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The Elastic Scattering of Protons by ^{6}Li in the Energy Range $(1.3 \div 5.6)$ MeV (*).

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The present work was undertaken in order to study the ^{6}Be nuclide in the excitation energy region above 7.18 MeV up to 10 MeV. A resonance at about 9.9 MeV excitation energy, with $\Gamma = 1.5$ MeV, has been observed.

A proton beam accelerated up to 5.6 MeV with the Van de Graaff accelerator of the University of Padua, and analysed by a magnet whose resolution was 0.15% (1), entered a scattering chamber, very similar to that described by Silverstein *et al.* (2). The countings were normalized to the same beam charge by a precision integration of the unscattered beam current collected by means of a Faraday cup.

Scattered protons, ^{3}He and ^{4}He particles, coming from the reaction ^{6}Li(p, ^{3}He)^{4}He were detected by an ORTEC solid-state detector, which subtended a solid angle of $2.2 \cdot 10^{-3}$ steradian at the target.

The target was made by vacuum evaporation of 99.3% enriched ^{6}Li metal on a 1000 Å nickel foil. The thickness of the target was equivalent to 30 keV energy loss for 1.3 MeV protons.

The pulses from the detectors were analysed by a 512-channel pulse-height analyser. The resolution of the counter and the thickness of the target were such as to allow a clear separation between the peaks of the protons elastically scattered from ^{6}Li and the peaks due to other particles.

Fig. 1 shows the excitation curves obtained; the cross-section and the angles are referred to the centre-of-mass system. The values of the angles correspond to zeros of the Legendre polynomials up to the fourth order, the 168° 39′ angle is the largest obtainable by the scattering chamber.

Figures 2*a*) and *b*) give the angular distribution. The curves show that, for energies larger than about 3 MeV, waves with $l = 2$ cannot be neglected.

Statistical errors varied between 0.5% and 1.5%. The mean value of the background correction was 1%. The errors

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(1) U. Fasoli, D. Toniolo and G. Zago: *Nuovo Cimento*, in press (1964).

(2) E. A. Silverstein, S. R. Salisbury, G. Hardie and L. D. Oppliger: *Phys. Rev.*, **124**, 868 (1961).

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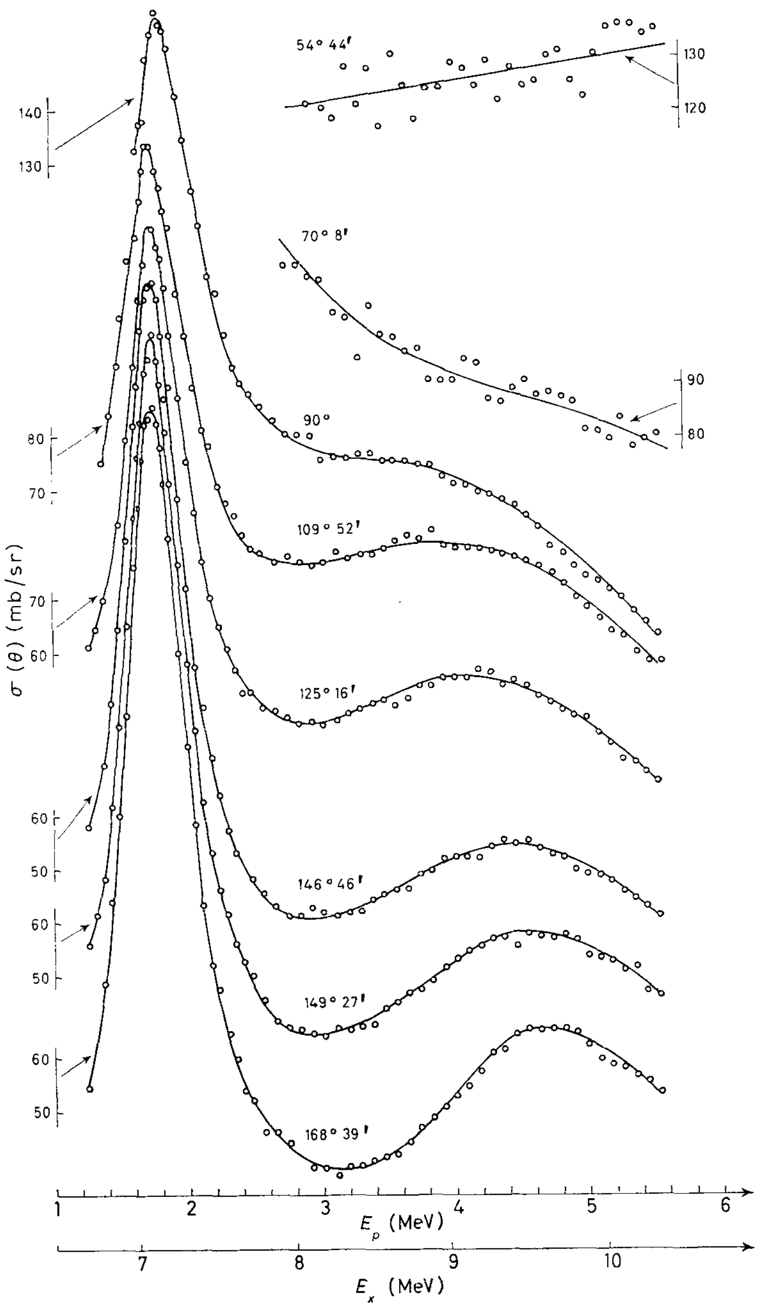

