THE $Li^6(p, He^3)He^4$ REACTION IN THE ENERGY RANGE 3-5.6 MeV *

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Recently, Tombrello and Parker [1]) quoted a new level of Be^7 at 9.9 MeV excitation energy as seen by Harrison and Whitehead [2]) in p-Li^6 elastic scattering measurement. Information on this level comes also from the work by Fasoli et al. [3]).

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

Protons accelerated by the Van de Graaff accelerator at Legnaro were focalized in a 99.3% Li^6 enriched target evaporated on 1000 Å Nickel backing, located in the centre of a scattering chamber. He^3 and He^4 particles were detected by means of an ORTEC solid state detector. The target and all the experimental set-up was the same as used in the work of Fasoli et al. [3]) 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 Faraday cup.

Protons elastically scattered by the target had energy equal 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 depth of the counter, the different particles were easily distinguishable.

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^o and 80^o in 5 degree steps. Above 4 MeV He^3 particles were counted also at the angles 145^o, 150^o, 155^o and 166.5^o. 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 an overall uncertainty of about 5%.

Each angular distribution has been fitted with an equation:

$$S(\theta) = A_0 \left(1 + \sum_{n=1}^{4} A_n P_n(\cos\theta)\right) ,$$

where $P_n(\cos\theta)$ is the Legendre polynomial of order n. The coefficients A_0 - 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. 1; continuous curves are the calculated best fits.

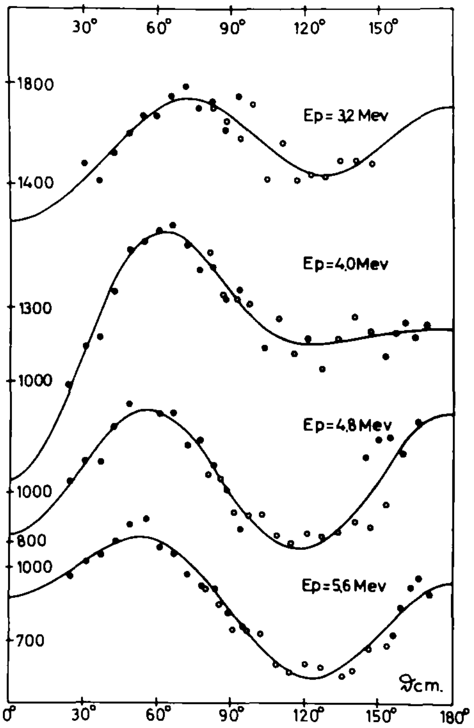

Fig. 1. Some He^3 angular distribution curves of the reaction $Li^6(p, He^3)He^4$. Full circles are He^3 data, open circles are derived from He^4 data.

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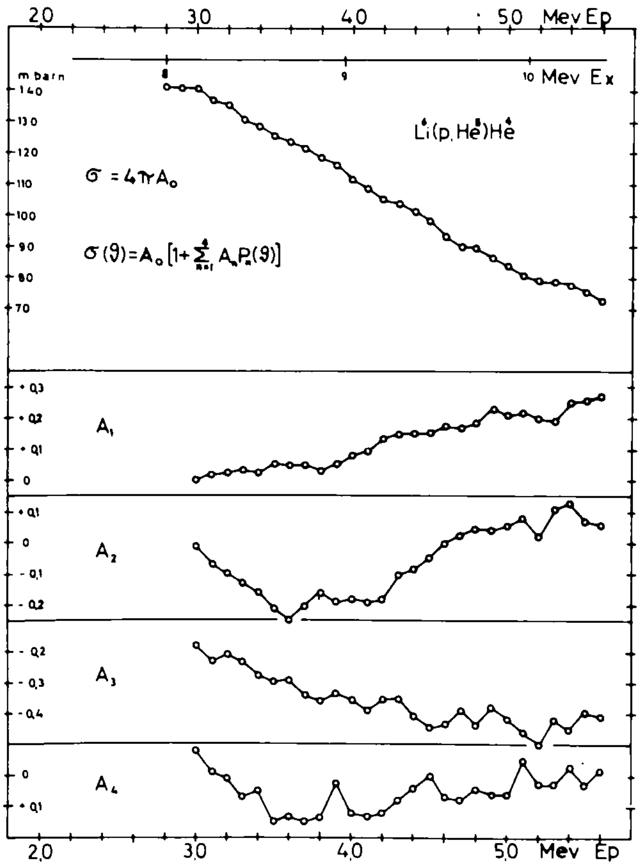

Fig. 2. Total cross section of the reaction $Li^6(p, He^3)He^4$ and coefficients of the angular distribution versus incident proton energy.

Fig. 2 shows the behaviour of the total cross section and of the A_n coefficients as functions of the energy.

The present experiment allowed only the measurement of relative cross sections. Absolute values were calculated by comparing, be means of the reciprocity theorem, our relative results to the results of Tombrello et al. [1], who measured the absolute cross section of the inverse reaction $He^4(He^3, p)Li^6$. Our total cross section agrees within 3% with that of Jeronymo et al. [4], and is 20% lower, although with the same behaviour, than the total cross section found by Han and Heydenburg [5].

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

References

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EXCITATION OF M1 TRANSITIONS IN Li^6 AND N^{14} BY INELASTIC ELECTRON SCATTERING

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An extensive programme has been under way at this Laboratory for some time to verify the predictions of the Born Approximation calculation of inelastic cross sections for electron scattering on light nuclei [1]. The study of the excitation of magnetic transitions by this method is of particular interest since it should take place by the exchange of entirely transverse virtual photons between the scattered electrons and the nuclear system. The exchange of transverse photons rather than longitudinal photons is characterised by the angular dependences of the cross section for a fixed momentum transfer, which are respectively