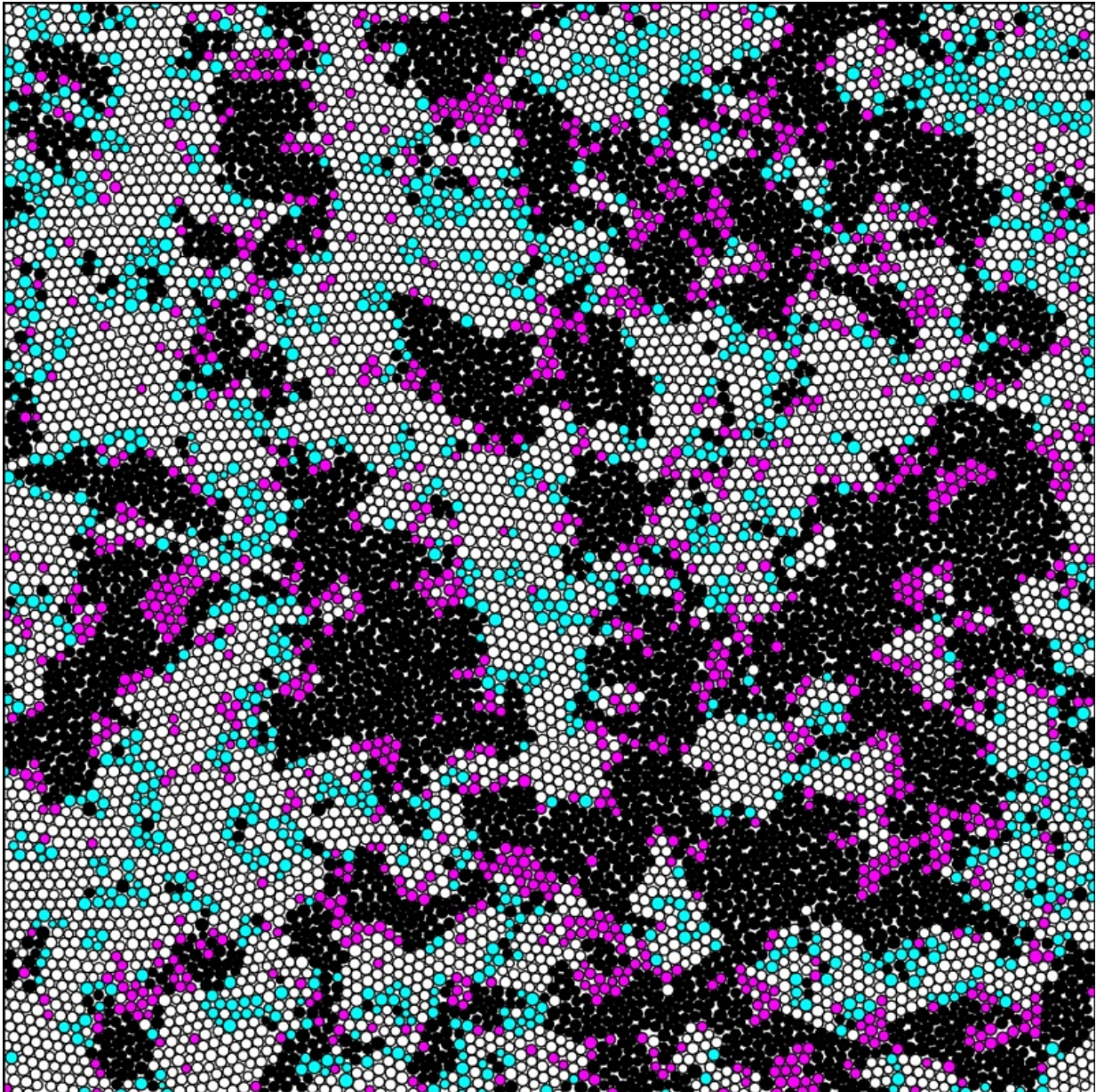


Structural origin of glass transition

June 23 2015



Snapshot of correlation of particle structure and dynamics at density of 0.97.

Disks are colored according to the following criteria: white, low mobility and high order; black, high mobility and low order; cyan, low mobility and low order; and magenta, high mobility and high order. Credit: John Russo, Hajime Tanaka

A University of Tokyo research group has demonstrated through computer simulations that the enhancement of fluctuations in a liquid's structure plays an important role as a liquid becomes a solid near the glass-transition point, a temperature below the melting point. This result increases our understanding of the origin of the glass transition and is expected to shed new light on the structure of liquids, thought until now to have been uniform and random.

Normally, a liquid changes to a solid when its temperature becomes lower than the [melting point](#). However, some materials remain liquid even below the melting point, finally solidifying with further cooling (supercooling) at what is called the [glass-transition](#) point. Despite intensive research over the years, its [physical mechanism](#) has remained elusive. One possibility is that increasing structural order develops in a supercooled liquid upon cooling, increasing the size of that structure and thus slowing down the dynamics and leading to the glass transition.

Because the structure of liquids that undergo a glass transition is disordered, it was difficult to detect fluctuations of such a structure, but a new method has been proposed recently. This method does not depend on the type of liquid structure and has attracted much attention as it may enable extraction of structure size, which is key to understanding slow dynamics, for all liquids.

The research group of Professor Hajime Tanaka and Project Research Associate John Russo at the Institute of Industrial Science, the University of Tokyo, were only able to retrieve the separation distance

of two particles using this method, finding instead that this method fails at extracting the correlation between more than two particles (many-body correlations) which are key for understanding the glass transition. In a liquid composed of disk-shaped particles that do not deform no matter how much force is applied (a hard disc liquid), it is apparent that the dynamics of the liquid are dominated by a hexagonal lattice [structure](#) that is impossible to extract using this method.

"These findings not only support the physical mechanism proposed by this group that slow glassy dynamics is a consequence of the development of structural fluctuations in a supercooled liquid, but also provides a new insight into the [liquid phase](#), which was believed to be uniform and random, and leads to a deeper understanding of the very nature of the supercooled [liquid](#) state," says Professor Tanaka.

More information: John Russo and Hajime Tanaka, "Assessing the role of static lengthscales behind glassy dynamics in polydisperse hard disks", *Proceeding of the National Academy of Sciences*, Online Edition: 2015/5/18, [DOI: 10.1073/pnas.1501911112](https://doi.org/10.1073/pnas.1501911112)

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