Stationary dynamics of tracer particles in an elasto-plastic model for the structural relaxation of amorphous solids

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We study numerically, at the mesoscopic level, the structural relaxation of two dimensional disordered systems free from external forces, only subject to temperature activated local plastic rearrangements [1]. The temperature-dependent steady state of our model is characterized by narrower local stress (coarse-grain) distributions and lower average plastic activity as the temperature decreases. This sets the scenario for the development of causal correlations among the plastic events stochastically occurring in the system. To observe this phenomena, we compute the mean square displacement and the dynamical structure factor for tracer particle trajectories in the system during the steady evolution. The relaxation caused by correlated plastic events depend on both length and time scales. At sufficient small time scales we observe a ballistic movement of the tracers, contrasting with a diffusive regime at larger time scales. A broad crossover among these regimes accounts for a non-trivial sub-diffusive behavior at low enough temperatures, that involves an unexpected length-scale dependence of the dynamical structure factor. Our results are discussed in light of previous experimental findings in colloidal gels, their heuristic explanations [2], and theoretical mean field predictions [3].

Références

[1] E.E. Ferrero, K. Martens, J-L. Barrat, *Structural relaxation of two dimensional elasto-plastic systems : A mesoscopic approach*, in preparation.

[2] L. Cipeletti, S. Manley, R.C. Ball, D.A. Weitz, *Universal Aging Features in the Restructuring of Fractal Colloid Gels*, Phys. Rev. Lett. **84** 2275, 2000.
A. Duri, L. Cipeletti, *Length scale dependence of dynamical heterogeneity in a colloidal fractal gel*, Europhys. Lett. **76** 972, 2006.

[3] J-P. Bouchaud, E. Pitard, *Anomalous dynamical light scattering in soft glassy gels*, Eur. Phys. J. E **9** 287, 2002.
J-P. Bouchaud, *Anomalous Relaxation in Complex Systems: From Stretched to Compressed Exponentials*, in “Anomalous Transport”, Wiley-VCH Verlag GmbH & Co. KGaA, p. 327–345, 2008.

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