Production of Spin Polarized Mass-Three Beams

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It is quite desirable to obtain as much information as possible on the non-central part of the nuclear force field. So far most of the direct information has come from the scattering of protons and neutrons on nuclear systems ranging from mass-one upwards. There is also a smaller body of information relative to the deuteron. Studies with polarized mass-three beams may provide additional illumination and perhaps be germane to three body spin orbit calculations [1][2]).

To observe polarization of mass-three particles we have considered double-scattering experiments in the classical pattern [2].

Guidance for such an observation might be expected from the phase shift analysis of mass-three scattering by He^4 analogous to the case of proton-He^4 [3]. Differential cross section input data for this procedure were supplied by a survey of triton and helium [3] scattering conducted by us [4], over a bombarding alpha energy range of 12 to 28 MeV. In the accompanying note of J. L. Gammel and R. M. Thaler some of these data have been analyzed in conjunction with the data of Miller and Phillips [5].

This analysis, graphically depicted in figure 1, indicates quite strong polarization in the 90° center-of-mass region over quite a range of input scattering energies.

Experiment

Whilst measurements on tritons or helium [3] particles are essentially equivalent we have chosen to use tritons because of their lower rate of energy loss. The first scattering of the tritons occurred in a small

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[2]) Numbers in brackets refer to References, page 223.

vessel containing tritium at a pressure of 140 cm Hg. Alpha particles from the Los Alamos cyclotron entered through a 0.4 mil molybdenum window. The cyclotron was adjusted so that the alpha particle energy in the collision volume [6] was about 16.4 MeV. Tritons recoiling at 90° center-of-mass or 45° forward in the laboratory with a spread of $\pm$ 2° emerged from the target vessel via a quarter mil permalloy window and proceeded in vacuo to the second scattering chamber. They entered through a quarter mil nylon window and scattered off He^4 which filled

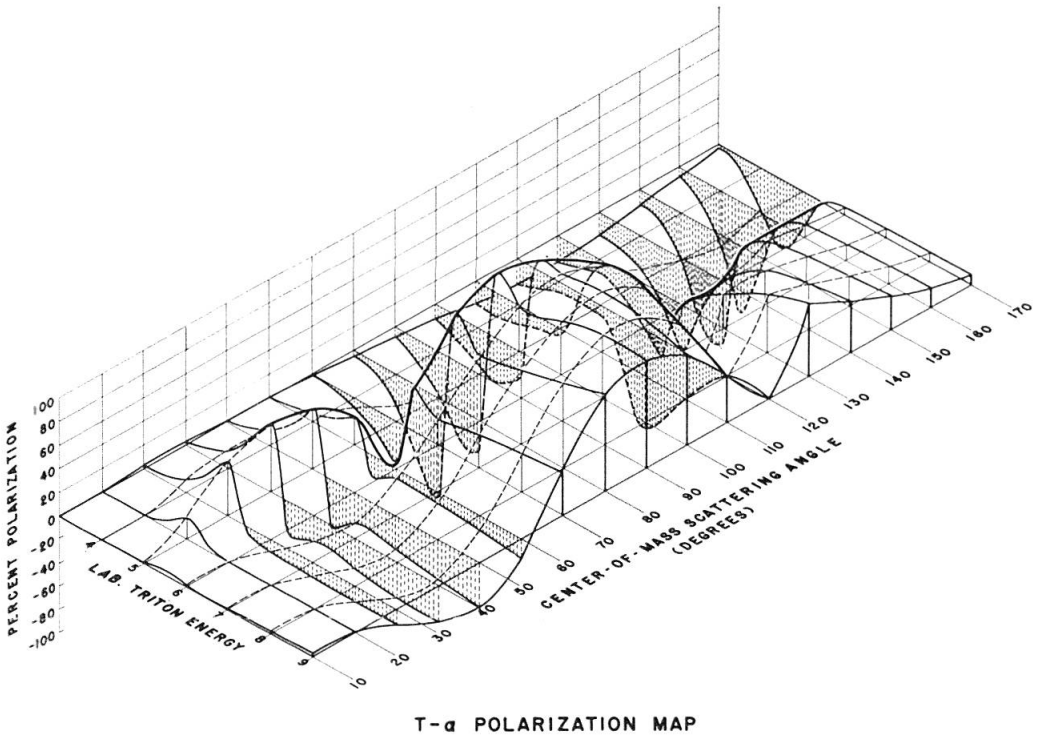

Figure 1

the chamber to a pressure of 119 cm Hg. 7.2 MeV tritons scattering at 53 $\pm$ 11° in the laboratory, again 90° in the center-of-mass, were detected in a tandem proportional counter filled with a mixture of argon plus 5% CO_2 to a pressure of 3.4 cm Hg as indicated in figure 2. The isolating window was quarter mil permalloy. The ambient nuclear radiation field was of such proportions as to make the detection of the tritons quite difficult. This condition was considerably mitigated by imposing a coincidence requirement between the triton and its associated alpha particle. The latter was detected by a one mil aluminized organic plastic scintillator viewed by a DuMont 6292 photomultiplier. The triple coincidence circuit had 1/2 microsecond resolving time. Juxtaposed about each triton counting run in either left or right station was a background

run. In the latter type run the first scattered tritons were intercepted prior to entering the second scattering chamber.

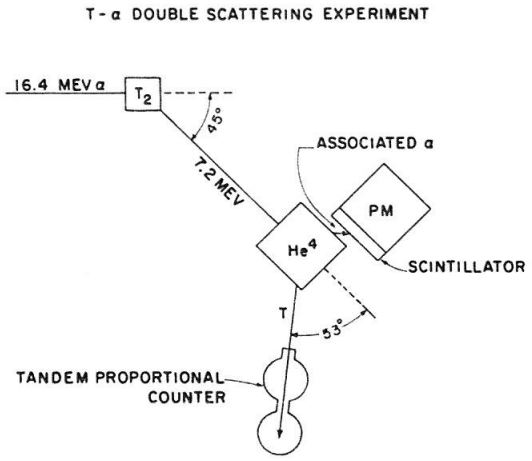

Figure 2

Results

Four separate runs produced the results of table 1 which lead to a left-right counting asymmetry ratio of 3.3 $\pm$ 35%. To compare this with the expectations from the phase shift analysis it is necessary to fold in the scattering cross sections and polarizations into the finite geometry. When this is done and a slight extrapolation is made for the polarization in the first scattering, we obtain a ratio of 4. Evidently the experimental results and the expected value are compatible and we are observing peak polarizations in the vicinity of 80 to 90%.

Table 1

Counts	Left	Right
Stopper in	93	83
Stopper out	234	125
Corrected counts .	141	42

Clearly further measurements are indicated, but on the basis of this result it is reasonable to contemplate a number of experiments: the scattering of polarized mass-three nuclei by other heavy nuclei to supplement the differential cross section data in optical model analyses: possible spin correlation experiments in reactions and scattering; $D + D \rightarrow P + T$, $P + T \rightarrow P + T$ for example; polarization produced in scattering $He^3 + T$ for example.

REFERENCES

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[4] Some of these data are summarized in: J. E. BROLLEY, JR., L. ROSEN and L. STEWART, Proceedings of the 1959 International Conference on the Few Nucleon Problem, London, Pergamon Press (to be published).
[5] P. D. MILLER and G. C. PHILLIPS, Phys. Rev. *112*, 2048 (1958).
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