## SHORT COMMUNICATIONS

# ANGULAR DISTRIBUTION OF $\alpha$-PARTICLES FROM THE $Li^7(p,\alpha)He^4$ REACTION AT LOW PROTON BOMBARDING ENERGIES*

By F. Hirst†

The work on the angular distribution of $\alpha$-particles from the $Li^7(p,\alpha)He^4$ reaction performed by Martin *et al.* (1949) and Hirst and Uebergang (1951) has been extended in the proton energy range 60–250 keV. to determine where the coefficient $A(E)$ arising in the angular distribution expression

$$Y(\theta)=Y(90^\circ)[1+A(E)\cos^2\theta+B(E)\cos^4\theta]$$

vanishes or becomes negative.

This expression implies that both $p$ and $f$ protons take part in the $Li^7(p,\alpha)He^4$ reaction and on this basis Inglis (1948) has derived a theoretical expression for $A(E)$ which requires that $A(E)$ becomes zero at two values of the proton energy. For $p$ protons alone, the $B(E)$ term is not present and the theoretical value of $A(E)$ vanishes only once.

In the present investigation it was found that the $A(E)$ curve crossed the abscissa near 100 keV. and the existence of this low energy node together with that discovered by Heydenburg *et al.* (1948*a*, 1948*b*) at a higher proton energy (viz. 2·7 MeV.) confirms the participation of $f$ protons in the $Li^7(p,\alpha)He^4$ reaction.

The measurements were obtained using nuclear emulsion photographic plates, the camera being the same as used by Martin *et al.* except that a movable target was provided. This allowed the target area to be changed five times during the plate exposure, thereby avoiding excessive deposition of carbon on the target surface. At least five exposures were made at each bombarding energy and, in particular, at 60 keV., 17 photographic plates were needed to record sufficient $\alpha$-particles. For proton energies between 100 and 250 keV., thin targets ($<$25 keV. in effective thickness) were used, whilst thick targets ($>$60 keV. in effective thickness) were employed for the 60 keV. exposures. Although the thick target result should be correlated with an energy less than the nominal bombarding energy, owing to the uncertainty of the correlation, this result has been displayed at 60 keV. in Figure 1.

As previous experimental evidence (Hirst and Uebergang 1951; Martin *et al.* 1949; Talbott, Busala, and Weiffenbach 1951) had shown that the $B(E)$ term arising in the above angular distribution expression was essentially zero in the proton energy range 60–250 keV., the data were analysed by a least

* Manuscript received March 25, 1952.
† Physics Department, University of Melbourne.

squares method for the $A(E)$ coefficient only. Figure 1 compares the results of this experiment with those of other workers. Observations below a proton energy of 250 keV. are difficult because of the low reaction cross section and previously only Young, Ellett, and Plain (1940) have published extensive results in this energy range. Since 100 keV. was the lowest proton energy at which measurements were recorded, Young, Ellett, and Plain failed to detect the point where $A(E)$ became negative. Figure 1 shows that the present results are consistent with those of Martin *et al.* and of Hirst and Uebergang. In general the data of the latter two investigations were analysed for both $A(E)$ and $B(E)$ coefficients, which accounts for their large statistical uncertainty.

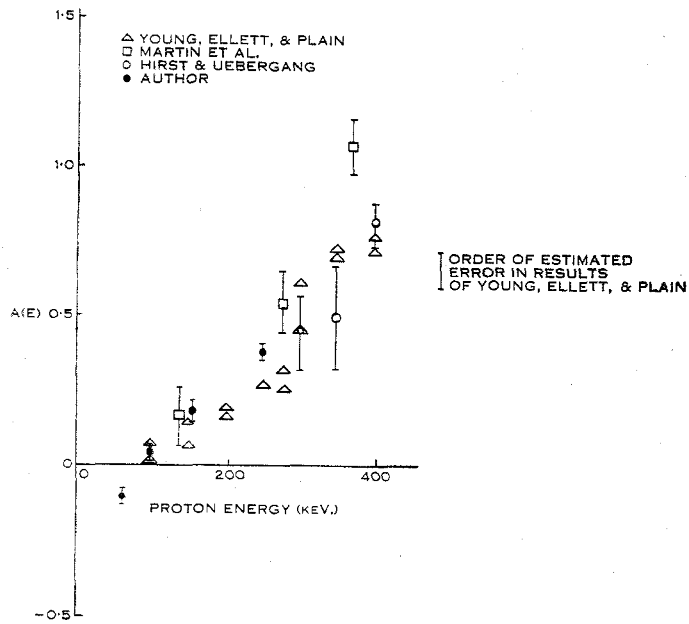


Fig. 1.—$A(E)$ against proton energy.

Although this experiment has defined the $A(E)$ curve more precisely at low proton energies, the assumptions concerning barrier penetrability and the levels of the $Be^8$ compound nucleus made by Inglis still provide sufficient freedom to account for the experimental observations now available.

*References*

HEYDENBURG, N. P., HUDSON, C. M., INGLIS, D. R., and WHITEHEAD, W. D. (1948*a*).—*Phys. Rev.* **73** : 241.

HEYDENBURG, N. P., HUDSON, C. M., INGLIS, D. R., and WHITEHEAD, W. D. (1948*b*).—*Phys. Rev.* **74** : 405.

HIRST, F., and UEBERGANG, R. G. (1951).—*Aust. J. Sci. Res.* A **4** : 284.

INGLIS, D. R. (1948).—*Phys. Rev.* **74** : 21.

MARTIN, L. H., BOWER, J. C., DUNBAR, D. N. F., and HIRST, F. (1949).—*Aust. J. Sci. Res.* A **2** : 25; *Nature* **164** : 310.

TALBOTT, F. L., BUSALA, A., and WEIFFENBACH, G. C. (1951).—*Phys. Rev.* **82** : 1.

YOUNG, V. J., ELLETT, A., and PLAIN, G. J. (1940).—*Phys. Rev.* **58** : 498.