NSE spectroscopy: some new frontiers

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Neutron Spin Echo started as a method for high resolution inelastic scattering. In the meantime Larmor precession encoding of particle velocities or velocity components also opened up new opportunities in fine angular resolution elastic neutron scattering studies, in combination of angular and/or velocity scans into multi-dimensional data collection, in spectroscopy with other neutral particles than neutrons, etc. Other talks at this meeting by authors of many important innovations cover much of these subjects. The present talk will focus on opportunities in inelastic neutron spectroscopy by giving a forcibly subjective overview of progress at new frontiers.

The trademark of NSE techniques is to use particle by particle encoding to get around the tight coupling between resolution and intensity via the Liouville theorem. This decoupling made possible to achieve energy resolutions up to 3 orders of magnitude beyond conventional techniques. Even if extreme monochromatization would be technically possible by any of the conventional approaches, without the NSE Liouville trick there would be no intensity left. For example a hypothetical time-of-flight instrument with the resolution of IN15 at ILL would deliver about 1 neutron a minute onto the sample. For this reason, NSE actually provides much higher beam intensities than even synchrotron radiation instruments do at comparable energy resolution, which is there achieved by nuclear resonance methods. Nevertheless, intensity remains the name of the game, and one key frontier is to enhance the capabilities of NSE in this respect by enhanced incoming beam divergence and detector solid angle.

The common Liouville coupling between intensity and resolution is in NSE replaced by a similar relation via the beam area accessible with high magnetic field homogeneity, which ultimately sets the limit to resolution - a few orders of magnitude further down the road though. Techniques to develop higher and more homogeneous precession field systems, either with resistive or with superconducting approaches represent a great challenge, where we will have to pay a lot of attention to practical experimental situations we do not fully understand today. The total length of your abstract is from one to three pages. All accepted abstracts will be used “as submitted” (photo-ready) for the abstract booklet.

A very promising new frontier is the hope that finally we will have enough intensity on dedicated triple-axis NSE instruments to do kind of routine studies of all kinds of excitations with resolution in the μeV domain at substantial energy changes in the meV or tens of meV range. This could have a great impact on what often called hard matter research, after all that tremendous work of our colleagues applying NSE in soft matter. New instruments working with thermal neutrons are particularly promising here, where providing high intensity in full polarization analysis mode of operation is the main technical challenge.