Measurement of the Analyzing Powers for the $\vec{d}\,d \rightarrow {}^3$He n and $\vec{d}\,d \rightarrow {}^3$H p Reactions at Intermediate Energies

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In the last two decades, the structure of a 'He nucleus has been investigated by the reactions of quasielastic knockout of the ^{3}He constituent nucleons[l][2]. The momentum and polarization distributions of the internal nucleons obtained by these experiments have not been reproduced by calculations using modern realistic ^{3}He wave functions in the internal momentum region of q > 300 MeV/c. These deviations indicate that the structure of ^{3}He in the high-rnomentum region has not been clearly understood. Since various kinds of mesons contribute to the nuclear interaction in the high-momentum region, investigation of high-momentum 3He structure may reveal new physics which has not been observed in the low-momentum region. Since the contribution from the D-state component becomes large in the high-momentum region, measurements of polarization observables sensitive to the D-component is necessary to study the high-momentum ^{3}He structure.

Calculation with One Nucleon Exchange (ONE) approximation [3][4] predicts that the tensor analyzing powers for the $\vec{d}\,d \rightarrow {}^3$He *n* reaction at the forward scattering angles of ^{3}He in the center-of-mass frame are directly connected with the D-/S-state ratio of the 3He wave function components. With a 270 MeV deuteron beam, the ^{3}He structure can be investigated up to a relative momentum of a d + *p* pair of ~ 600 MeV/c. Thus the tensor analyzing powers for the $\vec{d}\,d \rightarrow {}^3$He *n* reaction are appropriate probes to study the high-momentum ^{3}He structure.

We measured tensor and vector analyzing powers (A_{yy}, A_{xx}, A_{xz}, and A_y) for the $\vec{d}\,d \rightarrow {}^3$He *n* and $\vec{d}\,d \rightarrow {}^3$H p reactions at E_d =270 and 200 MeV over almost full angular range. A_{xx}, at $\theta_{cm} = 0^o$ and 180^o at E_d = 140 MeV were also measured. The experiment was performed at RIKEN Accelerator Research Facility. Polarized deuteron beams were injected onto a CD_2 target, and the scattered particles (^{3}He, ^{3}H, or *p*) were momentum analyzed with a spectrometer SMART and were detected with an MWDC and plastic scintillators.

The results were compared with the ONE calculations. Although the ONE calculations reproduced the qualitative features of the angular distributions of the obtained tensor analyzing powers at the backward angles, great discrepancies were found at the forward angles.

References

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