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ESRF	**Experiment title:** Nature of acoustic modes in different phases of ethanol	**Experiment number**: HS1753
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Report:

Anomalies in thermal properties, such as the low temperature specific heat and thermal conductivity, are considered as a fingerprint of glassy behaviour. Related to these phenomena is the excess in the low frequency vibrational density of states, commonly known as the Boson peak. Even though there is no fundamental understanding of the microscopic mechanism behind these anomalies, the common view is that they, in one way or the other, are connected to the nature of acoustic modes at wave lengths comparable to the length scale of the structural disorder in the material [1]. It is thus of great interest to investigate the nature of acoustic modes in disordered systems at mesoscopic length scales.

In order to quantitatively investigate the influence of structural disorder we have studied high frequency acoustic excitation in Ethanol. Ethanol is one of few polymorphic systems where both a well ordered crystal phase and a true topological glass can be obtained studied at the same temperature. In fact ethanol can be obtained in four different solid pahses: an ordered crystal (monoclinic), a rotator-phase crystal, an orientationally disordered BCC crystal and a true topological glass [6,7]. All these phases can be prepared from the liquid by variations of the thermal history and temperature. Of these four pahses the moniclinci crystal, the orientationally disordered crystal and the glass are all stable at temperatures below 97 K.

Using the high resolution inelastic x-ray scattering beamline ID16 we measured full dispersion curves for themonoclinic crystal, orientationally disprdered pahse and the glass using three spectrometer settings (Q=1-15 nm^{-1}). The different phases were prepared in situ the crysostat. Using the diffraction detector at the beamline we could determine that the proper pahse was obtained.

In fig. 1 IXS data is displayed. At low momentum transfers one observes well defined inelastic peaks, whereas at high momentum transfers the inelastic component is broad and the peaks are ill-defined. In order to quantitatively follow the development of the dynamic structure factor as a function of momentum transfer the spectra were fitted with a convolution of the resolution function and a damped harmonic oscillator for the inelastic contribution and a delta function for the elastic scattering. The results from this analysis are displayed in fig1.

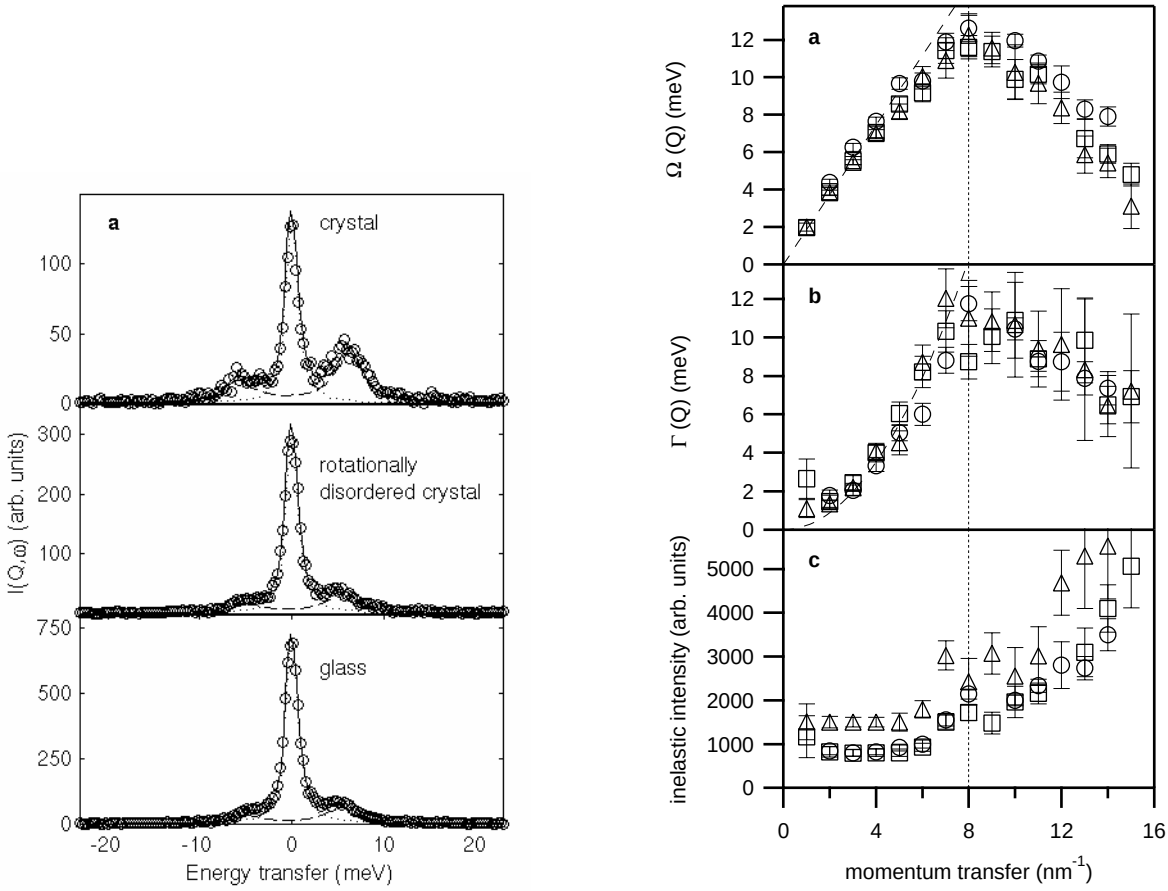

Fig. 1 Left: IXS data for the three phases at Q=3 nm^{-1}. Right: Results from the spectral analysis. Ω and Γ represents the position and linewidth of the excitations [4].

From the reuslts of the analysis it is evident that the dispersion as well as the linewidth for the glass as well as for the two polycrystals and they nature of these excitation must essentially be the same. The structural disorder plays little role apart from an intrinsic averaginng. Thus, the origin of the dyanmical anomalies in the glass cannot be directly related to these excitations [4].

References:

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