Observation on the Reaction $Li^7(p,\alpha)He^4$ Using Polarized Protons

By K. BEARPARK, I. HALL, R. E. SEGEL, S. M. SHAFROTH and N. W. TANNER
Clarendon Laboratory, Oxford

WOLFENSTEIN [1][1]) in 1949 predicted that the reaction Li^7 (p,α) He^4 would be sensitive to proton polarization which produces an additional term in the angular distribution of the form $\sin 2\,\Theta \cos \Phi$. The magnitude of the coefficient associated with this term could not be predicted because of the unknown channel spin phase which could not be deduced from the unpolarized angular distribution. However it was clear that a large azimuthal asymmetry would occur at least at some energies.

A polarized proton beam was obtained by scattering 2 to 4 MeV protons from carbon at 60° (lab) at which angle the polarization had been measured [2] as -25 to -35% depending on scattering energy. The scattered beam was allowed to pass through an absorber foil and impinge on a lithium target as shown in figure 1. Alpha particles from the reaction were detected by four CsI scintillation counters at 45° (c.m. angle approximately) to the scattered beam. Using a primary beam of $2\,\mu$A, a carbon target 8 mg/cm² thick and a lithium target 0.5 mg/cm² thick, about 1000 α-counts per hour per counter were recorded for a lithium bombarding energy of 2 MeV. The lithium bombarding energy was varied by appropriate choice of primary bombarding energy, scattering target thickness and carbon absorber thickness. The inherent asymmetry of the chamber was determined by replacing the carbon scatterer with a platinum foil of equivalent thickness.

Figure 2 shows the fractional change r (defined in the same way as WOLFENSTEIN's [1] r) in the intensity of the α-particles at $\Theta = 45°$, $\Phi = 0°$ due to proton polarization (100%).

The immediate consequence of the sign of the asymmetry is that the interpretation of Li^7 (p,α) He^4 in terms of compound states of $J = 0$ and $J = 2$ by INGLIS and by CRITCHFIELD and TELLER [3] is not acceptable. On the other hand two states of $J = 2$ (suggested by CHRISTY and

[1]) Numbers in brackets refer to References, page 338.

RUBIN [4] can give the right sign and magnitude. Three curves for the latter case calculated by WOLFENSTEIN [1] for channel spin phase γ are shown in figure 2. Apparently $\gamma \simeq 200°$.

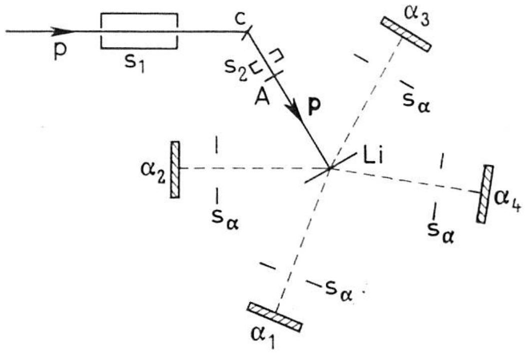

Figure 1

Geometry used for $Li^7(\boldsymbol{p}, \alpha)He^4$ measurement: p, primary beam; $\boldsymbol{p}$, polarized beam; S_1, S_2, S_α, collimating slits for primary and polarized beams and α-particles; c, carbon target; Li, lithium target; A, carbon absorber foil; $\alpha_1, \ldots \alpha_4$, CsI counters

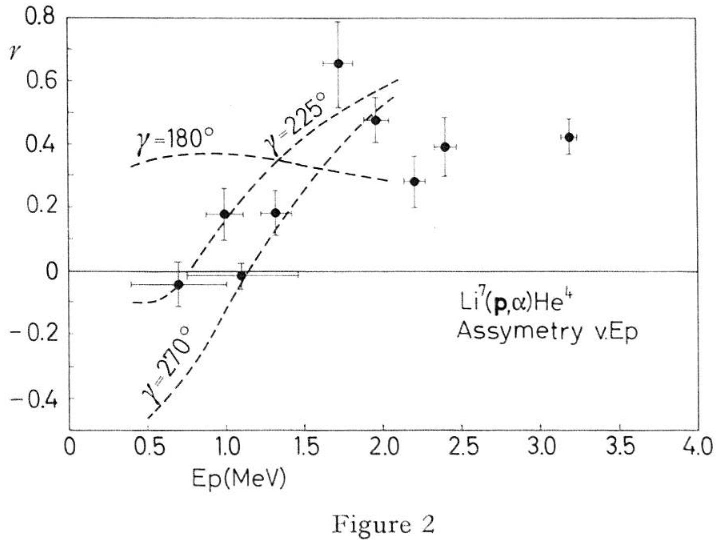

Figure 2

Asymmetry r as a function of E_p showing measured points and curves calculated by WOLFENSTEIN [1]

REFERENCES

[1] L. WOLFENSTEIN, Phys. Rev. *75*, 1664 (1949).
[2] J. E. EVANS and M. A. GRACE, Nucl. Phys. *15*, 646 (1960).
[3] D. R. INGLIS, Phys. Rev. *74*, 21 (1948). – C. CRITCHFIELD and E. TELLER, Phys. Rev, *60*, 10 (1941).
[4] R. F. CHRISTY and S. RUBIN, Phys. Rev. *71*, 275A (1947).