Measurement of the $\vec{n}+d$ scattering at 250MeV and the three-nucleon force effects

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One of the interesting problems for the few-nucleon system is the study of three-nucleon force (3NF) properties in the three-nucleon continuum. To study the 3NF effects in a Coulomb-free system, we have performed an $\vec{n}+d$ elastic measurement at $E_n = 250$ MeV firstly for $\theta_{cm} = 85^\circ - 180^\circ$ by employing the (n,p) facility [1] at RCNP[2]. Secondly we have carried out the measurements at $\theta_{cm} = 10^\circ$, 20°, 30°, 40° and 60° by detecting the scattered neutrons by NPOLII at RCNP[3].

For the next step, we performed the measurements of the differential cross sections and the vector analyzing powers for the $n+d$ elastic scattering for $\theta_{cm} = 60^\circ - 90^\circ$ at 250 MeV. The experimet was carried out at the (n,p) facility. The neutron beam was produced by the ^{7}Li$(\vec{p},\vec{n})^7$Be$^*(0^\circ)$ reaction at $E_p = 250$ MeV. We used two sheets of CD_2 targets [4] as the deuteron targets which were placed in the target chamber. Recoiled deuterons were momentum analyzed by LAS and were detected at the focal plane.

The results of the differential cross sections and vector analyzing powers are shown in figure 1 by solid circles and squares. Dark (light) shaded bands represent the results of Faddeev calculations with (without) the Tucson-Melbourne 3NF[5]. Solid and dotted lines represent the calculations with AV18+UrbanaIX-3NF and CD-BONN+TM′-3NF respectively. Concerning about the differential cross sections, it can be seen that the calculations including 3NF better reproduce the data but still underestimate largely at backward region. These discrepancies may be an indication of the relativistic effects[6] which are not taken into account in the present calculations. We have also carried out the $\vec{p}+d$ measurements at 250MeV [7] and these results are shown by open circles. This allows us to compare the $n+d$ and $p+d$ data. In figure 2, the ratio of the cross sections are plotted with open circles. The solid line represents the theoretical prediction at 250 MeV [8] which is based the CDBonn. In the calculation of the $p+d$ elastic scattering, the Coulomb force is included in an approximate way [9]. Although the amplitudes of the discrepancies from the value of 1 are much larger for the data than for the prediction, the angles where the data cross the value of unity around θ_{cm}= 110° are well reproduced by the theoretical prediction.

The data of the vector analyzing powers contain large statistical errors but these are consistent with the $\vec{p}+d$ data within the systematic error of the $\vec{n}+d$ data.

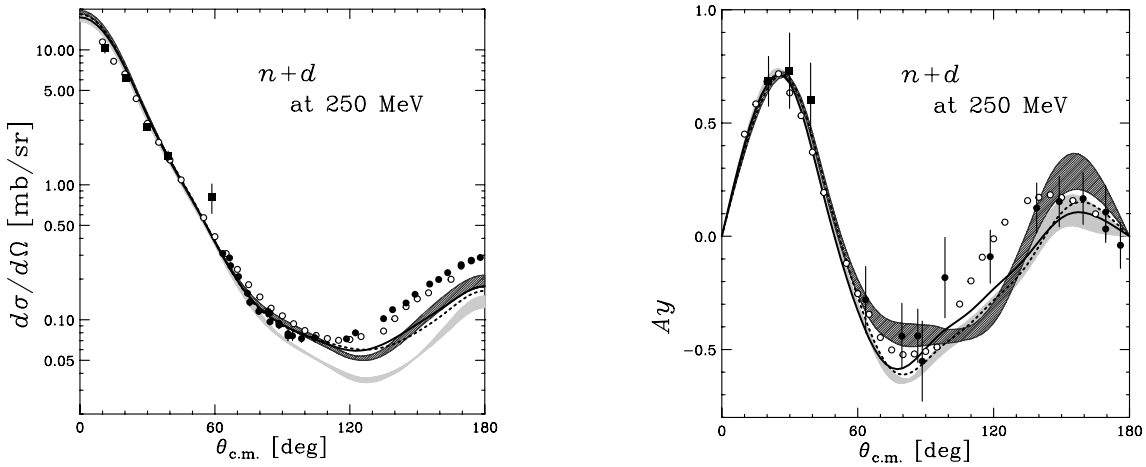

Figure 1: Differential cross sections and vector analyzing powers for the $\vec{n}+d$ elastic scattering at $E_n = 250$ MeV. The solid circles and squares (open circles) are the results of $\vec{n}+d$ ($\vec{p}+d$) measurements. The statistical errors are shown in the figures. The Faddeev calculations including various NN potentials with (dark shaded band) and without (light shaded band) TM-3NF, AV18+UrbanaIX (solid line) and CD-BONN+TM′-3NF (dotted line) are also shown.

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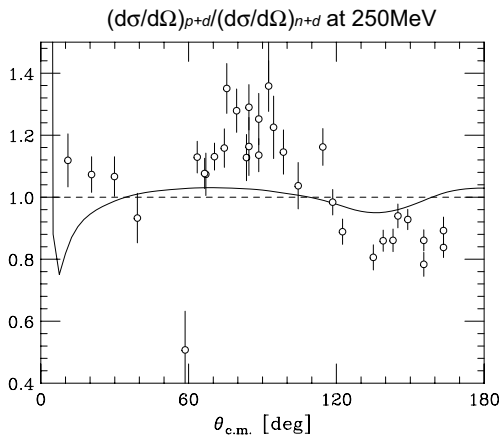

Figure 2: The ratio of the cross section of $p+d$ to that of $n+d$. The circles shows the results deduced from the data of this work and Ref. [7]. The solid line shows the theoretical predictions deduced by including the Coulomb interaction approximately.