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M. Lattuada and R. Potenza: ABSOLUTE DIFFERENTIAL CROSS-SECTION OF THE $^{10}B(d,\alpha)^{8}Be$ REACTIONS AT $E_d = 1.83$ MeV.

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M. Lattuada and R. Potenza: ABSOLUTE DIFFERENTIAL CROSS-SECTION OF THE $^{10}B(d,\alpha)^{8}Be$ REACTIONS AT E_d = 1.83 MeV[(x)].

The knowledge of the differential cross section for the first emitted (spectator) particle in the reactions with three bodies in the final state is useful either for the analysis of the data obtained from the bidimensional spectra or as an ausiliary information about the reaction mechanism, beyond that obtained from the angular correlation of two exit particles.

Having this in mind we studied the differential cross sections of the $^{10}B(d,\alpha_0)^{8}Be$ and $^{10}B(d,\alpha_1)^{8}Be^{x}$ processes (Q = 17.819 MeV and Q = = 14.919 MeV respectively) at E_d = 1.83 MeV.

At this incident energy there are only data on the excitation functions at 45°, 90° and 150°[(1)]. There are no data on the angular distributions of the α-particles. The known data at lower energies[(1,2,3)] and at higher energies[(4)] seem to indicate that a broad peak exists around 120°. This peak seems to increase with the incident energy, so suggesting a change in the mechanism of the reaction. To study the $^{10}B(d,\alpha)^{8}Be$ angular distributions we bombarded by deuterons a target of B_2O_3 (enriched at 95% in ^{10}B) obtained by vacuum evaporation on a thin carbon film (40 mg/cm^2 thick).

The target thickness was measured counting the protons from the $^{10}B(d,p)^{11}B$ reactions and using the known (d, p) cross sections[(5)]. It resulted (1.2 ± 0.2) mg/cm^2, that is 350 keV at E_d = 2 MeV.

Two surface barrier detectors, supplied by ORTEC, were placed with the target inside the scattering chamber. One of them was fixed at 90° and acted as flux monitor. The other one was allowed to rotate between 30° and 150°.

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The surface of this latter was 7 mm^2 and its distance from the centre of the target 102 mm.

The beam was collected by a Faraday cup subtending an angle $\Delta\theta = 30^o$ on the target and dip enough to avoid escape of secondary electrons. The total charge collected in each run was measured by a current integrator supplied by Welex Electronics. The pulses from the movable detector were sent to a 400 channels analyzer supplied by LABEN, after standard amplification through ORTEC chains.

Measurements were done from $\theta = 48^o$ to $\theta = 60^o$ in steps of 4^o; from $\theta = 60^o$ to $\theta = 122^o$ in steps of 2^o. The runs were done at constant collected charge.

Fig. 1A) shows one of the obtained spectra of the α-particles leaving the ^8Be nucleus in the ground or the first excited state a $E_x = 2.9$ MeV.

As is seen, the spectrum of the α-particles leaving the ^8Be in the first excited state is given by a peak superimposed on a continuous background. It is known that this background is produced by the detection of the other α-particles (besides the spectator) emitted in the $^{10}B + d \longrightarrow 3\alpha$ reaction(2). We estimated empirically this background by the curve reported in Fig. 1A). The trend of this curve agrees with that of the experimental points on both sides of the peak and maintains the correct value of the peak energy at all angles. However the use of this curve increases the errors on the values of the cross section for the peak itself as can be seen from Fig. 1B) and Fig. 2.

