

Re-Entrant Glass Transitions in a Model Colloid and its Relevance to Understanding Molecular Glasses

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We review recent advances in understanding nonergodic, amorphous states in dense colloidal suspensions with or without short-range interparticle attractions. Experiments, theory, and simulation show that two qualitatively different kinds of glassy states exist, dominated respectively by repulsion and attraction [1]. Under suitable conditions, a small change in the interparticle potential can lead to a re-entrant transition between these two kinds of colloidal glasses, which entails sharp changes in properties such as the non-ergodicity parameter and the shear modulus.

Practically, such colloidal glassy states are important in a variety of industrial processes, from the processing of slurries to the manufacture of ceramics. In terms of fundamental physics, colloids provide perhaps the simplest example of amorphous polymorphism in condensed matter. We show that data from the colloidal domain, typically plotted on volume fraction-interaction strength axes, can be mapped onto pressure-temperature axes, and provide insight into a long-standing question in molecular glasses: whether the glass transition is driven by temperature (energy) or pressure (entropy) [2]. It turns out that while energy-driven and entropy-driven glasses clearly exist in colloids, most data in the literature to date for molecular glasses show predominantly temperature-driven behaviour. Nevertheless, simulations of Lennard-Jones systems and a few high-pressure studies show that it may be possible to observe predominantly entropy-driven glass transitions in molecular systems under appropriate conditions.

References

- [1] K. N. Pham et al., *Science* **296**, 104, (2002). For a brief review see W. C. K. Poon, *Materials Research Society Bulletin*, Feb. 2004, p. 96.
- [2] Th. Voigtmann and W. C. K. Poon, in preparation.