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Forward-Angle Analyzing Powers and Cross Sections for the Reaction ${}^3\text{He}(d,p){}^4\text{He}$

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The reaction ${}^3\text{He}(d,p){}^4\text{He}$ is known to be a good analyzer of deuteron polarization. Data of this reaction are available at energies between 2.8 and 11.5 MeV ¹⁾ and between 10 and 22 MeV ²⁾. But the data in ref. ²⁾ are incomplete and the data at forward region ($0^\circ \sim 15^\circ$) are not available at all. It is favorable to use forward region from experimental considerations. We measured cross sections, vector and tensor analyzing powers of this reaction at $E_d=18, 20$ and 22 MeV in the angular range of $\theta_{\text{lab}}=0^\circ$ to 40° .

Primary beam was produced by a Lamb-shift type polarized-ion source and accelerated by 12UD Pelletron. Angular distributions of 0° to 15° are measured simultaneously by using a single-wire position-sensitive proportional counter (SWPC) ³⁾ while the rest are taken angle by angle with a plastic scintillator-photomultiplier system. Figure 1 shows the experimental arrangement of the forward angle run. The counter system was placed in the air behind the Faraday cup. SWPC was backed up with a 55 cm long plastic scintillator. Protons are allowed to go through the SWPC and stopped in this plastic scintillator. Multi-slit system, placed in front of the SWPC, spanned angular range of $\pm 15^\circ$ and defined the angular resolution of about $\pm 0.3^\circ$. Figure 2 shows the position spectrum obtained with this set up. Each peak corresponds to the slit hole. The beam intensity was less than 1 nA to avoid the counting rate problem. The pressure of the ${}^3\text{He}$ gas target was about 4 atoms. The data for backward angular region ($\theta_{\text{lab}}=10^\circ$ to 40°) were measured with plastic scintillators which were set in the scattering chamber. The angular resolution was about $\pm 0.5^\circ$. The pressure of the target was about 2 atoms. The experimental data at 22 MeV are shown in fig. 3. The errors are mainly due to statistics (2% at forward angles and 1% at backward angles) and to beam polarization ($\sim 3\%$). The angular distributions of the cross section and T_{20} were fitted by Legendre polynomials and those of iT_{11} and T_{22} were fitted by associated Legendre polynomials. Calculation for experimental formula for these data and experiment at lower deuteron energy are in progress.

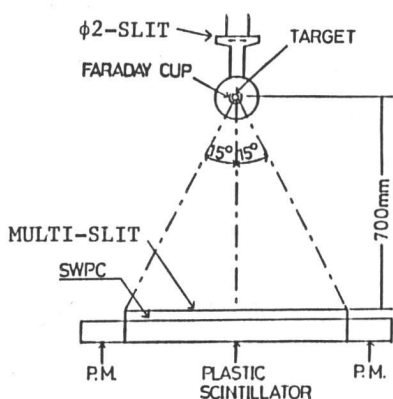


Fig. 1. The arrangement of detecting system at forward angular run.

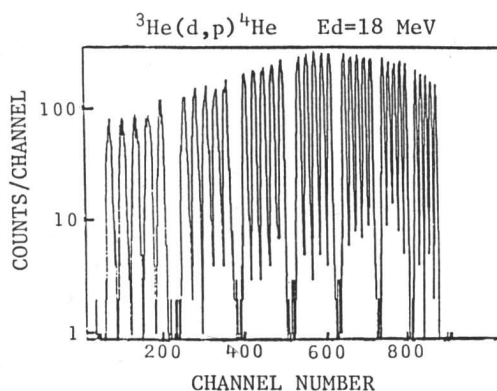


Fig. 2. Position spectrum obtained by using forward angular system. Each peak corresponds to the slit hole.

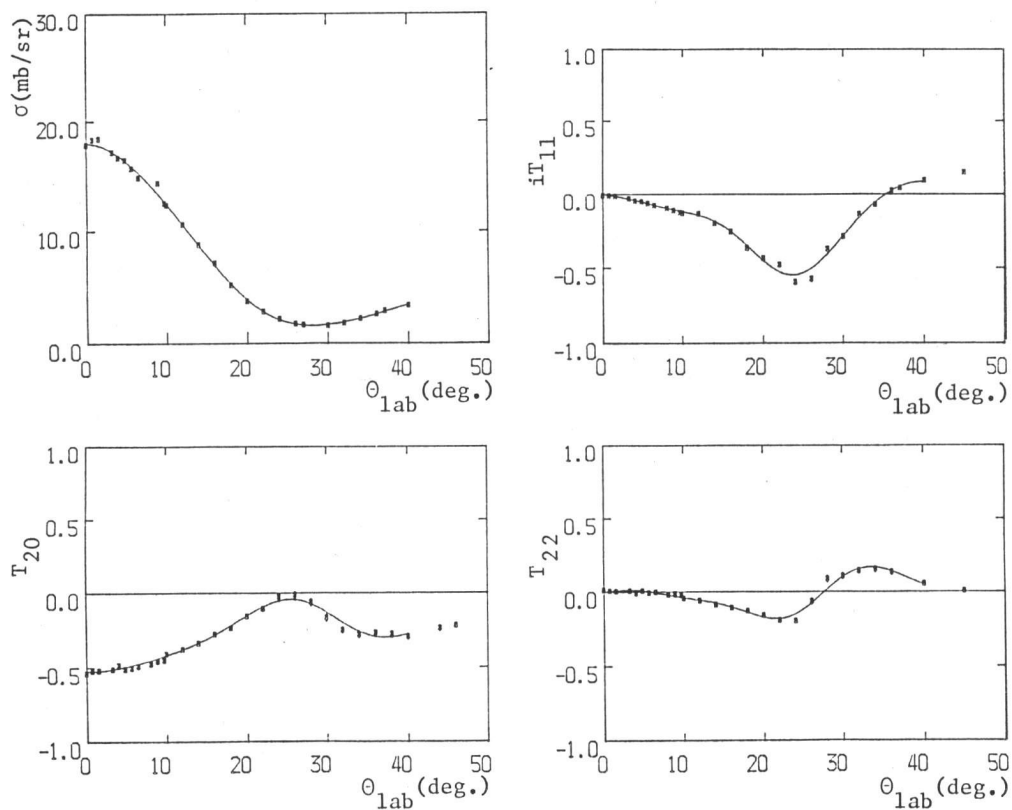


Fig. 3. Cross section and analyzing power for ${}^3\text{He}(d,p){}^4\text{He}$ at $E_d=22$ MeV. Solid-lines are least-squares fit.

References

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