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Energy Dependence of the Polarization Transfer Coefficient in $T(\vec{d},\vec{n})^4He$ Reaction

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For fast neutron experiments at tandem accelerators, the $T(\vec{d},\vec{n})$ reaction initiated with vector polarized deuterons is particularly interesting as a source of monoenergetic neutrons with large polarization. To perform high precision experiments, it is necessary to know the polarization transfer parameters of this reaction accurately. We report on new measurements of the vector polarization transfer coefficient, $K_y^{y'}(0°)$, for incident deuteron energies between 5 and 11 MeV.

The neutron polarization, $p_y^{(n)}(0°)$, for the $T(\vec{d},\vec{n})$ reaction is given by

$$p_y^{(n)}(0°) = \frac{3}{2} \cdot p_y^{(d)} \cdot K_y^{y'}(0°) / (1+\frac{1}{2} \cdot p_{yy}^{(d)} \cdot A_{yy}(0°)).$$

The deuteron beam typically had an intensity of 0.25 μA and a vector polarization $p_y^{(d)} = 0.61$. The sign of the polarization was reversed every 0.25 sec at the ion source. An effort was made to keep the tensor moments of the beam small ($p_{yy}^{(d)} < 0.05$) in order to minimize the influence of the tensor analyzing power.

The polarization of the neutrons emitted at 0° from a tritium gas cell was analyzed by elastic scattering from ^4He. A 100 atm. He gas cell [1] was used as a scatterer and four liquid scintillator (NE213) side detectors were symmetrically placed about the deuteron beam axis at lab angles of 75° and 115° where the $^4He(\vec{n},n)^4He$ analyzing power has an extreme value.

Each coincidence event between the He target and one side detector consisted of four signals: the energy of the recoil alpha particle in the He cell, the recoil proton energy and neutron-gamma pulse shape discrimination signal in the side detector, and the time-of-flight of the scattered neutron. A typical recoil alpha particle spectrum, where each event represents a neutron detected in the side detector and satisfies the correct time-of-flight, is shown in fig. 1.

Corrections in the data analysis included the finite geometry effects, in particular the angular and energy dependence of the $^4He(\vec{n},n)^4He$ analyzing power [2]. The background of accidental coincidences, which amounted to less than 1% of the total number of counts, was subtracted from the peak in the recoil alpha particle spectra.

The present data and those of ref. 3 are shown in fig. 2. The error bars do not include the uncertainties in the deuteron beam polarization (≈1%) and the n-He analyzing powers [3]. It is worth noting the larger values of $K_y^{y'}(0°)$ from this experiment at deuteron energies above 8 MeV.

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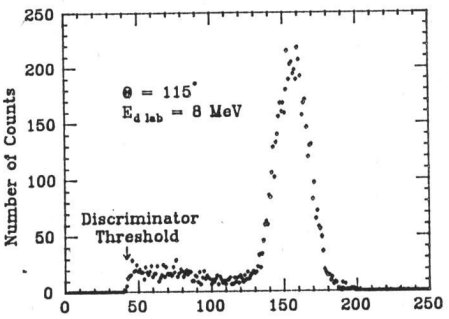

Fig.1.

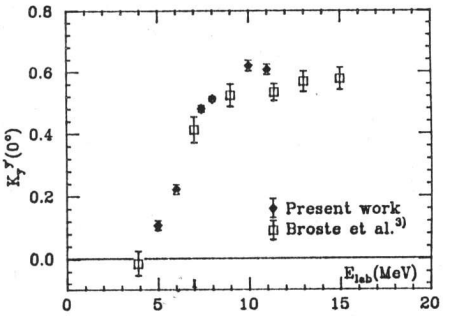

Fig.2.

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