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Critical slowing down at jamming transition

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In general (thermal or athermal) particulate systems at high density, the structural rearrangement is hard to realizable due to the exclusion volume effect. Therefore, the structural relaxation time and the viscosity drastically increase. Particularly, zero-temperature systems such as granular materials or emulsions acquire the elastic moduli above a certain density. This rigidity transition, which is also referred to as the jamming transition, is accompanied by some power-law behaviors that are characteristic to critical phenomena, e.g., a growing correlation length in terms of spatially heterogeneous diffusion. Actually, such dynamical heterogeneities are also observed in more genral (thermal) systems such as super-cooled liquids and dense colloids. This suggests the potential relation between the glass and jamming transitions, although still controversial.

Here we investigate a relaxation process of non-Brownian particles in a sheared viscous medium using molecular dynamics simulation; the system is subject to the small shear strain and then undergoes relaxation. We estimate the exponents with which the relaxation time and the correlation length diverge as the density approaches the jamming density from below. The exponent In particular, the dynamic critical exponent is estimated as 4.6□ [1]. It is also found that shear stress undergoes power-law decay at the jamming density, which is reminiscent of critical slowing down.

Interestingly, some expoents exhibit dimensional-independence as opposed to conventional critical phenomena. We discuss the dimensional-(in)dependence from the viewpoint of density of states.

References:

12. T. Hatano, *Phys. Rev. E,* **79**, 050301(R) (2009).