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New formulation of the jamming phase diagram of soft and hard spheres

We present a new formulation of the jamming phase diagram for a class of glass-forming fluids consisting of spheres interacting via finite-ranged repulsions. Our phase diagram is universal at low pressure, i.e., observables such as the relaxation time are insensitive to details of the interaction potential and collapse onto the values for hard spheres. Furthermore, for soft spheres we do not observe any reentrant glass transition while such a transition might occur in the classical jamming phase diagram where the packing fraction is considered as a control parameter.

We also show that the dynamics of soft spheres can be described in terms of the dynamics of hard spheres. By introducing an effective hard sphere diameter that is determined from the soft-sphere pair potential via the Andersen-Weeks-Chandler approximation, the relaxation times of soft spheres can be mapped onto the curve known for hard-sphere liquids. These results indicate that the dynamics of soft spheres depend on an effective free volume in a universal way.