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What controls the relaxation time? Lessons learnt from simple liquids' quasiuniversality

JEPPE DYRE, Roskilde University

The relaxation time of a supercooled liquid is extremely temperature and density dependent, approaching hours upon cooling or compression. Is this quantity controlled by the entropy, is it controlled by high-frequency elastic properties as assumed in the shoving and related elastic models, or by another physical property? It is far from certain that there is a simple and generally valid answer to this question for glass-forming liquids with quite different chemistry, but as physicists we like to think that this is the case. The talk summarizes recent results [1] on the quasiuniversality of simple liquids, where a simple liquid is defined as a system with strong virial / potential-energy correlations in the equilibrium NVT fluctuations. Such systems, which include e.g. the Lennard-Jones liquid, have good isomorphs. An isomorph is a curve in the phase diagram along which structure, dynamics, and some thermodynamic properties in reduced units are invariant to a good approximation [2-5]. It was recently conjectured [1] that simple liquids have almost the same isomorphs in the sense that these systems are characterized by a quasiuniversal one-parameter family of reduced-coordinate constant-potential-energy manifolds encoding all isomorph invariants. The entropy is the logarithm of the area of this manifold and the high-frequency elastic properties are basically the surface's curvature. Since the relaxation time is also encoded in the manifold, both quantities will appear to "control" the relaxation time, as will any isomorph invariant.

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