Measurement of the polarization transfer coefficients of the $\vec{p}d$ elastic scattering at 250 MeV

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Recently, large progress has been made in the study of the three-nucleon (3N) system both experimentally and theoretically. The set of data is being significantly enriched for cross sections and spin observables of the elastic nucleon-deuteron scattering and the break-up process at proton energies lower than 200 MeV [1, 2, 3, 4]. For the differential cross section of nucleon-deuteron elastic scattering at lower energies (E $\leq$ 150 MeV) theoretical calculations including Tucson-Melbourne (TM) [5] three nucleon force (3NF) removes the discrepancies at minima between experimental data and predictions. However at higher energies (E $\simeq$ 200 MeV) there remained some discrepancies. For analyzing powers of $\vec{p}d$ elastic scattering, there are larger discrepancies at higher energies [6]. These facts suggest that there may be something unknown in the spin structure of 3NF. Relativistic effects can be expected as well as the deficiencies in the spin structure of 3NF.

At RCNP, we measured the angular distributions of the polarization transfer coefficients $K_i^{j'}$ for the $\vec{p}d$ elastic scattering at 250 MeV. Precise measurements of the spin observables give an opportunity to clarify the spin dependence of 3NF. We can provide beams whose polarization axes are either in S (sideways), N (normal), or L (longitudinal) direction by using two sets of superconducting solenoid magnets in the injection line from the AVF to the ring cyclotrons. Scattered protons were detected by the Grand Raiden (GR) spectrometer and their polarizations were measured by a Focal Plane Polarimeter (FPP). The Large Acceptance Spectrometer detected recoil deuteron in the kinemtical coincidence mode. The polarization transfer coefficients $K_i^{j'}$ are defined by the following relation.

$$I\begin{pmatrix}1\\ p'_{x'}\\ p'_{y'}\\ p'_{z'}\end{pmatrix} = I_0\begin{pmatrix}1 & 0 & A_y & 0\\ 0 & K_x^{x'} & 0 & K_z^{x'}\\ P_{y'} & 0 & K_y^{y'} & 0\\ 0 & K_x^{z'} & 0 & K_z^{z'}\end{pmatrix}\begin{pmatrix}1\\ p_x\\ p_y\\ p_z\end{pmatrix}$$

Figure 1 shows the angular distributions of the polarization transfer coefficients $K_x^{x'}$, $K_z^{x'}$, $K_x^{z'}$, and $K_z^{z'}$ of the $\vec{p}d$ elastic scattering. Experimental data are compared with results of Faddeev calculations by H. Kamada [7] using charge dependent Bonn potential with and without TM 3NF. For $K_x^{z'}$ and $K_z^{x'}$, we can see the large difference between with and without TM 3NF around 90° degree. Predictions without TM 3NF generally reproduce experimental data. There remain discrepancies between experimental data and predictions with and without 3NF at forward angles. For $K_x^{z'}$ and $K_z^{x'}$, the predictions explain experimental data well at forward angles. However there remain substantial discrepancies between them. These discrepancies suggest that more investigations are required on the spin dependence of the 3NF.

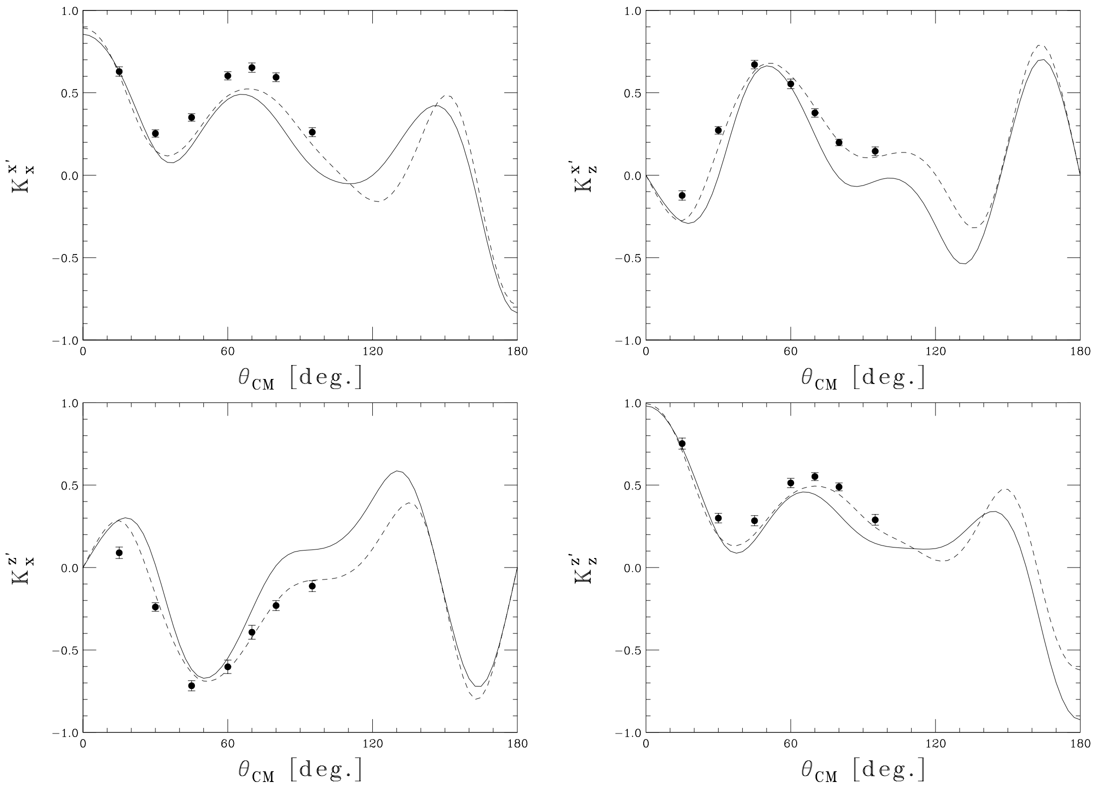

Figure 1: The polarization transfer coefficients $K_x^{x'}, K_z^{x'}, K_x^{z'}$, and $K_z^{z'}$ in $\vec{p}d$ elastic scattering at $E_p = 250$ MeV. The solid and dashed lines are the CD-Bonn + TM 3NF and CD-Bonn only, respectively.

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