Search for Alpha-Particles from the $O^{16}(d,\alpha)N^{14*}$ Reaction*

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(Received February 18, 1952)

Studies of the gamma-rays from several nuclear reactions have indicated the existence of an energy level in N^{14} at approximately 2.3 Mev. An investigation of the $O^{16}(d,\alpha)N^{14}$ reaction has been carried out in order to investigate this region of excitation in N^{14}. Two-million-volt deuterons from an electrostatic generator were employed, and the alpha-particles were analyzed with a magnetic spectrograph. The region of excitation studied was from 0 to 2.8 Mev. With the exception of the ground-state group, no alpha-particle groups were found, although any group with an intensity greater than 2 percent of the ground-state group would have been observed.

SEVERAL researches,[1] using different nuclear reactions, have reported the observation of a gamma-ray of about 2.3 Mev which appeared to be associated with a level at 2.3 Mev in N^{14}. Fowler, Lauritsen, and Lauritsen[2] in the re-evaluation of data for the reaction $C^{13}(p,\gamma)N^{14}$ found a gamma-ray of about 2.3 Mev. Bombarding C^{13} with deuterons, Thomas and Lauritsen[3] reported a gamma-ray of 2.318 ± 0.008 Mev which is attributed to N^{14*}. Beghian, Grace, and Halban[4] have bombarded B^{11} with polonium alpha-particles and report a gamma-ray of 2.2 ± 0.2 Mev as probably due to an excited state in N^{14}. Alburger,[5] bombarding PbO_2 with 3.7-Mev deuterons, observed indications of a gamma-ray of about 2.1 Mev. Sherr, Muether, and White[6] have investigated the decay of O^{14} and have observed the emission of 1.8-Mev positrons and a gamma-ray of about 2.3 Mev.

Mandeville and Swann[7] have investigated neutron groups from the reaction $C^{13}(d,n)N^{14}$, and they reported groups corresponding with levels in N^{14} at 4.90, 3.87, 3.47, and 2.19 Mev.

However, Fulbright and Bush,[8] using the reaction $N^{14}(p,p')N^{14*}$, found no proton group that might be associated with a 2.3-Mev level in N^{14}. It occurred to the present authors that suitable observations of alpha-particles from the reaction $O^{16}(d,\alpha)N^{14*}$ might make more definite the assignment of the 2.3-Mev gamma-ray and, moreover, might give further evidence regarding the possibility that an additional unresolved state may be involved. A search for such alpha-particles has therefore been made.

Deuteron bombardments of targets containing oxygen have been carried out at 2.0 and 2.1 Mev. The charged particles emitted at 90 degrees to the incident beam were analyzed with a 180-degree magnetic spectrograph. The results of the bombardments at 2.1 Mev are shown in Fig. 1, where the number of particle tracks per unit area of emulsion is shown as a function of $H\rho$. The deuterons elastically scattered from the target nuclei are shown, together with the alpha-particles observed. The survey shown extends over a range of values of $H\rho$ corresponding to alpha-particle energies that would be associated with N^{14} levels between 2.8 Mev and the ground state. This range corresponds to alpha-particle energies from about 1.6 to 3.8 Mev.

In the figure, the peaks due to oxygen and to carbon are double. This is because of the composite nature of the target, which was a film of Formvar, upon one side of which a thin layer of aluminum had been evaporated. The aluminum serves to increase the exposure that the Formvar can withstand without failure. The target was placed at an angle of 45 degrees to the deuteron beam, the aluminum being on the front side facing the oncoming beam and also facing the main part of the spectrograph.

In Fig. 1, the peak resulting from the ground-state alpha-particles is double, as is also the peak resulting from the deuterons elastically scattered from oxygen. This shows the presence of oxygen at the front of the aluminum in addition to the oxygen at the back of the aluminum. The fact that the peak due to the deuterons elastically scattered from carbon is double shows that there is also a layer of carbon contamination in the region of the front surface of the aluminum. Analysis of the data plotted in the figure shows a layer of contamination about 2.5 kev thick lying on top of the front-surface oxygen layer.

