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U. Fasoli, D. Toniolo and G. Zago: THE $Li^6(p, He^3)He^4$ REACTION IN THE ENERGY RANGE 3 - 5,6 MeV.

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dei Laboratori Nazionali di Frascati
Cas. Postale 70 - Frascati (Roma)

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ABSTRACT

The $Li^6(p, He^3)He^4$ reaction has been studied in the energy range 3 ÷ 5. 6 MeV. The total cross section decreases monotonically in the above energy range, without showing any appreciable structure of the compound nucleus Be^7. -

INTRODUCTION

The excitation curve of the reaction $Li^6(p, He^3)He^4$ at a laboratory angle of 164° in the energy range 1 ÷ 3 MeV has first been obtained by Bashkin and Richards(1). The curve shows a maximum related to the 7.18 MeV energy level of Be^7. Later, Marion et al. (2) and Kahn et al. (3) measured excitation curves and angular distributions respectively from 0. 6 to 2. 9 MeV and from 100 to 300 KeV. Recently, Tombrello and Parker(4) quoted a new level of Be^7 at 9. 9 MeV excitation energy as seen by Harrison and Whitehead(5) in p-Li^6 elastic scattering measurement. Information on this level comes also from the work by Fasoli et al. (6).

The present work has been undertaken in order to get more information on the above level.

This work was in progress when Jeronymo et al. (7); published a study of the $Li^6(p, He^3)He^4$ extended up to 5 MeV proton energy.

EXPERIMENTAL METHOD

Protons accelerated by the Van de Graaff accelerator at Legnaro were focalized in a 99. 3% Li^6 enriched target, evaporated on 1000 A Nickél backing, located in the centre of a scattering chamber. He^3 and He^4 particles were detected by means of a ORTEC solid state detector The target and all the experimental set-up was the same as used in the work of Fasoli et al. (6) on the $Li^6(p, p)Li^6$ elastic scattering. Countings were monitored with a precision integrator of the unscattered beam current collected by a Farady cup.

(x) Laboratorio dell'Acceleratore, Istituto di Fisica dell'Università, Padova; I. N. F. N., Sezione di Padova.

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Protons elastically scattered by the target had energy èqual to or very near that of He^3 or He^4 particles. The solid state detector was therefore polarized so that the corresponding depletion depth was just a little larger than the range of more energetic alpha's. Owing to the large difference of energy deposited on the sensitive layer of the counter, the different particles were easily distinguishable. Figure 1 shows a typical pulse height spectrum.

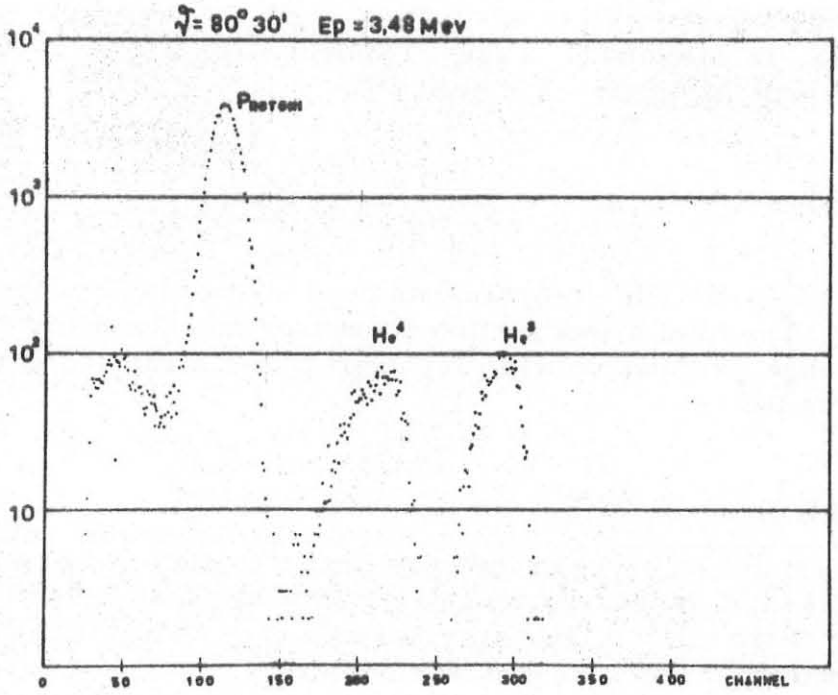

Fig. 1 - A pulse height spectrum of the particles scattered from the Li^6 target. -

