Neutron Polarization by Polarized Proton Filter

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1. Introduction

A white beam of cold, thermal and epithermal neutrons transmitted through a polarized proton filter becomes highly polarized, because the cross section for neutron-proton scattering in the singlet state is much larger than that for the triplet state within the energy range 10^{-3}eV - 10^{5}eV.

The use of a polarized proton filter therefore makes it possible to obtain a polarized neutron beam of higher intensity and covering a wider energy range than that available by other techniques.

2. Thermal Neutron

The performance of a polarized proton filter as a slow neutron polarizer was tested using apparatus installed at the JRR-2 reactor. The experimental procedure and the polarization of thermal neutron beams (80 meV) by the filter are discribed in reference 1). Fig.1 shows a schematic view of the experimental arrangement. Fig.2 displays a diagram of the He^3 cryostat. The protons in a sample of ethylene glycol containing a few percent of Cr^V complexes were dynamically polarized in a He^3 cryostat in magnetic field of 25KG. The polarization of neutrons transmitted through the filter as a function of the proton polarization is depicted in Fig.3. The solid line indicates the neutron polarization calculated according to

$$P_n = \tanh P_p n \sigma_p t$$

where P_n and P_p are newtron and proton polarizations, n is the number of protons per cm^3 in the filter and t is the filter thickness. A value for the polarization cross-section of σ_p = 27b was determined from this curve.

Fig. 1

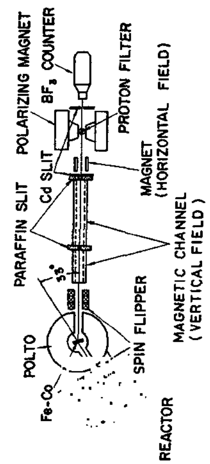
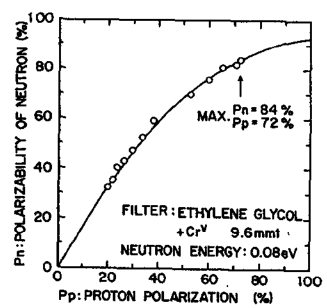


Fig. 3



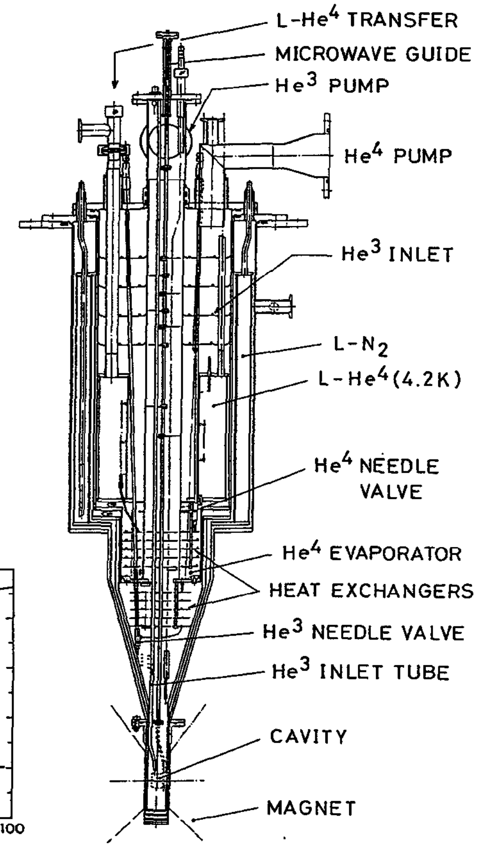


Fig. 2

3. Application to Epithermal Neutron and Scattering of Coaxial n-p Spins Along the Beam

Fig.4 shows the calculated polarizations of neutron beams transmitted through a filter composed of an organic material with 80 % transversely polarized proton and with thicknesses of 10 mm and 20 mm. For the polarization cross section we used the value determined in our experiment for an energy of 80 meV and calculated values from the expression given by Lushchikov et al. 2). The method will open a way for the polarization of intense neutron beams covering wide energy range without serious restrictions on the angular divergence.

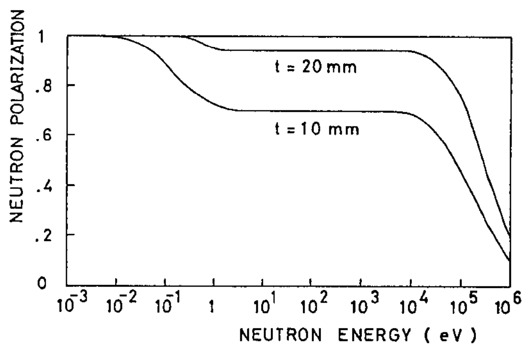
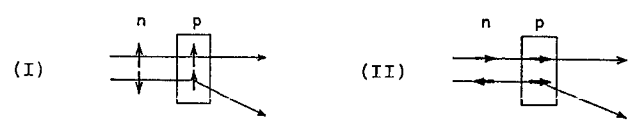


Fig.4 Calculated neutron polarizations (proton filter is an organic material with 80 % polarization)

The polarization cross sections for n-p scattering in which the spins are parallel transverse to the beam and parallel coaxial (II) with the beam direction were estimated by N. Hoshizaki 3).



