MAR16-2015-003458

Abstract for an Invited Paper
for the MAR16 Meeting of
the American Physical Society

Lars Onsager Prize: The mean field solution for Hard Sphere Jamming and a new scenario for the low temperature landscape of glasses.

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In a hard spheres systems particles cannot overlap. Increasing the density we reach a point where most of the particles are blocked and the density cannot be increased any more: this is the jamming point. The jamming point separates the phase, where all the constraint can be satisfied, from an unsatifiable phase, where spheres do have to overlap. A scaling theory of the behavior around the jamming critical point has been formulated and a few critical exponents have been introduced. The exponents are apparently super-universal, as far as they do seem to be independent from the space dimensions. The mean field version of the model (i.e. the infinite dimensions limit) has been solved analytically using broken replica symmetry techniques and the computed critical exponents have been found in a remarkable agreement with three-dimensional and two-dimensional numerical results and experiments. The theory predicts in hard spheres (in glasses) a new transition (the Gardener transition) from the replica symmetric phase to the replica broken phase at high density (at low temperature), in agreement with simulations on hard sphere systems. I will briefly discuss the possible consequences of this new picture on the very low temperature behavior of glasses in the quantum regime.