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Polarized 3He for neutron scattering applications

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3He has a strong spin-dependent neutron absorption cross section and polarized 3He gas by optical pumping can be employed to effectively polarize and spin-analyze large area, widely divergent, and broadband neutron beams. The adiabatic fast passage (AFP) nuclear magnetic resonance (NMR) technique allows to invert the 3He nuclear polarization, hence the neutron polarization. These unique features of a 3He neutron spin filter (NSF) together with the recent advancements in the 3He NSF technique have made many new polarized neutron measurement capabilities possible, including thermal triple axis spectrometry, small-angle neutron scattering, wide-angle polarization analysis, and diffuse reflectometry. I will present an overview of the recent development of the 3He NSF technique at the NIST Center for Neutron Research. I will discuss a substantial effort towards improving the 3He polarization close to the theoretical limit (~95%) set by the anisotropic spin exchange optical pumping (SEOP). I will show how one can achieve a nearly lossless 3He polarization inversion to address the need of inverting the polarization in an order of minutes. I will present a recent development of a large fully-reblown "horseshoe"-shaped SEOP cell necessary for a neutron spin analyzer of a wide-angle polarization analysis capability with a simultaneous scattering angle coverage of 240 degrees. I will discuss the development of compact magnetostatic cavity devices that provide a homogeneous magnetic field to maintain the 3He polarization with field gradients on the order of 10-4 cm-1 for a cell volume of 1000 cm3. The polarized neutron measurement capabilities developed have played an important role to uncover the nature of magnetism in complex materials in condensed matter physics and materials science. Examples of such scientific applications will be presented.

Summary

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