Simulations of elasto-plasticity at constant pressure close to the unjamming point

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Soft sphere interacting via finite-range pairwise potentials undergo an unjamming transition as the imposed hydrostatic pressure p is reduced towards zero [1]. As the critical point $p = 0$ is approached, gradually softer vibrational modes appear in the density of states of these systems [2], and lengthscales characterizing the elastic response grow [3]. When these systems are sheared under constant volume conditions close to unjamming, fluctuations in the critical packing fraction ϕ_c, at which the pressure vanishes under constant volume conditions, impose significant difficulties on the systematic study of how the unjamming point affects the elasto-plastic response [4].

In my talk I will present a numerical method [5,6,7] that allows us to impose quasi-static simple shear deformation on soft-sphere systems, while keeping the pressure constant instead of the volume. By constraining the pressure under quasi-static conditions, we tremendously reduce the effect of fluctuations of the critical packing fraction, and can therefore cleanly study the effect of the proximity of the unjamming point on the rheology. I will present data from simulations utilizing this method, and show that plasticity-induced anisotropy gives rise to dramatic changes in the linear elastic response of these systems close to the unjamming point.

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