Measurement of differential cross sections and vector analyzing powers for the $\vec{n}d$ scattering at 250MeV in the forward angular region

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Three-nucleon force (3NF) effect is one of the hot topics in nuclear physics[1]. 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 $\theta_{cm} = 85° - 180°$ by employing the (n,p) facility [2] at RCNP[3]. In this experiment, we measured the differential cross sections and the vector analyzing powers by using the deuterated polyethylene (CD_2)[4] as deuteron targets and detecting recoiled deuterons by LAS.

For the next step, we planned to extend our measurement to the forward angular region, where the Coulomb effect is expected to be large. In the forward angle measurement, we can not apply the same technique used in the backward measurement since the recoiled deuteron energy becomes too low to detect by LAS. Thus we performed the nd elastic measurement by detecting scattered neutrons at the NTOF facility at RCNP. The experimental layout is schematically illustrated in Figure 1.

The polarized neutron beam is produced by the ^{7}Li$(p,n)^7$Be$^*(0°)$ reaction at $E_p = 250$ MeV in the vacuum chamber of the beam swinger magnet. The neutron beam pass through the neutron exit window of the vacuum chamber and bombard the deuteron target. The distance between the ^{7}Li target and the deuteron target is 2m. The scattering angle of the ^{2}H(n,n) reaction can be varied from $\theta_{lab} = 0° - 40°$ by moving the ^{7}Li target along the proton beam trajectory and moving the deuteron target simultaneously. The scattered neutrons run through the 70 meter time-of-flight (TOF) tunnel and be detected by NPOL2[5]. In this experiment, we used the deuterated liquid scintillator BC537 as the deuteron target and performed the coincidence measurement.

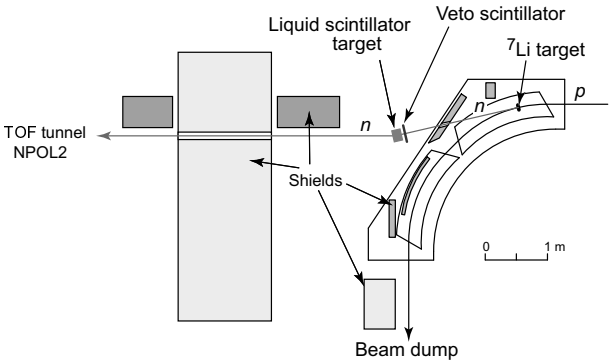

Figure 1: A schematic layout of the nd measurement of the forward angular region at the NTOF facility at RCNP.

We also used the liquid scintillator NE213 as the proton target and measured np elastic reactions for the normalization. These targets were contained in a 1mm^t alumite cylinder with a diameter of 9 cm and a length of 6 cm. To reduce the accidental coincidence events, we applied the n - γ discrimination method to these targets[6].

The preliminary results of the differential cross sections and vector analyzing powers are shown in Figure 2 by solid circles Dark (light) shaded bands represent the results of Faddeev calculations with (without) the Tucson-Melbourne 3NF[7]. 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[8, 9] which are not taken into account in the present calculations. We have also carried out the $\vec{p}d$ measurements at 250MeV [10] and these results are shown by open circles. We can see some interesting discrepancies between $\vec{n}d$ and $\vec{p}d$ data, but it is still difficult to say that these are the effects of Coulomb force because the $\vec{n}d$ data have large systematic errors yet. 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.

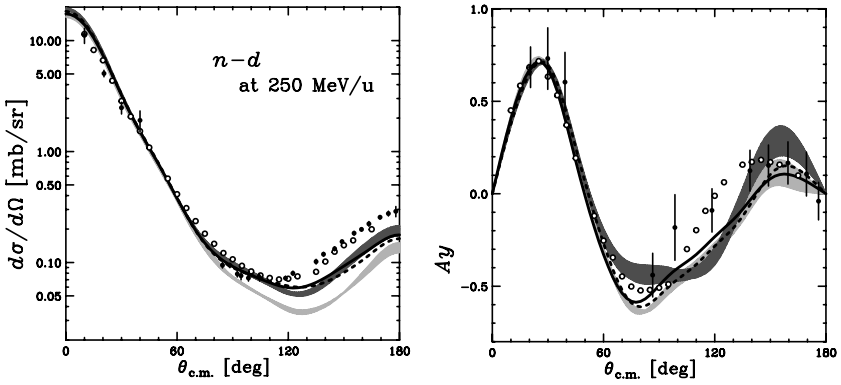

Figure 2: Differential cross sections and vector analyzing powers for the $\vec{n}d$ elastic scattering at E$_n$ = 250 MeV. The solid (open) circles are the results of $\vec{n}d$ ($\vec{p}d$) measurements. The statistical errors are shown in the figures. The Faddeev calculations including various NN 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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