Using the ground-state alpha-particle peak shown in Fig. 1, the Q value for the reaction $O^{16}(d,\alpha)N^{14}$ has been computed. With proper correction for the layer of contamination just mentioned, the result for the Q value is 3.111 Mev, which is in good agreement with that obtained in previous measurements.[9]

Except for the ground state, only one small group of alpha-particles was observed. This group has a maximum count of 15 and in Fig. 1 occurs at a value of

* This work has been supported by the joint program of the ONR and AEC.
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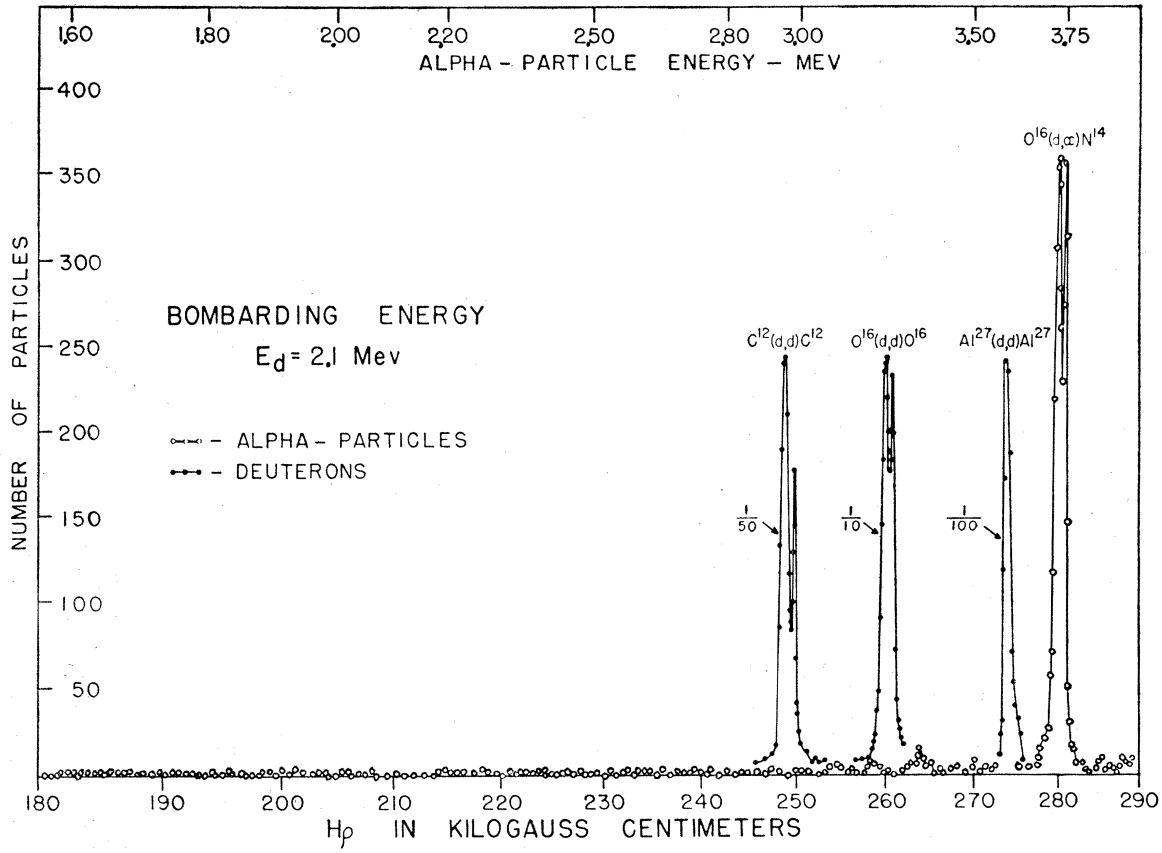

FIG. 1. Particle groups from aluminum-Formvar target bombarded with 2.1-Mev deuterons.

$H\rho = 264$ gauss-centimeters. Measurement of the shift in energy of the alpha-particles when the bombarding voltage was shifted from 2.1 to 2.0 Mev indicated that the target nucleus involved was not oxygen, but one of considerably higher atomic number, possibly aluminum. A test bombardment was then made, using a target of Formvar backed with copper. As the alpha-particle group was no longer observable, it was concluded that the group previously observed was not from oxygen.

Thus, there were observed within the range of the survey no alpha-particle groups that could be associated with an excited level in the N^{14} nucleus. It is estimated that a group equal in intensity to about 2 percent of the ground-state group could have been observed. However, it is evident that the alpha-particle yield, if it exists, might be much greater under other conditions of angle and voltage.

This result is in agreement with the recently reported work of Ashmore and Raffle[10] who studied the region of excitation in N^{14} from 2.0 to 6.1 Mev using 6.8-Mev cyclotron deuterons and magnetic analysis of the alpha-particles from this reaction. They found no levels in N^{14} between 2.0 and 3.95 Mev.

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