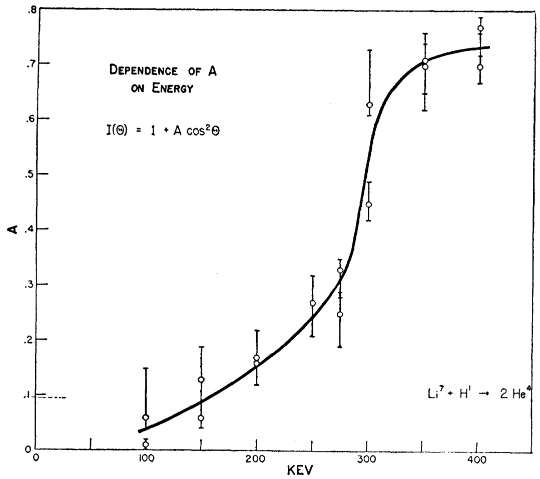

FIG. 3. The variation with bombarding energy of A in the expression $1+A\cos^2\theta$ which is found to represent the distribution in angle of the alpha-particles from $Li^7+H^1\rightarrow 2He^4$.

target in question at a particular bombarding energy, then the yield from a thick target both at this and at a somewhat lower energy so chosen that the decrease in thick target yield was approximately equal to the yield of the thin target. This gives only a rough value of target thickness, but probably good enough for the present purpose which is merely to make sure that the use of even thinner targets would not give sensibly different data. Targets were replaced after bombardment for less than half the time which experience showed to produce appreciable "fatigue."

RESULTS

The relative yields at various angles, transformed to the center of mass coordinate system, normalized to unity at 90°, and plotted against $\cos^2\theta$ are shown in Fig. 2 for several bombarding energies. The number of particles counted at any window is 3000 or more for the window in question and 10,000 or more on the monitor. Straight lines, $1+A\cos^2\theta$, have been drawn through these points by inspection and the values of A so determined are plotted against bombarding energy in Fig. 3. Vertical bars are estimated limits of error arrived at by drawing through the observed points of Fig. 2 straight lines of greatest and least admissible slope, admissibility being determined merely by the best judgment of the authors.

DISCUSSION

The appearance of Fig. 3 obviously suggests resonance to a rather broad excited state of Be^8.

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The Distribution in Angle of the Long Range Alpha-Particles from Fluorine Bombarded with Protons

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The distribution in angle of the long alpha-particles from the reaction $F^{19}+H^1\rightarrow O^{16}+He^4$ has been determined at bombarding energies of 330, 375 and 435 kev. This distribution shows a very strong fore and aft asymmetry which varies only slightly with the bombarding voltage. The distribution is well represented by the expression $1+0.66\cos\theta+0.25\cos^2\theta+0.41\cos^3\theta$.

THE present paper is concerned with the distribution in angle of the long range alpha-particles from fluorine bombarded with protons. The apparatus shown in Fig. 1 differs essentially from that described in the previous[1] paper only in the form of target support and in the dimensions of the defining apertures, which are as given in Fig. 1. Targets were prepared by electrolysis of hydrofluoric acid onto tantalum. Care was used to avoid boron contamination arising from the solution of Pyrex glass in the

[1] Young, Ellett and Plain, Phys. Rev. this issue.

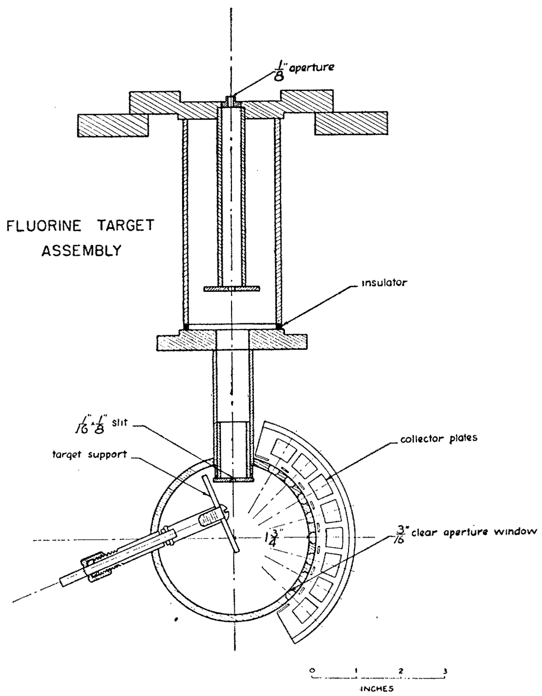

FIG. 1. Cross-sectional view of the target chamber and defining apertures. The chamber is connected to the accelerating tube by means of the greased joint shown at the top of the figure. The target spot is approximately a rectangle 3 mm wide by 4 mm long.

hydrofluoric acid, as the boron reaction has at low energies a much larger yield than the fluorine reaction. Observations were made at 330, 375 and 435 kev by the method outlined in the preceding paper, and the results are presented in Fig. 2.

