Neutron spin control on the road to real-space neutron imaging

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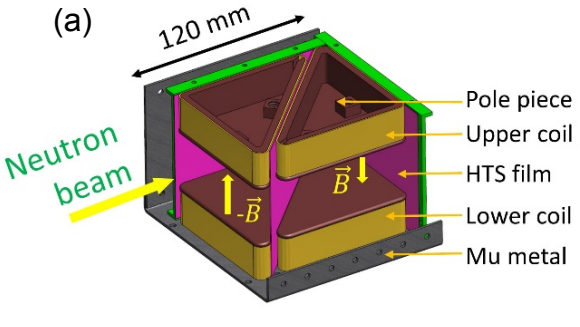
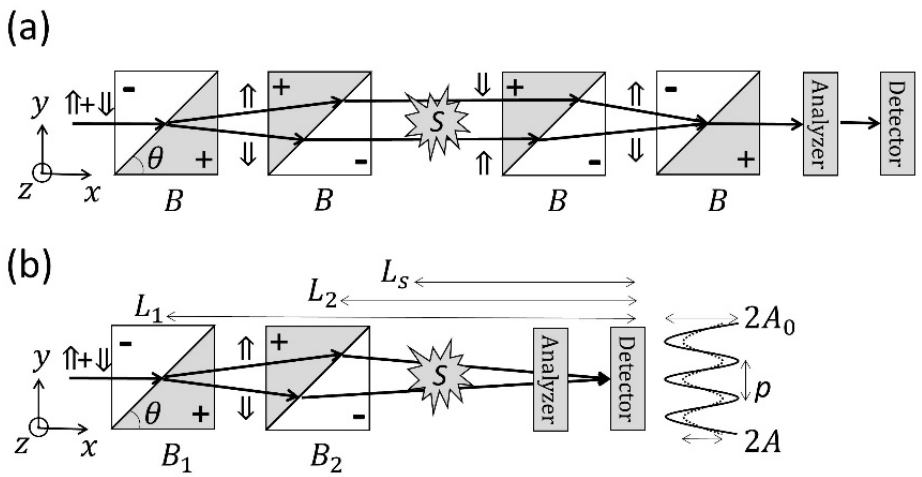
By tapping into MagLab expertise in high temperature superconducting (HTS) tapes and films, as well as magnet cryogenics, *researchers have constructed a highly efficient magnetic Wollaston Prism (WP) device for neutron spin encoding that overcomes some of the limitations arising from the low flux and lack of coherence of neutron beams*.

A single WP is comprised of two neighboring triangular regions of uniform magnetic field that share a 45˚-inclined interface at which the magnetic field direction reverses abruptly (see figure), thereby splitting the direction of the neutron beam according to the spin orientation of the neutrons. Four triangular coils are wound individually, each containing a soft iron pole piece wound with HTS tape. A pair of triangular coils with opposite polarity are partnered and then surrounded by another four layers of HTS film that ensure field uniformity. Two of these assemblies make a single WP, with the assemblies separated by a gap of 35 mm through which the neutron beam passes.

This device complements and in some ways surpasses the capabilities of small angle neutron scattering (SANS). This is because it can be used to implement spin-echo small-angle neutron scattering (SESANS) or spin-echo modulated small angle neutron scattering (SEMSANS) to measure the density autocorrelation functions in real space (not reciprocal space) of materials of interest in chemistry, biology and engineering over a remarkably broad length scale ranging from 10 nanometers to 10 microns, well beyond what SANS achieves.



(a) 3-D drawing of a magnetic Wollaston prism with the front and side HTS films removed. (b) A HTS coil wound on the pole pieces.



Schematic of the (a) SESANS and (b) SEMSANS setups using magnetic WPs, with the average wave vectors of the two neutron spin states denoted by arrows. The sample under study is labelled as *S*.

Facilities: Magnet Science and Technology Division

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