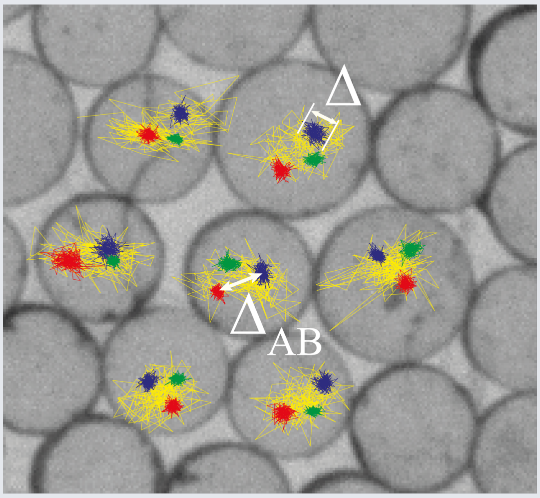
A new transition into the glass phase has been observed

A. Seguin (FAST), F. Ladieu (SPEC), O. Dauchot. (ESPCI-GULLIVER)

Low temperature glasses have all kinds of anomalous properties. Very recent theoretical developments have predicted the existence of a marginal glass phase, the Gardner phase, which would be at the origin of these anomalies.

When a liquid solidifies without any order emerging, it forms a glass. Molecules move more and more slowly until they are trapped in a strange state between liquid and solid. Many disordered structures are possible depending on the glass forming conditions. One might think that once the liquid is trapped in a particular glass, its transport properties result, as in a crystal, from the vibrations of the particles around their average positions, which define a disordered underlying network. But that is not the case. The anomalous thermal or mechanical properties observed in these glasses cannot be explained by this description.

Very recent theoretical work has shown that these anomalies can be understood as the persistence of a new phase transition - Gardner phase transition, which distinguishes between two types of amorphous solids: mechanically stable simple glass and marginally stable glass. Numerical simulations in finite dimension confirmed the existence of this transition and showed that it is associated with a heterogeneous organization of particle vibrations within the cages formed by their neighbours.



Based on this image of cages, we obtained the first experimental confirmation of the existence of the Gardner phase in a granular glass, carried out at the Condensed State Physics Department (SPEC, CNRS/CEA). This glass is recognized as a model glass material. We followed the individual trajectories of the particles that make up the glass at the time of glass formation. Initially, by adiabatic compression, we formed a granular glass in which each particle vibrates in a cage formed by its neighbors. Then we have shown that there is a density above which the cages divide into several "sub-cages" defined by neighbouring particles with which the number of collisions increases. This experimentally observed threshold is a signature of Gardner phase transition, revealed by the fractal interweaving of increasingly smaller cages within this granular glass.

This fundamental result, which is important for understanding and optimizing the properties of glass, should lead to a new reading of the anomalous properties of certain glasses, in the light of the existence of this new glass phase.

A.Seguin & O. Dauchot, *Experimental Evidence of the Gardner Phase in a Granular Glass*, Phys. Rev. Lett. 117, 228001 (2016)

Résultats obtenus dans le cadre du projet D&COY financé par le thème 2 du LabEx PALM et porté par Antoine Seguin (FAST) et Francois Ladieu (SPEC)