POLARIZATION IN He^3-He^4 SCATTERING NEAR 26 MeV

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ABSTRACT

Using the classical double scattering technique in which center of mass energies and angles are matched ($A = P^2$) we have measured the polarization of He^3 scattered by He^4 at $\theta_{cm} = 130^o$ near $E_{LAB} = 26$ MeV. The observed asymmetry was $A = 0.190 \pm 0.030$ which yields $|P| = 0.436 \pm 0.054$ indicating the usefulness of the He^3-He^4 scattering as a source of 26 MeV polarized He^3 particles.

Prepared for the Int. Conf.
on Nuclear Physics,
Sept. 12-17, 1966
Gatlinburg, Tennessee

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In the last few years the elastic scattering of mass-3 particles from He^4 has been studied both experimentally (ref. 1) and theoretically (ref. 2). Little work has been done, however, to investigate the spin-dependence of this interaction. At lower energies only a few polarization measurements (ref. 3) exist which agree qualitatively with predictions from phase shift analyses (ref. 4). At higher energies, neither theoretical predictions nor experimental data on He^3 polarization are available.

As a beginning of a detailed study of the He^3-He^4 system, we have started to measure the polarization near 26 MeV. Unfortunately, accurate measurements of the polarization are not available in the elastic scattering from complex nuclei, which could be used as analyzers. Therefore, we have chosen the double scattering experiment which involves the reactions $He^3(\alpha, He^{3'})He^4$ and $He^4(He^3, He^3)He^4$. Since the center of mass energies and angles can be matched, the polarization can be easily evaluated ($A = P^2$). Because the logarithmic derivative of the cross section with respect to angle for the He^3-He^4 scattering is smaller than that for heavy nuclei, this method has an advantage over the alternate scheme of doubly scattering from a heavier nucleus. The major difficulties with this experiment are low scattering cross sections and the low He^3 energy after the second scattering, which necessitates a thin second target.

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The details of the experiment are as follows. Within a small chamber, He^3 at a pressure and temperature of 6.5 atm and 77° K was bombarded by 42 MeV α's from the NASA 60-inch Cyclotron. The recoil He^3 (25° LAB, 130° CM) were focussed by a set of quadrupole lenses at the center of the second scattering chamber which contained the detectors and He^4 gas at a pressure of 2 atm. The scattered He^3 (81.7°LAB, 130° CM) were detected on the left and right of the incident He^3 beam by two 100 μ surface barrier detectors. A count was registered only if in coincidence ($2\tau = 100$ ns) with the pulse from a 1 x 3 cm^2 conjugate detector which counted the recoiling He^4. This technique was necessary in order to reject background counts. The full angular spread was 5° and 7° in the first and second scattering, respectively. The He^3 laboratory energies were 28.3 and 24.2 MeV at the respective target centers. Since the cross section (ref. 5) varies slowly over this energy range and the energy spreads were 2.7 MeV and 1.0 MeV, respectively, it is reasonable to assume $P_1 \approx P_2$. Instrumental asymmetries were minimized (<1 percent) by careful initial alignment of the second scattering chamber, and inverting it periodically during the run. The accidental rate was checked by interchanging the conjugate He^4 counters, while keeping the geometry and electronics the same.

The resulting data are presented in the following table:

Counts	Right (up)	Left	Right (down)	Left
Total	344	239	242	349
Background	0	24	9	36
Net	344	215	233	313

A right-left asymmetry A = 0.190 ± 0.030 is observed. From $A = P^2$ it follows $|P| = 0.436 \pm 0.054$. This fairly large polarization and the intensity of 10^6 He^3 /μC after the first scattering indicate the usefullness of the α-He^3 scattering as a source of polarized He^3. Utilizing this source, the measurement of the polarization angular distribution in He^3-He^4 scattering is now under way.

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