THE ENERGY SPECTRUM OF PROTONS FROM THE $^{7}Be(d,p)^{8}Be$ REACTION*

By R. H. SPEAR†

The experimental evidence relating to the low-lying excited states of ^{8}Be has been discussed in a previous paper (Spear 1958). This note presents the results of a preliminary study of the energy spectrum of protons from the previously unreported $^{7}Be(d,p)^{8}Be$ reaction, undertaken with a view to obtaining further information on the problem.

The main difficulty of the experiment was to obtain a suitable ^{7}Be target; ^{7}Be is unstable, and decays by K-capture with a half life of 53 days (Strominger, Hollander, and Seaborg 1958). The target was prepared by evaporating down a solution of ^{7}Be in hydrochloric acid onto a backing of gold foil of thickness $22 \cdot 7$ mg cm^{-2}. Unfortunately, the solution contained a good deal of impurity, and the solid material deposited on evaporation formed a thick and rather uneven target. The target covered an area of approximately $0 \cdot 3$ cm^{2}, and had an estimated activity of 20 μc.

The reaction was studied using the camera described by Martin *et al.* (1949), and each plate was given an integrated exposure of the order of 70,000 μC of $0 \cdot 85$ MeV deuterons from an electrostatic generator. The plates were processed

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† Physics Department, University of Melbourne.

and proton ranges measured, by conventional methods. The proton energies E_p were determined from the range-energy relation given by Gibson, Prowse, and Rotblat (1954) for Ilford C2 emulsions.

Spectra have been obtained at three angles : 0, 90, and 270°, corresponding to mean values of φ, the true angle to the incident beam, of 13, 87, and 268° respectively. At each angle measurements were made over an area of approximately 1–2 cm² at a radial distance of approximately 4·7 cm from the point in

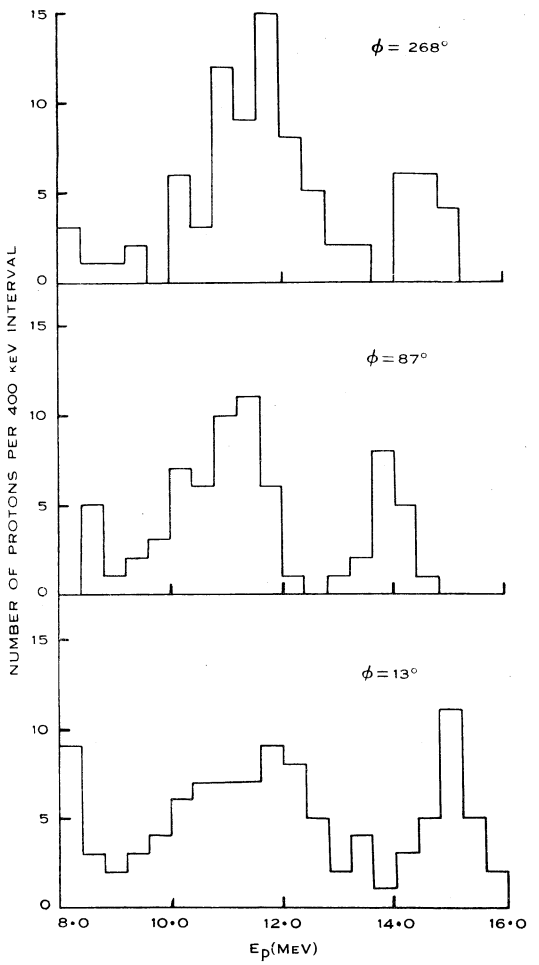

Fig. 1.—Energy spectrum of protons from ^{7}Be$(d,p)^{8}$Be.

the plate above the target spot. The absorbing foils were sufficiently thick to absorb the products of most contaminant reactions. So as to avoid tracks from the ^{14}N$(d,p)^{15}$N reaction (Q=8·609 MeV), tracks were accepted only if their range was greater than two fields of view (approximately 390 μ).