RESULTS

The distribution shows a very large fore and aft asymmetry, with a strong preference for the forward direction. It appears to change very slightly with bombarding energy. It is true that the points taken at 330 kev and 435 kev do not coincide exactly, but their differences are hardly significant, as the number of counts was only about 500 on a particular point, giving a statistical probable error of 3 percent. These curves were taken with a relatively thin target (apparent width of the gamma-ray resonance was about 40 kev) and since the distribution appeared to change but little with energy we decided that the use of a somewhat thicker target would be legitimate and would permit the reduction of the statistical error. Data secured with a thicker target and larger number of counts (between 2000 and 3000 per point) at a bombarding energy of

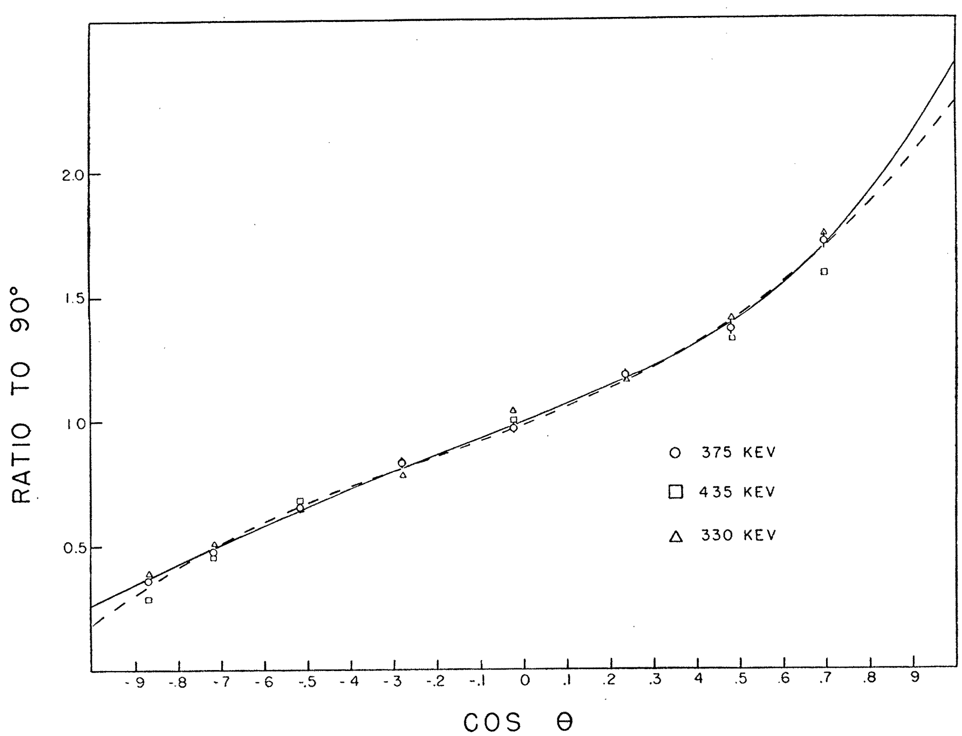

FIG. 2. The distribution in angle in the center of mass system of coordinates of the long range alpha-particles from the reaction $F^{19}+H^1\rightarrow O^{16}+He^4$. The triangles are for a bombarding energy of 330 kev, the circles for 375 kev, and the squares for 435 kev. The broken line represents the expression $0.985+0.656\cos\theta+0.25\cos^2\theta+0.40\cos^3\theta$ and the solid line the expression $1+0.65\cos\theta+0.11\cos^2\theta+0.44\cos^3\theta+0.24\cos^4\theta$.

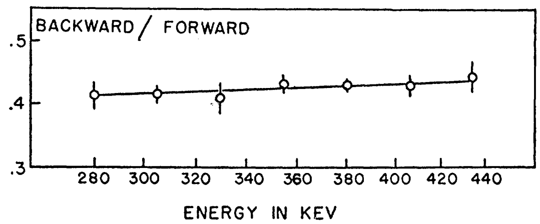

FIG. 3. The ratio of the yield of alpha-particles at three backward windows (105°, 120°, and 135°) to three forward windows (45°, 60°, and 75°) as a function of energy. This curve is plotted in the laboratory system of coordinates.

375 kev have been fitted with an empirical equation by the method of least squares. The best curve of the fourth degree is found to be:

$$1+0.650\cos\theta+0.11\cos^2\theta+0.44\cos^3\theta+0.24\cos^4\theta$$

and is shown in Fig. 2 by the solid curve. The best third degree curve is found to be:

$$0.985+0.656\cos\theta+0.25\cos^2\theta+0.40\cos^3\theta$$

and is shown by the broken curve in Fig. 2. It is clear that the inclusion of the fourth-degree term leads to no significant improvement in fit.

We have not been able to make similar observations at lower energies because of the low yield. However, we determined the ratio of the number of alpha-particles backward to forward (windows at 45°, 60°, and 75° were connected to one amplifier and those at 105°, 120°, and 135° to the other) down to 280 kev. This ratio, plotted as a function of bombarding energy, is shown in Fig. 3.

DISCUSSION

In view of the rather unexpected nature of this distribution we were careful to check possible sources of error in the experimental arrangement. The foils were measured by means of a standard polonium source and a shallow ionization chamber and found to have a stopping power of 2.3 centimeters air equivalent. The outer edges of the collector plates were at a distance of 1.5 centimeters from the foils so that all particles of range greater than 3.8 centimeters should traverse the full depth of the ion chamber. The pulses as seen on the screen of an oscilloscope were of uniform height, indicating that all of the alpha-particles were traversing the full depth of the sensitive volume of the ionization chamber. As a further check the alpha-particles from $B^{11}+H^1$ were observed using the same target chamber and foils. Since these particles, which have a range about one centimeter less than that of the fluorine alpha-particles, were counted at all windows it was certain that none of the fluorine alpha-particles was being lost. The distribution of the alpha-particles from Li^7+H^1 at bombarding voltages below 100 kev was also observed with this apparatus and found to be very nearly spherically symmetric in agreement with the results of the preceding paper.