Brief Communications

THE REACTION (d, α) ON B^{11} *AND* O^{16} *AT A DEUTERON ENERGY* 6.6 MeV

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IN the study of the reaction (d, α) one of the first questions is that of the interaction mechanism. Compared with the (d, p) reactions we can expect the compound nucleus mechanism to assume a larger role and the distorting factors in the direct processes to increase. In addition, intense peaks are possible at large angles, corresponding to the stripping of the α-particle formations from the target nuclei. The available experimental data indicate predominance of the direct processes in (d, α) reactions on light nuclei at energies above 10 MeV, and of the mechanism of the compound nucleus at low energies. The deuteron energy region 5—8 MeV has been least investigated; at the same time, the competition of the two main reactions of the mechanism is apparently strongest here.

A beam of deuterons with energy 6.6 MeV extracted from a cyclotron struck a target placed at an angle of 45° to the beam direction in the center of the scattering chamber. The deuterons passing through the target were gathered by a Faraday cylinder and registered by a current integrator, the state of the target being monitored with a scintillation counter with CsI(Tl) crystal. The targets were a boron film ~ 70 $\mu g/cm^2$ thick sputtered on a carbon substrate of the same thickness, and a free standing film of SiO_2 approximately 20 $\mu g/cm^2$ thick. The measurement error in the absolute values of the reaction cross section amounts to ± 50% and is due mostly to the errors in weighing the targets.

A semiconductor counter was located in the upper rotating part of the scattering chamber. In view of the exothermal nature of the (d, α) reactions in the course of formation of the low-lying levels of the product nuclei and large α-particle ionizing ability, the α particles were reliably separated by selecting the optimal bias on the semiconductor detector. The resolution of the surface-barrier semiconductor detector was 1—3% of the total energy. The range of measured angles was from 20 to 160° in the laboratory frame.

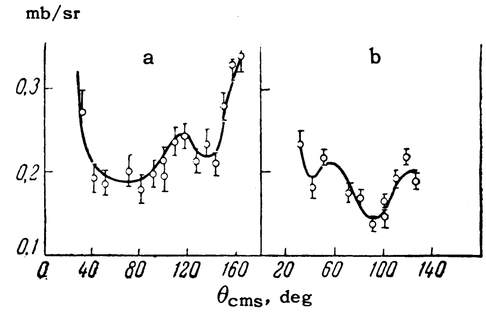

FIG. 1. Angular distribution of alpha particles in the $B^{11}(d,\alpha)Be^9$ reaction for the ground (a) and second excited (b) states of Be^9; E_d = 6.6 MeV.

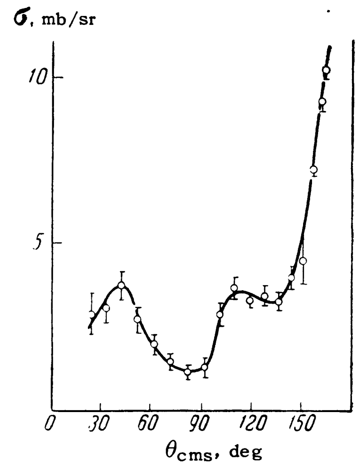

FIG. 2. Angular distribution of $O^{16}(d,\alpha)N^{14}$ reaction for the second excited (3.94 MeV) state; E_d = 6.6 MeV.

Measurement of the angular distribution of the alpha particles in the reaction $B^{11}(d, \alpha)Be^9$ has been carried out for the first time (see Fig. 1). We have observed in the energy spectrum all first four levels of Be^9, including the ~ 1.7 MeV level, the existence of which is still under doubt. The angular distributions have been measured satisfactorily only for the most intense ground and second-excited states. The differential cross sections for these levels have a form which is symmetrical with respect to 90° and small absolute values, thus favoring the compound-nucleus mechanism.

In the reaction $O^{16}(d, \alpha)N^{14}$ the cross sections for the ground and second-excited states of N^{14} increase radically in the region of angles close to 180° (see Fig. 2). A similar picture was observed by other authors at deuteron energies near 4 MeV[1] and 14.7 MeV[2]. This suggests that the increase in the cross section at angles close to 180° is a characteristic feature of the (d, α) reaction in O^{16} for the ground and second-excited levels of N^{14} over a wide energy range. Our curves can be roughly represented by a sum of a Legendre polynomial of low degree and a peak in the region of backward angles, that is, as the result of interference between the processes of the compound nucleus and the stripping of an alpha particle from the target nucleus. Specific calculations are now under way. It is interesting to note that the elastic scattering of an alpha particle with energy 18–22 MeV by even-even nuclei[3] also yields strong peaks in the region of backward angles, ascribable to the stripping of alpha particles from the target nucleus.

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[2] T. Yanabu, J. Phys. Soc. Japan **16**, 2118 (1961).

[3] Jodogne, Macq, and Steyart, Phys. Lett. 2, 325 (1962).

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206

THE REACTIONS (p, pn) AND (p, n) ON Sc^{45} *INDUCED BY HIGH-ENERGY PROTONS*

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THE present work continues experiments on radiochemical studies of simple nuclear reactions at bombarding-proton energies on the order of several hundred MeV.

The table lists the cross sections of the investigated reactions, the ratios of the cross sections for the production of the isomers Sc^{44g} and Sc^{44m}, and the cross sections of the monitor reaction. The table also lists for comparison the cross sections of the (p, pn) and (p, n) reactions on Ca^{48}[1].

The difference in the values of the cross sections of the reactions (p, pn) on nuclei that have close values of A and Z offers evidence of the strong influence of the structure of the target nucleus. An analysis of the results of the present work, of the earlier work[1], and also a comparison of the data obtained in them with the calculations of Benioff[2], supports our previous hypothesis that the mechanism of direct knock-on of a neutron in the reaction (p, pn) becomes predominant already in the energy range on the order of several hundred MeV.

Starting from this mechanism, we can calculate the ratio of the cross sections for the production of the isomers in the reaction (p, pn), similar to what was done by Porile and Tanaka[3]. The agreement with experiment is attained when the parameter σ contained in the expression for the dependence of the density of the nuclear levels on the spin assumes a value $\sigma \approx 4$. A theoretical esti-

Reaction	Cross Section, mb						
	E_p=120	200	300	400	500	600	670
Sc^{45} (p, pn)	70.1±1.8	50.4±1.2	48.5±1.2	47.7±1.0	43.1±1.0	42.0±0.7	39.4±0.7
Sc^{45} (p, n)	3.80±0.07	2.29±0.03	1.82±0.04	1.40±0.07	1.14±0.09	1.07±0.09	0.83±0.02
Ca^{48} (p, pn)	118±2	106±10	106±4	101±4	101±4	110±8	110±2
Ca^{48} (p, n)	7.8±0.3	4.7±1.2	4.1±0.3	3.6±0.1	3.9±0.2	2.2±0.2	2.6±0.1
Al^{27} (p, 3pn)	10.2	9.1	11.0	11.3	11.1	11.0	10.9
Sc^{44g}/Sc^{44m}	2.10±0.06	2.21±0.03	2.19±0.01	2.22±0.01	2.19±0.06	2.18±0.02	2.20±0.04