The results obtained from four plates (three 400 μ and one 200 μ) are shown in Figure 1. The tracks at 8·1 MeV on the 13° spectrum are probably due to the high energy tail of the ground state group from the ^{14}N$(d,p)^{15}$N reaction. In

order to combine the results in terms of excitation energy E_{ex} in ^{8}Be, the following procedure was adopted. It was assumed that the high energy group at each angle was the ground state group from ^{7}Be$(d,p)^{8}$Be. From the energy of this group and the Q-value of 16·661 MeV for the reaction (as determined from the mass values), the total absorber thickness (i.e. target plus foils) at each angle was calculated. This thickness, obtained in centimetres air equivalent using the range-energy relation for protons in air given by Bethe and Ashkin (1953), was then used to find the relation between E_p and E_{ex} at each angle. The results for the three angles are plotted in terms of E_{ex} in Figure 2. The upper limit

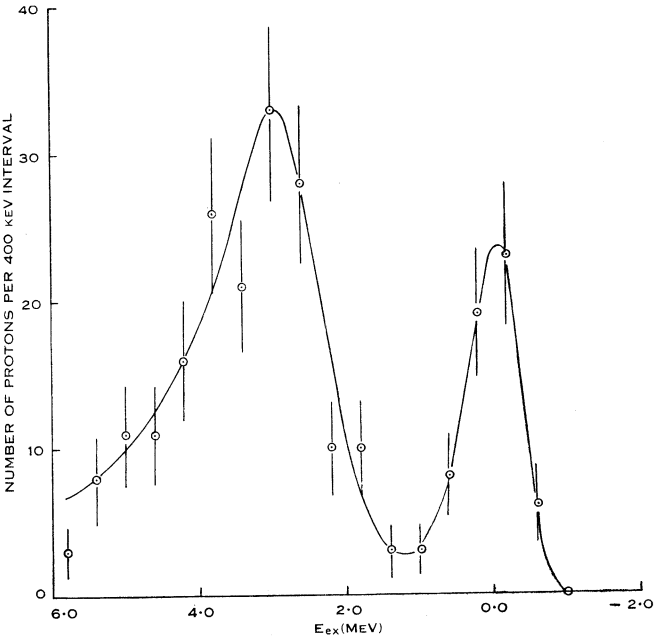

Fig. 2.—Energy spectrum of protons from ^{7}Be$(d,p)^{8}$Be (combination of results for φ=13, 87, and 268°).

taken for E_{ex}, 5·8 MeV, corresponds to E_p=9·0, 8·1, and 9·1 MeV at 13, 87, and 268° respectively. There is no feasible contamination reaction which could give protons in the range of energies covered by Figure 2. The nearest would be the ^{10}B$(d,p)^{11}$B reaction (Q=9·227 MeV); if the target thickness were zero this would give protons of energies 8·2, 7·5, and 8·3 MeV at 13, 87, and 268° respectively.

The general shape of the spectrum is very similar to that obtained for the " mirror reaction " ^{7}Li$(d,n)^{8}$Be (Spear 1958), with a very broad group peaked at E_{ex}=2·95 MeV. The intensity of the ground state group relative to the 2·9 MeV state group is rather less than was obtained for the ^{7}Li$(d,n)^{8}$Be reaction. This may be explained by the fact that in the 200 μ plate many of the longer tracks passed right through the emulsion into the glass backing, and so were neglected; this would tend to suppress the high energy end of the spectrum.

The half-width of the ground state group is approximately 0·9 MeV. This relatively large width is due mainly to the use of a thick, uneven target and to the angular straggling caused by the necessity to scan a large area at each angle in order to obtain sufficient tracks. After allowing for experimental resolution, a value of $1{\cdot}6 \pm 0{\cdot}4$ MeV is obtained for the width of the 2·9 MeV level, in good agreement with the value obtained from the ^{7}Li$(d,n)^{8}$Be reaction (Spear 1958).

Although the statistical accuracy of the measurements is not high, the results do not indicate the existence of any low intensity excited states of ^{8}Be in the region covered.

It is intended to extend the measurements using a purer sample of ^{7}Be in order to obtain a higher yield and better resolution.*

* *Note added in Proof.*—It has recently been brought to the author's attention that C. A. Barnes, R. W. Kavanagh, and J. B. Marion studied this reaction at the California Institute of Technology in 1956, using a scintillation spectrometer, but did not publish their results. Their 90° spectrum is similar to the present results.

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