For every angle and energy both He^3 and He^4 particles were counted by computing the areas under the peaks of the corresponding pulses registered with a multichannel analyzer.

Angular distribution curves were taken between 3. 0 and 5. 6 MeV in 100 KeV steps and between 20° and 80° in 5 degree steps. Above 4 MeV, He^3 particles were counted also at the angles 145°, 150° and 166. 5°. The backward yield of He^3's has been evaluated from the He^4 forward yield, by means of the kinematic of the reaction.

Statistical errors vary between 2% and 4%. Deadtime corrections were less than 2%. The main source of error arises from the estimation of the background, which varies between 5% and 10%, leading to overall uncertainty of about 5%.

RESULTS

Each angular distribution has been fitted with an equation:

$$S(\theta) = A_o \left[1 + \sum_{n=1}^{4} A_n P_n(\cos\theta) \right] ,$$

where $P_n(\cos\theta)$ is the Legendre polynomial of order n. The coefficients A_o, which is proportional to the total cross section, and A_n have been calculated with the least squares method by an electronic computer.

Some typical angular distributions obtained are shown in Fig. 2; continuous curves are the calculated best fits.

Figure 3 shows the behaviour of the total cross section and of the A_n coefficients as functions of the energy.

The present experiment allowed only measurement of relative cross sections. Absolute values were calculated by comparing, by means of the reciprocity theorem, our relative results to those of Tombrello et al. [4], who measured the absolute cross section of the inverse reaction $He^4(He^3, p)Li^6$. On Fig. 4 our results are compared to Tombrello's data Our total

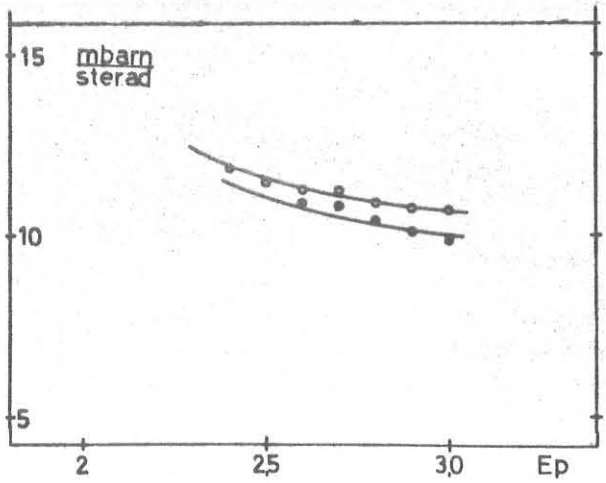

Fig. 4 - Normalization of our He^3 yields (open and full circles) from the reaction $Li^6(p, He^3)He^4$ to the cross section values derived by the recirpocity theorem from the results of Tombrello and Parker on the inverse reaction. The two continuous curves have been obtained from the curves of Tombrello at 20^o and 30^o

cross section agrees within 3% with that of Jeronymo et al [7], and is 20% lower, although with the same behaviour, than the total cross section found by Han and Heydenburg[8].

The absence of any singularity in the total cross section curve implies that the Be^7 level at about 10 MeV of axcitation energy has a small width for α particle emission.

