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Inelastic Neutron Scattering Studies of the Dynamics of Glass-Forming Materials in Confinement

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The study of the dynamics of glass-forming liquids in nanoscopic confinement may contribute to the understanding of the glass transition. Especially, the question of a cooperativity length scale may be addressed. In this presentation, results obtained by inelastic neutron scattering are presented. The first experiments were done to study the α relaxation of glass-forming liquids and polymers in nanoporous silica. Neutron scattering is a suitable method to study such composite materials because the scattering of the liquid component can be emphasized by proper choice of isotopes. By combining time-of-flight spectroscopy and backscattering spectroscopy it is possible to cover the large dynamical range spanned by the dynamics of glass-forming materials. The experiments demonstrated a broadening of the spectrum of relaxation times with faster as well as slower components compared to the bulk. In later experiments 'soft' confinement in a microemulsion was used to reduce surface effects. In this system a definite acceleration of the dynamics was observed. In all cases the glass-specific fast vibrational dynamics (boson peak) was also studied, revealing a characteristic confinement dependence which allows conclusions on its nature. Finally, studies were carried out on polymers by neutron spin echo spectroscopy with the aim of observing the confinement effect on polymer specific dynamics (Rouse motion). These studies showed that a comparatively simple model is able to explain the deviation from bulk behavior.