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Service de Physique de l'Etat Condensé
SÉMINAIRE

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Orme des Merisiers SPEC Salle Itzykson, Bât.774

Finite shear-elasticity in glass formers and viscous liquids

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On the basis of a Maxwell gas model (1867), it has long been suspected that liquids exhibit a shear elastic effect at sufficiently high solicitation frequencies. Recent experimental improvements carried out at the Lab. Léon Brillouin show that actually it is possible to reveal shear elasticity at low frequency. In other words, liquids exhibit long range solid-like correlations at a macroscopic scale away from any phase transition. This result is coherent with studies emerging from different disciplines as microrheology[1], NMR [2], X-ray photon correlation spectroscopy[3], voltage effects[4] evidencing relaxation modes much slower than those described in conventional theoretical models. The consideration of this non-negligible macroscopic component is of first importance to redefine the relevant parameters for a better understanding of glass and glass former properties and more generally, of the fluid properties.

In these experiments, the shear modulus is measured by applying a mechanical stress to the sample (dynamic relaxation). This mechanical technique is currently the only one able to probe long time scales. The stress transmitted by the sample is measured by simple contact between the sample and the surface submitted to small mechanical oscillatory solicitations. The boundary conditions between the surface and the sample play a major role since the efficiency of the transmission of the motion. The quality of the measurement is completely dependent on the interaction between the surface and the material. Up-to-date progresses in the sensitivity of the instrumentation and in the techniques allow the access to the measurement of the shear modulus with a high precision and over 6 decades of magnitude [5]. These improvements have considerably widened the frequency window and the modulus range. Our developments show that it is also possible to improve significantly the measurement by controlling the boundary conditions between the material and the substrate whereby the stress and the measurement are transmitted[6]. Using this method, we enable the detection of subtle properties that would not been considered before as the identification of a non-zero low frequency shear elasticity in the liquid state. A new (patented) protocol has been established to measure these elastic properties at the sub-millimetre scale in various materials as glass formers (Glycerol, PPG, o-Terphenyl, alkanes) and also polymer melts so far considered as viscous liquids away from any phase transition[7]. These results contrast with the conventional macroscopic description. The solid-like property is

usually not considered since this delicate signal mostly observable at low thickness geometry is hidden in conventional measurements [8].

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