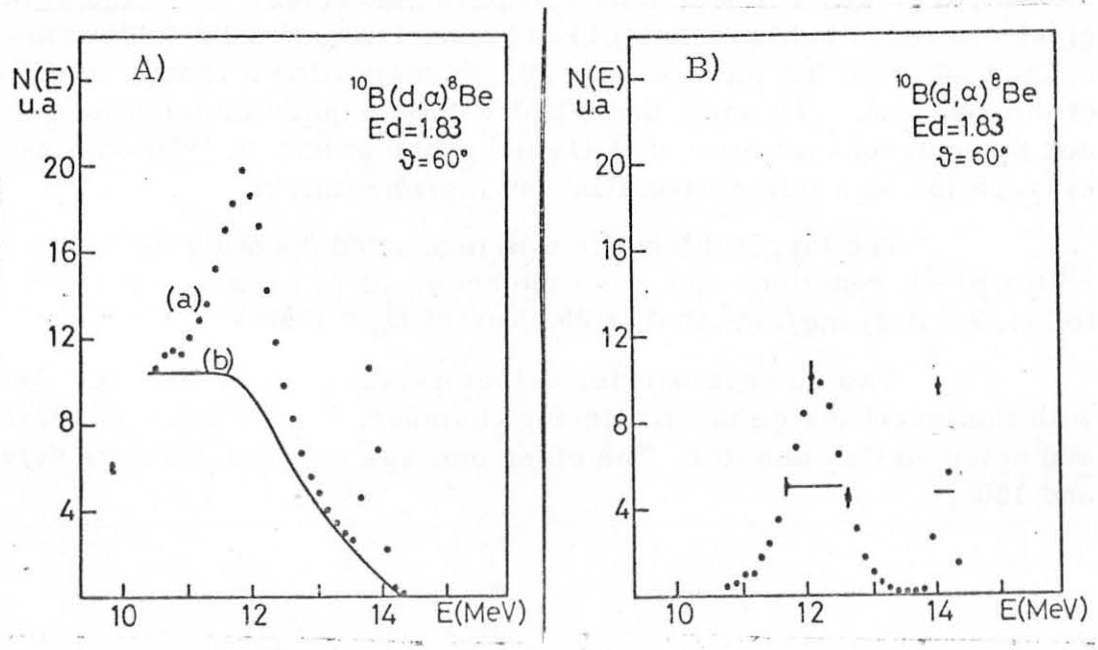

FIG. 1 - A) - Experimental α-particle spectrum at $\theta = 60^o$; the full curve represents the estimated three body background.
B) - α-particle spectrum after substraction of the background.

Fig. 1B) shows the spectrum of Fig. 1A) after the correction for the three bodies background. The error bars take into account the errors due to this background subtraction.

The width of the peak corresponding to the first excited state of the ^{8}Be is produced by the natural width of the state and by the experimental broadening measured by the width of the ground state peak. The natural width obtained from the spectrum is $\Gamma = 1.2 \pm 0.1$ MeV for the 2.9 MeV state. This value is in agreement with that found by other authors(6). The excitation energy corresponding to the peak was $E_x = 2.8 \pm \pm 0.2$ MeV, in agreement with other values(6).

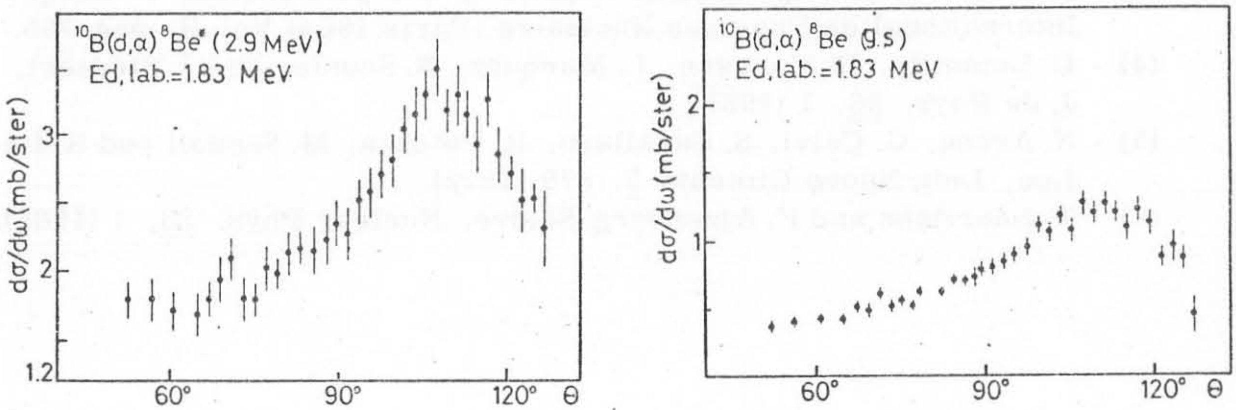

FIG. 2 - Angular distributions of the $^{10}B(d, \alpha_1)$ and $^{10}B(d, \alpha_o)$ reactions.

Fig. 2 reports the angular distributions of the $^{10}B(d, \alpha_o)^{8}Be$ and $^{10}B(d, \alpha_1)^{8}Be^{x}$ processes at $E_d = 1.83$ MeV in the centre of mass system. The pulses under the peak pertaining to the first excited state of the ^{8}Be were transformed to the c. m. system as if all had the peak energy. The errors reported in Fig. 2 contain the statistical and background subtraction contributions. They affect clearly also the relative values of the cross section.

The absolute values were obtained by comparison with the cross section of the $^{10}B(d, p)^{11}B$ reaction(5). The protons were in fact detected together the α-particles in the same measurements. The errors in the absolute values are about 12% due to the uncertainty in the (d, p) cross sections (10%) and in the proton number ($\sim$ 2%). From the proton counting and taking into account the solid angle subtended by the detector we obtained the target thickness. The obtained values of the cross-sections are in agreement with those reported in Ref. (1), at $\theta = 90^{o}$, within the errors.

As is seen from Fig. 2, both angular distributions show a pronunced peak at $\theta \cong 110^{o}$. This seems to indicate the presence of an heavy particle stripping mechanism with $\ell \neq 0$ at backward angles. In a model where a ^{6}Li is stripped from the ^{10}B by the incident deuteron, the possible other values of ℓ are 2 or 4. Using the relation

$$\ell \cong qR$$

for $q = 4.1 \times 10^{12}$ cm^{-1} at the peak angle and $R = 4.8 \times 10^{-13}$ cm, we had $\ell \cong 2$. So we conclude that the data are compatible with the presence at backward angles of heavy particle stripping with $\ell = 2$.

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