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A combined local-macroscopic approach to investigate plasticity of athermal amorphous solids

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Understanding the origin of plasticity in amorphous systems remains a challenging problem. The absence of long-range order prevents a clear definition of structural defects and therefore of their evolution during deformation. Furthermore, the interplay with temperature or the rate of deformation makes their dynamics difficult to describe.
However, for systems slowly deformed in athermal conditions, plastic flow occurs through local rearrangements of particles. These shear transformation zones (STZ) are not independent and their interactions lead to intermittent collective rearrangements in the form of avalanches [1].
Recently, a scaling description of the yielding transition based on the depinning transition has been proposed [2]. The predictions of this theory have been validated by mesoscopic elasto-plastic models and particle scale simulations in the steady-state flow. However, conflicting points of views have emerged regarding the phenomenology in the transient regime [2-4].
In this work, we investigate the emergence of plasticity by considering molecular simulations of a Lennard-Jones glass former. In the athermal quasistatic shear limit, we study in a complementary way deformations at the macroscopic scale and at the local scale by using the frozen matrix approach. In particular, the evolution of the scaling properties of stress and strain distributions with deformation will be investigated.

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[2] J.Lin et al. PNAS, 40, 111, 2014

[3] K. M. Salerno and M. O. Robbins , PRE, 88(6):062206, 2013

[4] H.G.E Hentschel et al. PRE, 92(6) 062302, 2015

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