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8.11 Dynamically polarized proton filter for a low energy neutron polarizer

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Polarized thermal neutrons have been used for the study of parity-violating effects in nuclei for many years. Recently, the studies using polarized low energy neutrons in the region of eV were performed[1),2)]. However, decisive conclusion has not yet been obtained about the fundamental parity-violating effect and further studies are required. In addition to these studies, an ambitious experiment about a time reversal test in nuclei using the low energy neutrons was proposed[3)]. For these experiments intense polarized low energy neutron beam is necessary. A polarized proton filter is a suitable polarizer for this purpose. The reason is that it does not impose great restrictions on the angular divergence and the neutron energy selection and has large polarizability in the region of eV, which cannot be expected for usual polarizers using the magnetic Bragg scattering and the magnetic mirror.

In the present experiment, highly polarized low energy neutron beam was produced using the dynamically polarized protons of ethylene glycol containing Cr(v) complex[4)]. As primary neutrons the spallation neutron source at KEK was used, because the neutron intensity is high in the region of eV compared with the reactor. The arrangement of the present experiment is shown in Fig. 1. The protons were polarized to P_p = 67 % by the dynamic polarization method. The neutrons were polarized by passing through a filter of the polarized protons. The neutron polarization was determined by the ratio of the transmission at P_p = 67 % to the one at P_p = 0 % using the neutron scattering cross sections of polarized proton by Lushchikov et al.[5)]. The polarization at a target position for neutron scattering experiments was also measured using the FeCo magnetic Bragg scattering. The results of the neutron polarizations are shown in Fig. 2. The differences between these two kinds of polarizations are due to the depolarization after the passage through the filter.

The present neutron polarizations at the filter determined by the transmission measurements are better than the values by the LMN filter of Lushchikov et al.[5)]. Typical polarizations at 1 eV are 80 % and 65 % for the present and the LMN filters, respectively. In the comparison between the two filters, we should mention about the quality factor which is defined as (neutron polarization)^2 x (neutron transmission). The polarization and the intensity of the transmitted neutrons are both depend on the proton polarization and the filter thickness. The present proton polarization is comparable with the value of the LMN filter. At the same proton polarization the number density of protons is essential in order to obtain higher quality factor in the region of eV, because neutrons are also scattered by other nuclei and the effect to the beam intensity is not negligible. The quality factor of the LMN filter of optimum thickness is about 0.07 at P_p = 65 % by Lushchkov et al.[5)] in the region of eV. The value of the present filter was calculated to be 0.11. Thus the present filter was found to be one of the best polarizers for the low energy neutrons in the region of eV.

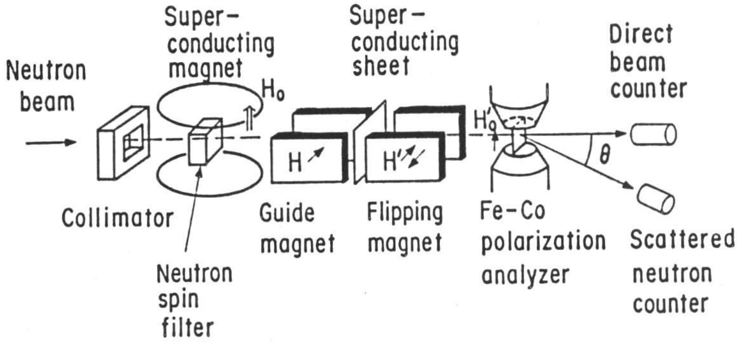

Fig. 1. Experimental arrangement for the determination of the neutron polarization. Neutron spin was held and reversed in a neutron spin flipper after the passage through the filter for the determination of the polarization by the Fe_8Co_{92} magnetic Bragg scattering. For the determination at the filter the neutron transmission was measured by a monitor counter set upstream and a direct beam counter set downstream.

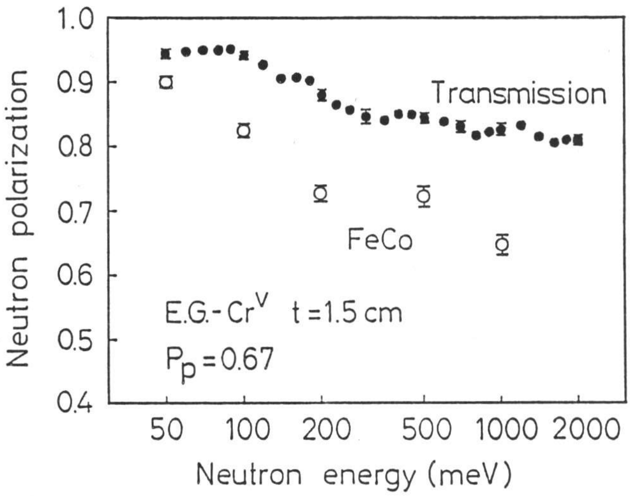

Fig. 2. The neutron polarizations. Closed and open circles are the values determined by the transmission and the magnetic Bragg scattering, respectively.

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