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Development of Polarized 3He at CSNS

The development of polarized neutron technology is pivotal for advancing studies in material science and fundamental physics, particularly in probing magnetic structures and symmetry violations. At the China Spallation Neutron Source (CSNS), significant progress has been made in the design and implementation of polarized 3He neutron spin filters (NSFs) based on spin-exchange optical pumping (SEOP) [1-5]. An off-situ system demonstrated exceptional performance with 77.4% 3He polarization and a polarization lifetime exceeding 200 hours, making it highly suitable for long-duration experiments [2]. The in-situ NSFs also achieve significant progress, building on the first-generation (70 cm × 70 cm × 60 cm, 74.4% ^{3}He polarization) [3], a compact in-situ system (55 cm × 56 cm × 48 cm) was developed [4], integrating a uniform magnetic field (<1.74×10^{-4}/cm), dual-laser optical pumping, and precise thermal control (±0.15℃) with low-noise NMR monitoring. Validated on the BL-20 beamline, this system achieved 75.66%±0.09% 3He polarization and 96.30% neutron polarization at 2 Å. These advancements have enabled versatile deployment across multiple CSNS beamlines. For instance, the Back-n white neutron source utilizes the in-situ NSF for time-reversal violation studies [5], while a specially designed in-situ NSF for the Very Small Angle Neutron Scattering (VSANS) instrument successfully implemented China's first polarization-analyzed small-angle neutron scattering (PASANS) technique [6].

As an underdevelopment polarized neutron facility, our group poised to enhance system stability and expand the applications in complex magnetic materials with polarized neutron, such as investigations of magnetic skyrmions and beyond-Standard Model physics. Future efforts will focus on optimizing performance for advanced experiments in nuclear weak interactions and exotic symmetry-breaking phenomena.

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