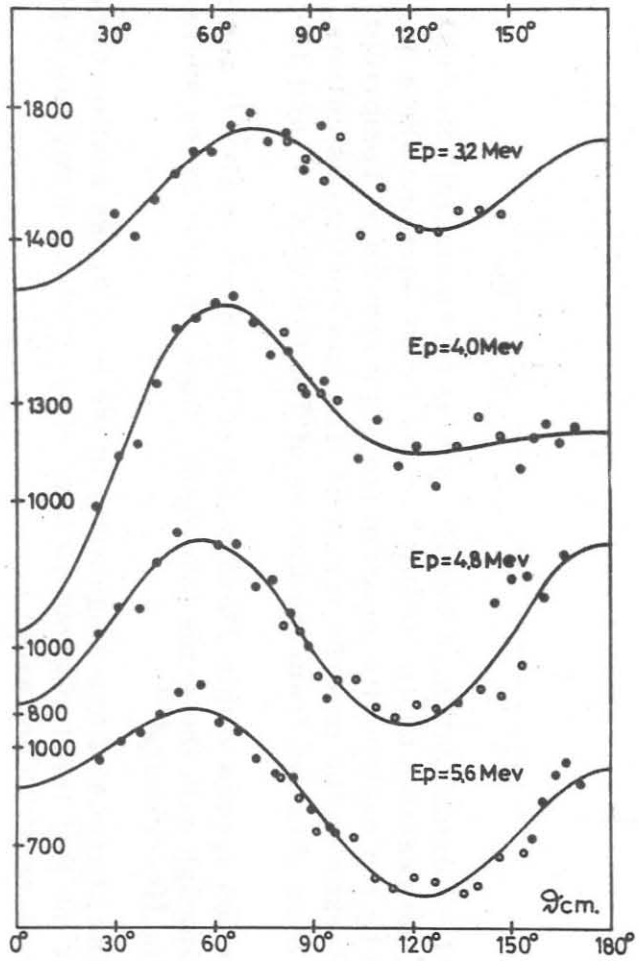

FIG. 2 - Some He^3 angular distribution curves of the reaction $Li^6(p, He^3)He^4$. Full circles are data, open circles are derived from He^4 data.

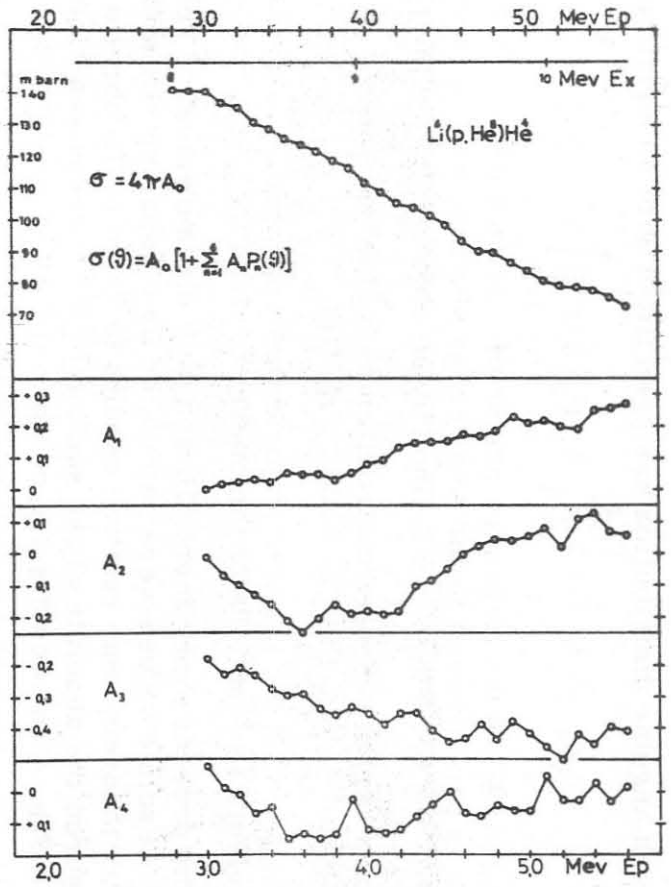

FIG. 3 - Total cross section of the reaction Li $Li^6(p, He^3)He^4$ and coefficients of the angular distribution versus incident proton energy.

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