Development of d-beam polarimeter at 200 MeV

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A polarimeter for a d-beam from the ring cyclotron has been developed and calibrated at $E_d = 200$ MeV. The polarimeter uses $d+p$ scattering, which has high values for the analyzing powers of A_y and A_{yy} and has fairly large cross section. The d-polarimeter uses the same target chamber and the same target foil (CH_2) as the existing p-polarimeter.

Scattered deuterons and recoil protons from the $d+p$ scattering were detected by plastic scintillators of 10 mm in thickness placed in the atmosphere. Energy spectra of virtually no background were obtained by detecting protons and deuterons in kinematical coincidence. The proton detectors were placed at $\theta_{lab} = 30^\circ$ and 36° at which A_{yy} and A_y took the maximum values, respectively. The deuteron detector placed at 30° was enough wide that the solid angles for the detection were defined by the proton detectors as 2.3 msr at both the angles. The detections were made symmetrically on the left and the right hand sides of the beam, and the deuteron detectors were placed in front of the proton detectors.

First we checked whether the spin axis of the d-beam from the ring cyclotron was vertical. The spin axis of the d-beam before injected to the ring cyclotron was rotated in the plane perpendicular to the beam axis using the superconductive solenoid, and the vector polarization in the horizontal plane p_x of the beam accelerated by the ring cyclotron was measured using the polarimeter in the vertical plane. It was confirmed from the measurement that the spin axis of the d-beam from the ring cyclotron was vertical within an uncertainty of $\pm 1^\circ$ when the solenoid was switched off.

The tensor analyzing power A_{yy} of the d-polarimeter was calibrated using the known value of $A_{yy}(= -1/2)$ of ^{12}C(d,α)^{10}B(2+, 3.587 MeV) at 0°. The asymmetry $p_{yy}A_{yy}$ of this reaction and that of the polarimeter were simultaneously measured for a d-beam of the tensor polarization p_{yy}, and the polarimeter A_{yy} was determined. The α particles from ^{12}C(d,α)^{10}B reaction at 0° were well separated in the momentum spectrum by the spectrograph Grand Raiden (GR) when we used a 15 mg/cm^2 C target, as shown in Figure 1. The d-beam was polarized (pure tensor mode) and unpolarized alternately for every 10 sec, and the data collection was paused for 1 sec to completely cover the time for the polarization change and the time constants of the electronic circuits. Since the d-beam intensity varied with the beam polarization mode, the time constant for the beam charge collection was carefully checked.

The cross section and A_{yy} of ^{12}C(d,α)^{10}B(2+, 3.587 MeV) at 2°-5° were also measured and the results were fitted by Legendre polynomials, as shown in Figure 2. From the angular dependence of the cross section and A_{yy}, the correction of A_{yy} (0°) for the finite solid angle of GR was made. Then the A_{yy} of the polarimeter was calibrated with an uncertainty of $\pm 1.8\%$ (see Table 1).

The A_y of the polarimeter was determined from the calibrated A_{yy} and the rf transition probability in the atomic ion source[1]. The (3-5) transition was selected in the ion source and the beam tensor polarization p_{yy} was determined using the calibrated value of the polarimeter A_{yy}. The beam vector polarization p_y was estimated from the relation $p_y = \gamma/3 = -p_{yy}$ with

γ being the (3-5) transition probability, and the polarimeter A_y was determined (see Table 1).

The calibrated d-polarimeter was first used for the H(d,^{3}He)γ experiment to investigate NN force and 3N force in 3N system [3].

Table 1: The analyzing powers of d-beam polarimeter at 200 MeV

θ_p^{Lab}	A_y	A_{yy}
30°	0.341±0.006	0.615±0.011
36°	0.437±0.008	0.568±0.010

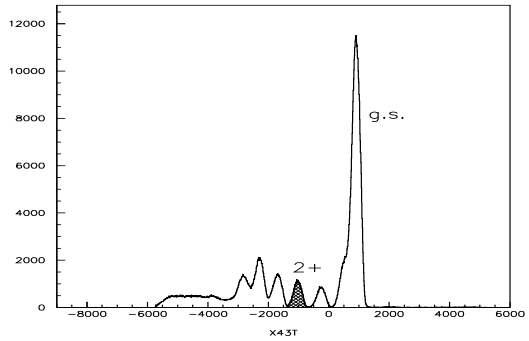

Figure 1: Typical momentum spectrums of emitted α particles form ^{12}C($\vec{d}$,α)^{10}B reaction at 0°.

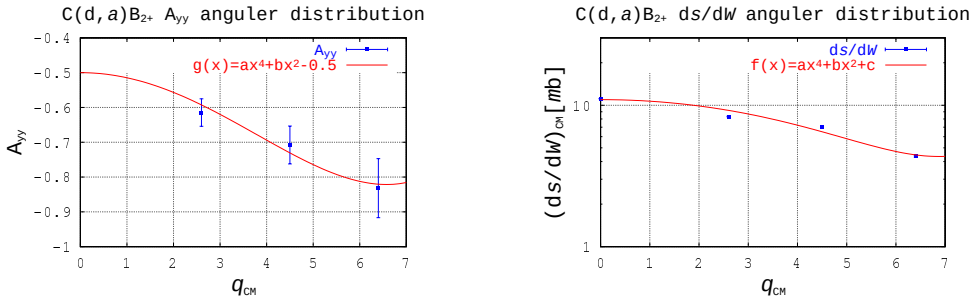

Figure 2: The angular distribution of the A_{yy} and cross section of $^{12}(\vec{d},\alpha)^{10}$B(2+) reaction

References

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