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Wide-angle polarization analysis at ISIS: past, present, and future.

Polarization analysis increases the information that can be gained from neutron scattering experiments by enabling separation of the sample cross section and magnetisation components. This capability has previously been combined with a wide variety of neutron techniques to study phenomena ranging from the magnetisation distribution in magnetic heterostructures to complex magnetic structures in bulk magnets to coherent and incoherent dynamics in liquids. On the other hand, implementing polarization analysis can be both technically challenging and costly, particularly on instruments with broad wavelength bands and/or large solid-angle detectors. In this talk, I will discuss our approach to overcoming these challenges in the context three of three instrumentation projects at ISIS: In 2019, uniaxial polarization analysis was installed on the LET cold neutron time-of-flight spectrometer. To take full advantage of the large detector solid-angle of the instrument, 3He was chosen to analyze the polarization of the scattered beam. The polarized option on LET is now in routine operation, and has been used for quasi-elastic scattering studies of liquids, energy materials, and biological and soft matter.

Historically, the most prominent application of polarized neutrons has been the study of magnetic materials. This includes the separation of weak magnetic components from the remainder of the scattering using the so-called XYZ method. To provide these capabilities at ISIS, we are developing a polarized option for the WISH diffractomer based on a transmission-based super-mirror polarizer and wide-angle analyzer. A prototype for the latter has been built and tested on the Larmor and IMAT instruments. Looking further into the future, we aim to capitalise on the potential demonstrated by early experiments on LET by building a high-resolution and high-count-rate polarized indirect spectrometer called SHERPA. Like WISH, this will use supermirror devices for both polarization and analysis. SHERPA will provide a greater than order-of-magnitude performance increase versus LET at high resolution, and promises to extend the polarized quasi-elastic scattering to a much wider range of materials, including battery materials, catalysts, and biological systems.

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