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The Measurement of K_{NN}, K_{LL} in $\vec{p}d\rightarrow\vec{n}X$ and $\vec{p}^{9}Be\rightarrow\vec{n}X$ at 800 MeV*

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ABSTRACT

The spin transfer parameters, K_{NN} and K_{LL} have been measured in $\vec{p}d\rightarrow\vec{n}X$ and $\vec{p}^{9}Be\rightarrow\vec{n}X$ at 0° and 800 MeV. The rather large values of K_{LL} demonstrate that this transfer mechanism will provide a useful source of polarized neutrons at LAMPF energies.

DISCUSSION

Measurements of polarization transfer coefficients in (p,n) reactions are of interest to determine whether these mechanisms can be used for the production of a polarized neutron beam at medium energies; the coefficients can also provide information relative to n-p scattering phase shifts and to pion exchange models. Using the LAMPF polarized proton beam incident on liquid deuterium and beryllium targets, we have carried out measurements of the polarization transfers K_{NN} and K_{LL} at 0°. The proton beam was polarized vertically for the K_{NN} measurements, and almost longitudinally for the K_{LL} work. A small horizontal component existed for the latter. In both cases the proton beam, after passing through the LD_2 or ^{9}Be target, was collected through 60° and transported to a shielded beam dump. The 0° neutrons traversed a ~3.7 m (12 ft.) steel collimator which terminated with a ~5 cm (2 in.) diameter apperture. The neutron flux was cleared of charged particles with a sweep magnet. In the K_{LL} measurement the sweep magnet was also used to compensate for the precession caused by the proton beam line bending magnet which the neutrons traversed.

The neutron polarization was deduced with an analyzer consisting of a ~40 cm long liquid hydrogen radiator and a multiwire proportional chamber spectrometer. For the K_{LL} measurements the polarization of the neutrons incident on the LD_2 was oriented vertically by means of a 90° spin precession magnet. Values of recently measured analyzing powers in the charge exchange scattering, $np\rightarrow pn$, were used.[1] Since the

neutrons in the present experiment were polarized and the protons in the LH_2 radiator were not, charge symmetry invariance, $A(\vec{n}p) = A(\vec{p}n)$, was invoked.

The proton beam polarization was measured with beam line polarimeters, and was typically about 70%.[2] Spin reversal was accomplished by reversing the spin of the incident polarized proton beam at the accelerator ion source every three minutes.

The major sources of background were the inelastic reactions in the LH_2 radiator leading to a proton in the final state, which made polarization transfer measurements difficult for lower energy (pion associated) neutrons. This background problem was handled using an analysis technique developed by Glass.[3]

The results for the K_{NN} and K_{LL} $\vec{p}d \rightarrow \vec{n}X$ measurements are shown in Figs. 1 and 2 respectively. The sign convention is such that a negative value of K_{LL} implies that the spin of the outgoing neutron is antiparallel to that of the incident proton. The polarization transfer values for the high momentum quasi-elastic peak of the neutron spectrum are given in Table 1, together with predicted values based on Arndt's phase shift calculations for free (n,p) 180° scattering.[4]

Bugg[5] has made predictions at 210, 325, 425, and 510 MeV for both free (n,p) scattering at 180° and also for CEX scattering from deuterium, and his results, extrapolated to 800 MeV, are also shown. There is overall rather good agreement between our results and the values predicted for free and quasi-free CEX (n,p) scattering.

From a practical consideration, the rather large values of K_{LL} demonstrate that the transfer mechanism will provide a useful source of polarized neutrons at LAMPF energies.

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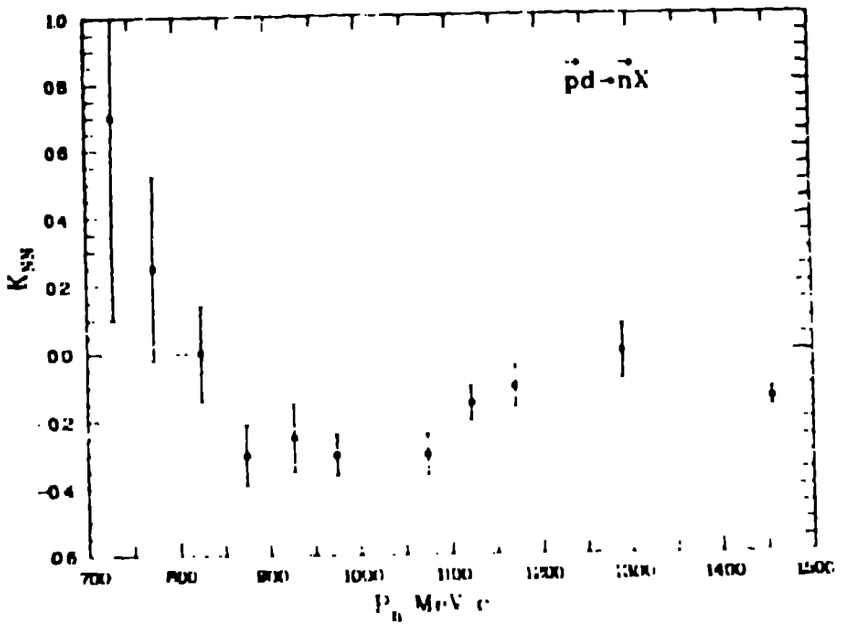

Fig. 1. E_{SS} for pd→n3 at 0° and 800 MeV.

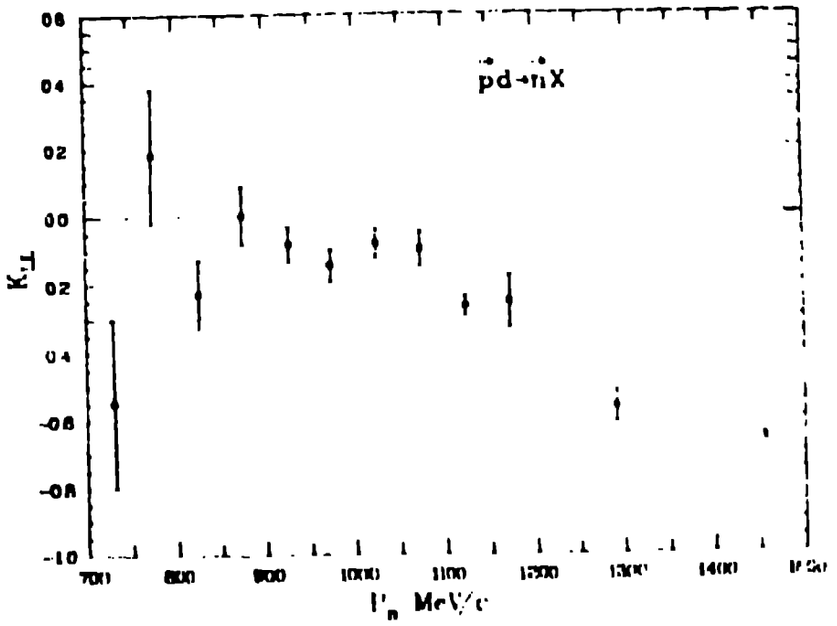

Fig. 2. E_{LL} for pd→nX at 0° and 800 MeV. A negative value of E_{LL} implies that the spin of the outgoing neutron is antiparallel to that of the incident proton.