Three-body effect in $\vec{p}d$ 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 in elastic nucleon-deuteron scattering and in the breakup process at proton energies lower than 200 MeV [1, 2, 3, 4]. Theoretical formulation of 3N scattering based on modern nucleon-nucleon(NN) forces has matured in recent years, and computationally accurate solutions of the 3N Faddeev equation can be achieved [5]. The NN system is very intensively investigated and the increased data set provides a sound foundation for reliable modern phase-shift analysis. For elastic *pd* scattering, the data are scarce at energies higher than 200 MeV and not at all comparable with that for NN.

At RCNP, we have measured angular distributions of cross sections, analyzing power and polarization transfer coefficient $K_y^{y'}$ for $\vec{p}d$ scattering at 250 MeV. Precise measurements of the spin observables give an opportunity to consider further the spin dependence of the 3N models. For this purpose, the beam line polarimeter was calibrated to a level close to 1 %. For the elastic scattering of spin $\frac{1}{2}$ particles off spin 0 targets, there are relations among spin observables,

$$A_y = P_y = P_{y'}, \quad K_y^{y'} = 1, \quad R \equiv K_x^{x'} = K_z^{z'}, \quad A \equiv K_z^{x'} = -K_x^{z'}$$

$$A_y^2 + R^2 + A^2 = 1.$$

From the last relation, a search for the $A_y = 1$ point via R, A measurements has the character of a null experiment so that an accurate knowledge of the absolute beam polarization, for instance, is not needed. A calibration was performed by the elastic scattering off ^{58}Ni at 250 MeV and $\theta_{lab} = 18.75°$ where the analyzing power has a value close to 1. The measured values are

$$A = -0.145(\pm 0.02), \quad \text{and} \quad R = 0.071(\pm 0.02).$$

Uncertainties are statistical only. From these results, the analyzing power of ^{58}Ni(p,p$_0$) at 250 MeV and θ=18.75° reads

$$A_y = 0.987(\pm 0.004).$$

The beamline polarimeter was finally calibrated to

$$A_y = 0.362(\pm 0.003)$$

for ^{1}H(p,p)^{1}H scattering at $\theta_{lab.}$=17°. Target is a polyethylene (CH_2) foil and elastically scattered two protons are detected in a kinematical coincidence mode.

Figures 1 and 2 show the angular distributions of the cross section and analyzing power of $\vec{p}d$ elastic scattering, respectively. They are preliminary. Experimental data are compared with results of Faddeev calculations by H. Kamada [6] using charge dependent Bonn potential with and without 3N force(3NF) in the form of Tuscon-Melbourne model [7]. Predictions with 3NF improve the fits to the cross section, but there remain some discrepancies at larger scattering angles. For the analyzing power, calculations with 3NF reproduce the experimental data quite well at angles smaller than 100°, but large discrepancies are observed at larger angles. This tendency looks consistent with results reported by E. Stephenson *et al.* [3]

In order to extend the data base and to investigate the spin dependence of 3NFs, all the polarization transfer coefficients will be measured near future.

We wish to thank Dr. H. Kamada for the results of his calculations which he made available to us along with very useful comments.

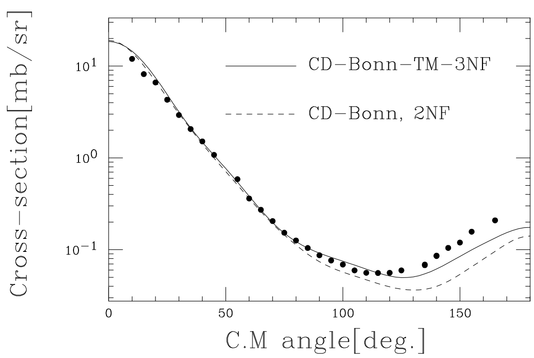

Figure 1: Preliminary results of the cross section of *pd* elastic scattering at 250 MeV. The dashed curve shows a theoretical prediction of Faddeev calculation with NN forces only, CD-Bonn. The solid curve shows results with 3NF in the form of Tuscon-Melbourne model.

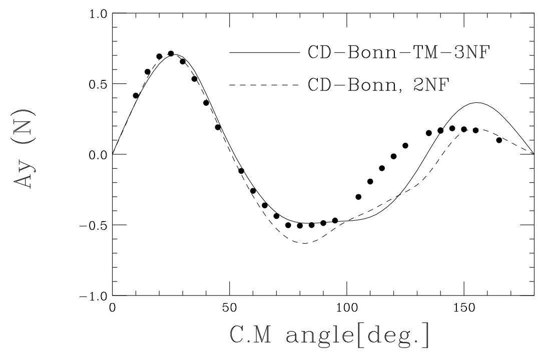

Figure 2: Analyzing power A_y of $\vec{p}d$ elastic scattering at 250 MeV. For notations, see Fig. 1.

References

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