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1) Our notation coincides with that used in [1].

TOTAL NUCLEAR DECAY REACTIONS

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There are many nuclei (Be^8, C^{12}, O^{16}) whose properties agree well with the assumption that they contain strongly-bound nucleon clusters of the α-particle type. In some nuclei, the α-particle clusters are weakly coupled, so that when such particles collide the emission of α particles, or even complete decay into α particles, has a higher probability than the emission of individual nucleons [1-3].

An investigation of the total decay into α-particle clusters in interactions between α-noncorrelated nuclei (for example, $N^{14} + B^{10} \rightarrow 6\alpha$), and a comparison of these reactions with analogous ones between α-correlated nuclei (for example, $C^{12} + C^{12} \rightarrow 6\alpha$) makes it apparently possible to ascertain whether a regrouping of nucleons with formation of α-particle clusters takes place during the instant of collision, or whether the breakup into α-particle clusters is due only to the α-particle structure of the colliding nuclei.

We have previously measured [3] the cross sections of certain reactions with emission of α particles, due to B^{10} ions interacting with light nuclei in emulsion. In the present paper we report on a more detailed investigation of the reaction

$$N^{14} + B^{10} \rightarrow 6\alpha$$

Type NIKFI-D nuclear emulsions 400 μ thick were bombarded with B^{10} ions accelerated to 100 MeV in the multiply-charged-ion linear accelerator of the Ukrainian Physico-technical Institute. The strictly parallel beam of B^{10} ions entered the emulsion at an angle of 25° to the surface. The emulsions made possible reliable visual discrimination of the tracks of singly-charged or doubly-charged particles, and of heavier nuclei.

From a total of approximately 10,000 stars produced by the interaction between the B^{10} ions and nuclei in the emulsion, we identified, as a result of visual selection, measurement of all the star parameters, and subsequent detailed kinematic analysis, a total of 22 six-pronged stars due to the reaction

$$N^{14} + B^{10} \rightarrow 6\alpha + 0.4 \text{ MeV}, \tag{1}$$

one seven-prong star due to the reaction

$$N^{14} + B^{10} \rightarrow 5\alpha + 2d - 23.5 \text{ MeV} , \quad (2)$$

and one seven-prong star due to the reaction

$$O^{16} + B^{10} \rightarrow 6\alpha + d - 20.5 \text{ MeV} . \quad (3)$$

The kinematic analysis of the stars and all the subsequent calculations were carried out with the "Ural-2" electronic computer.

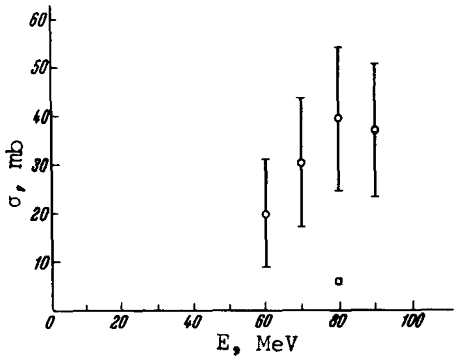

Fig. 1. Excitation function of the reaction $N^{14} + B^{10} \rightarrow 6\alpha$. The small square corresponds to the reaction $N^{14} + B^{10} \rightarrow 5\alpha + 2d$ (in the laboratory system).

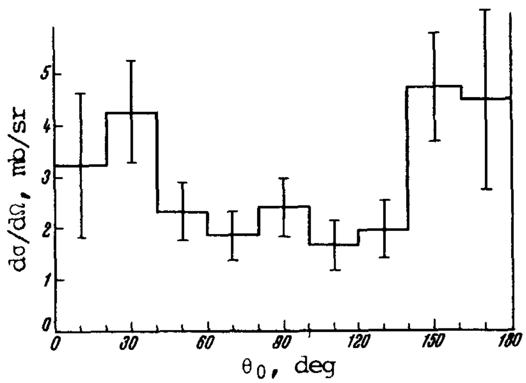

Fig. 2. Angular distribution of α particles from the reaction $N^{14} + B^{10} \rightarrow 6\alpha$ (in the c.m.s.).

The excitation function of the first reaction is shown in Fig. 1. The errors indicated are statistical. Not a single case of the indicated reaction was observed at bombarding-ion energy less than 55 MeV. The cross section for the reaction increases quite rapidly with increasing bombarding-ion energy, reaching 40 mb at 80 MeV.

The only observed case of the second reaction occurred at 80 MeV bombarding-ion energy. This case corresponds to a reaction cross section ~5 mb. The corresponding point is also shown in Fig. 1.

The observed case of reaction $O^{16} + B^{10} \rightarrow 6\alpha + d$ occurred at 82-MeV B^{10} energy and corresponds to a cross section ~2 mb (not shown in Fig. 1).

The angular distribution of the α particles from the first reaction is shown in Fig. 2. It has maxima in the forward and backward directions.

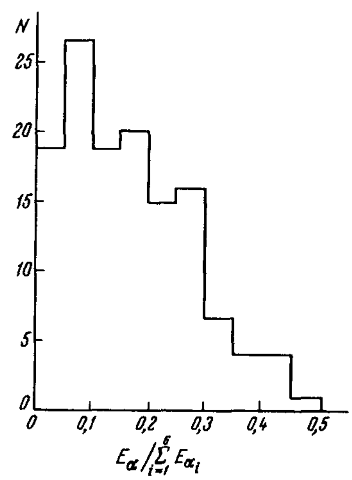

Fig. 3. Distribution of the relative energies of the α particles (in the c.m.s.).

Figure 3 shows the energy distribution of the α particles. To construct this distribution, the kinetic energy of each of the six α particles in the star was divided by the sum of the kinetic energies of all six α particles. Thus, the sum of the kinetic energies of all six α particles in the star was set equal to unity.

It is seen from this distribution that there is a noticeable probability of observation of α particles with much more than their equal share of kinetic energy. (If the energy is equally divided among all six α particles, the relative fraction should be 0.15 - 0.20.) Some individual α particles have an energy equal to almost half the total kinetic energy, reaching 20 - 23 MeV in absolute magnitude.

In conclusion the authors consider it their pleasant duty to note the large volume of work carried out by V. N. Emelyanova, K. P. Skibenko, E. V. Chernavskaya, E. K. Minakova, and T. N. Startseva in processing emulsions.

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