The calculated value of the polarization cross section in case (II) is almost the same as in case (I). We are going to confirm this fact in our next experiments at KENS. For this experiment the apparatus will consist of a holizontal He^3 cryostat and a superconducting solenoid magnet of 25 KG. (Fig.5)

Recently, stable Cr^V-complexes were developed for use as the paramagnetic species in dynamic polarization experiments 4) 5). Proton polarizations of 70 - 80 % have been obtained using such samples at 0.5 K and 25 KG. For our project, we will use such complexes in the polarized proton filter.

Fig.6 shows a proposed schematic plan view of the project of polarized epithermal neutron beam (PEN) at KENS. These partrs are in preparation and the experiment will be started at the beginning of 1982.

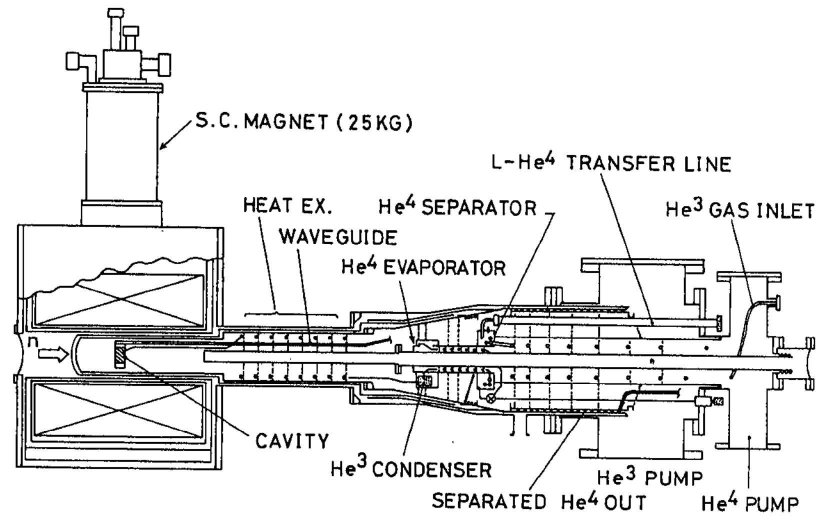


Fig.5 Side view of a He^3 cryostat and a superconducting magnet

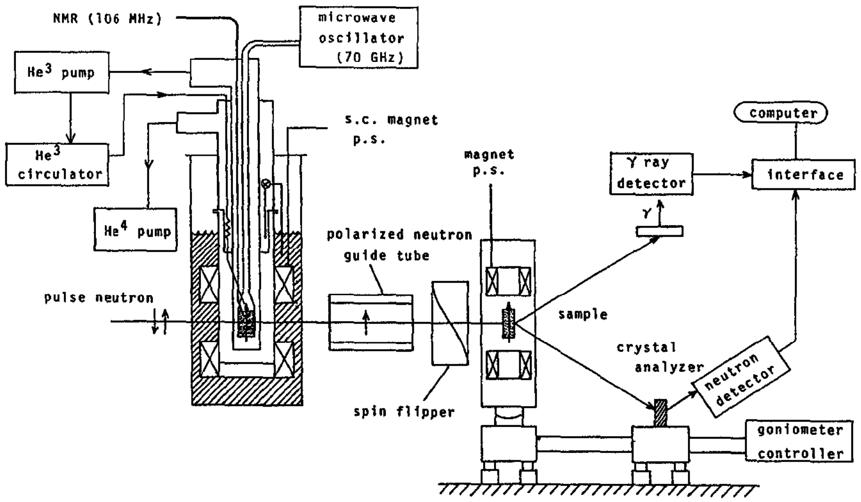


Fig.6 Schematic plan view of the PEN

References

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2) V. I. Lushchikov, Yu. V. Taran and F. L. Shapilo, Yad. Fiz. 10 (1969) 1178. [Sov. J. Nucl. Phys. 10 (1970) 669]

3) N. Hoshizaki; private communications

4) D. Hill, R. Miller, M. Krumpolc and J. Rocek, Nucl. Instr. and Meth. 150 (1978) 331.

5) S. Hiramatsu, S. Isagawa, S. Ishimoto, A. Masaike, and K. Morimoto, Nucl. Instr. and Meth. 160 (1979) 193.