# Sub-meV-Resolution IXS to Investigate Viscous Relaxation in Liquids

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Inelastic x-ray scattering (IXS) with ~meV resolution is practiced at five specialized spectrometers world-wide, as it offers unique opportunities to probe to atomic dynamics, providing access to classes of samples and to information that is not available with other methods. However, IXS is limited by the achievable energy resolution, which, in all practical cases, has remained not better than ~1.4 meV, as was achieved 3 decades ago. About 10 years ago, we began a push toward substantially sub-meV resolution at the world's most powerful IXS facility, BL43LXU of the RIKEN SPring-8 Center. We have now achieved resolution as good as 0.35 meV at 29.96 keV in an extreme setup, and 0.61 meV resolution at 25.7 keV in a robust setup. We are using this to investigate viscous relaxations in liquids, which often appear on length and energy scales that are only accessible by IXS, and as have been especially hampered by the previously poorer resolution. To understand our results we have extended a generalized Langevin memory function analysis in new directions, providing a conceptual basis for the evolution of liquid dynamics on the mesoscale. The talk will focus on (1) the motivation and background for the work (2) the instrumentation development needed to achieve these record-breaking resolutions and (3) liquid dynamics on the mesoscale, especially how viscous relaxations appear in the dynamical response.

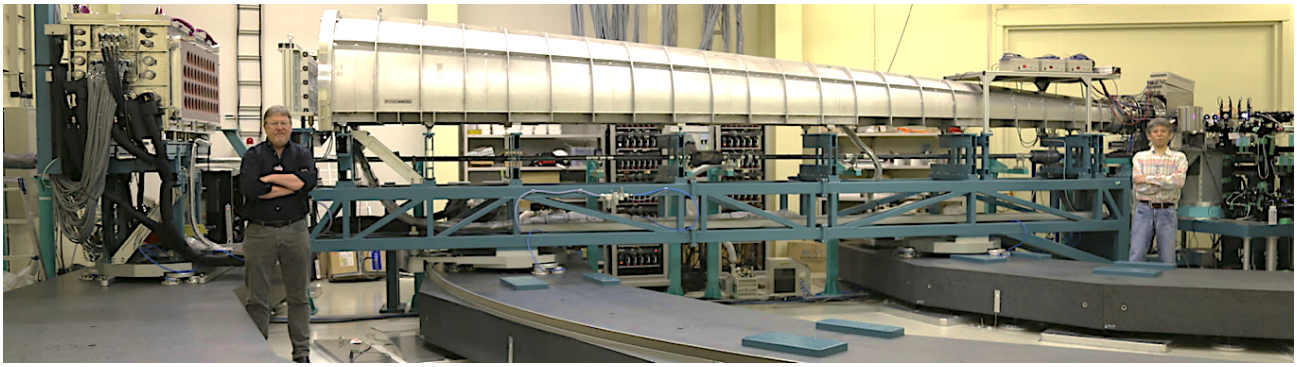

Photo of the 10m two-theta arm of the meV IXS spectrometer at BL43LXU of SPring-8. The x-ray beam is incident from the right and the sample location is at the far right of the photo, while the backscattering analyzer array is in the vacuum chamber at the far left. The arm moves on air pads on the granite base.

Further information about IXS may be found in
https://arxiv.org/abs/1504.01098 (Spectrometers, Phonons in Crystals, diamond anvil cells)
https://arxiv.org/abs/2406.08670 (Disordered Materials)
and the references therein.