



Kolloquium

Thursday,

12th December
2013

at: 5.00 pm

Hörsaal für
Theoretische
Physik
Linnéstr. 5
04103 Leipzig

*Coffee will be
served from
4.30 pm!*

Prof. Jeppe C. Dyre

The Department of Science, Systems and Models,
Glass and Time, Roskilde University, Denmark

What controls the relaxation time in glass-forming liquids and polymers? New insights from density scaling and the isomorph theory

The relaxation time of a supercooled liquid increases dramatically upon lowering temperature or increasing density; the same applies for the alpha relaxation time of polymeric systems. In extreme cases a 1% temperature decrease leads to more than a factor of ten increase of the relaxation time. The relaxation time is typically probed as the inverse dielectric loss-peak frequency, but there are also other ways of measuring it, for instance via the viscosity that is roughly proportional to the shear stress relaxation time.

One of the most fundamental questions of contemporary condensed-matter physics is what controls the relaxation time. Is it the configurational entropy, the free volume, the potential energy, the instantaneous shear modulus, or ...? It is not obvious a priori that there is a universal theory for relaxation that exists, which applies to all glass-forming systems, but as physicists many of us believe and hope this is the case.

The discovery of density scaling [1] and its subsequent explanation in terms of the isomorph theory [2] throws new light on this question. According to density scaling, which applies e.g. for van der Waals bonded systems but not for hydrogen-bonded systems, the relaxation time is a function of density to some exponent over temperature. The isomorph theory explains this in general terms: Many systems have curves in their thermodynamic phase diagram ("isomorphs") along which many properties are invariant, for instance the excess entropy, C_v , the instantaneous shear modulus, structure and dynamics in reduced units, etc. In particular, the relaxation time is an isomorph invariant. Thus for the large class of liquids with good isomorphs – the "Roskilde-simple" liquids – one cannot say that entropy, instantaneous shear modulus, etc, controls the relaxation time; no causal link is implied even though the relaxation time is a function of all these quantities.

1. C. M. Roland et al., Rep. Prog. Phys. 68, 1405 (2005).
2. T. Ingebrigtsen et al., Phys. Rev. X 2, 011011 (2012).

