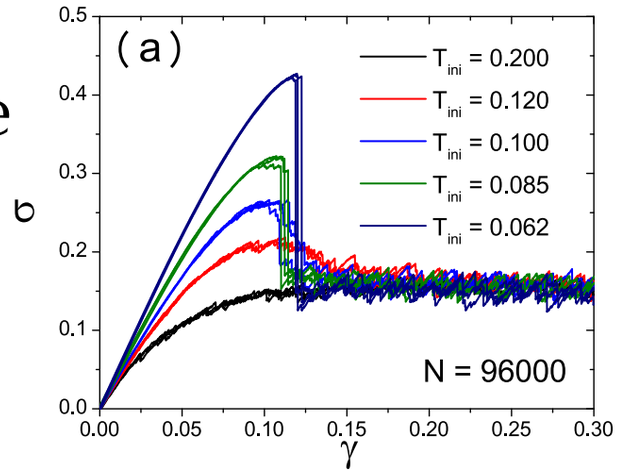
Can one reconcile all of the results in one grand scheme?

- There are **common features** associated with yielding and plasticity in the 3 different classes under study: scale-free avalanches, marginal stability (maybe except for brittle bond-forming glasses?), scaling is not mean-field depinning, etc.

- **Yet, the models and theoretical approaches are quite different!**

- **What is universal?** Is there a common framework for ductile, brittle, amorphous, crystalline, etc., systems? Or should one consider separate classes of systems?

- Ductile to brittle transition… Is there a unique description? Work by Misaki Ozawa et al. vs. random fuse model???



Plasticity and yielding… criticality left, right and center!

- Yielding viewed as a **continuous transition** from the flowing phase (flow curve, scale-free avalanches).
- Yielding transition (in quasi-static athermal strain-controlled protocol) as a **critical spinodal** [$d=\infty$ hard spheres, Itamar Procaccia et al.].
- **RFIM-like critical point** in the yielding pattern as a function of glass preparation [Ozawa et al.].
- Marginal stability [Wyart et al., more] and **extended criticality** (in amorphous and crystalline materials!, see S.Z.).
- Yielding of amorphous solids as a **depinning** or as a **percolation transition** [also for brittle disordered solids, see S. Z.].

That's a lot of criticality…

Criticality in plasticity

- **How to disentangle "extended criticality" due to singular excitation spectrum and other forms of criticality?**

  For instance in F.Z.'s work on amorphous plasticity how can one disentangle the system-spanning avalanches due to the marginal stability from the spanning cluster associated with the percolation transition et yielding?

- Minor question: In F. Z.'s study of amorphous plasticity (tensorial elasto-plastic model) the scaling of avalanche properties is non mean-field. Yet it is independent of dimension??

- **Percolation, depinning, RFIM critical point, critical spinodal, marginal stability**…. Dependence on control parameters?? Different classes of materials??