Fig. 1. – Excitation curves of ^{6}Li(p, p)^{6}Li reaction; the cross-section scale and the angles are in the c.m.s.; smooth curves have been drawn through the points; E_x is the excitation energy of ^{7}Be.

are slightly larger for the two curves in the forward emisphere.

Corrections for the deadtime of the counting chain and for deterioration of the target were not applied because they were negligible.

lute cross-section values of the inverse reaction obtained by TOMBRELLO and PARKER (4).

A systematic difference of 17% has been found between our data and McCRAY's (5) data, who performed the

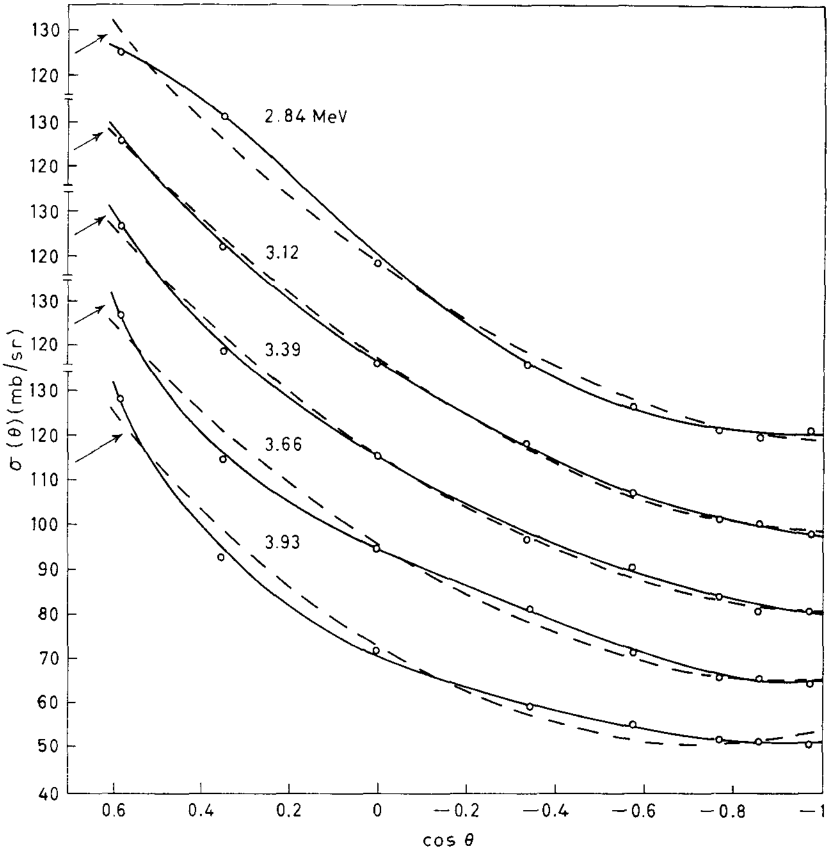

Fig. 2 *a*). – Angular distribution in the c.m.s. of the ^{6}Li(p, p)^{6}Li reaction. The curves have been obtained with the least square method, using second- and fourth-order polynomials (dashed and continuous lines, respectively).

The energy scale is estimated to be correct within about 10 keV.

The present measurements gave only relative values of the cross-section. The absolute cross-section scale has been evaluated by the reciprocity theorem, normalizing our ^{3}He yield from the reaction ^{6}Li(p, ^{3}He)^{4}He (3) to the abso-

same experiment up to 3 MeV of proton energy; the relative values agree well within the statistical errors.

The maximum on the excitation curve at $E_p = 1.85$ MeV is related to

(3) U. FASOLI, D. TONIOLO and G. ZAGO: *Phys. Lett.*, **127**, 8 (1964), and INFN/BE-64/1 (1964).

(4) T. A. TOMBRELLO and P. D. PARKER: *Phys. Rev.*, **130**, 1112 (1963).

(5) J. A. McCRAY: private communication and *Phys. Rev.*, **130**, 2034 (1963).

the known ^{7}Be level at 7.18 MeV excitation energy.

A second broad maximum is apparent between 4 and 5 MeV of proton energy corresponding to about 9.9 MeV excitation energy of ^{7}Be. The same

The structure of ^{7}Be levels is now rather well understood up to 7.18 MeV excitation energy. A recent work of TOMBRELLO *et al.* (4) has resolved the question of the existence and position of the $^2F_{\frac{5}{2}}$ level. The 7.18 MeV level

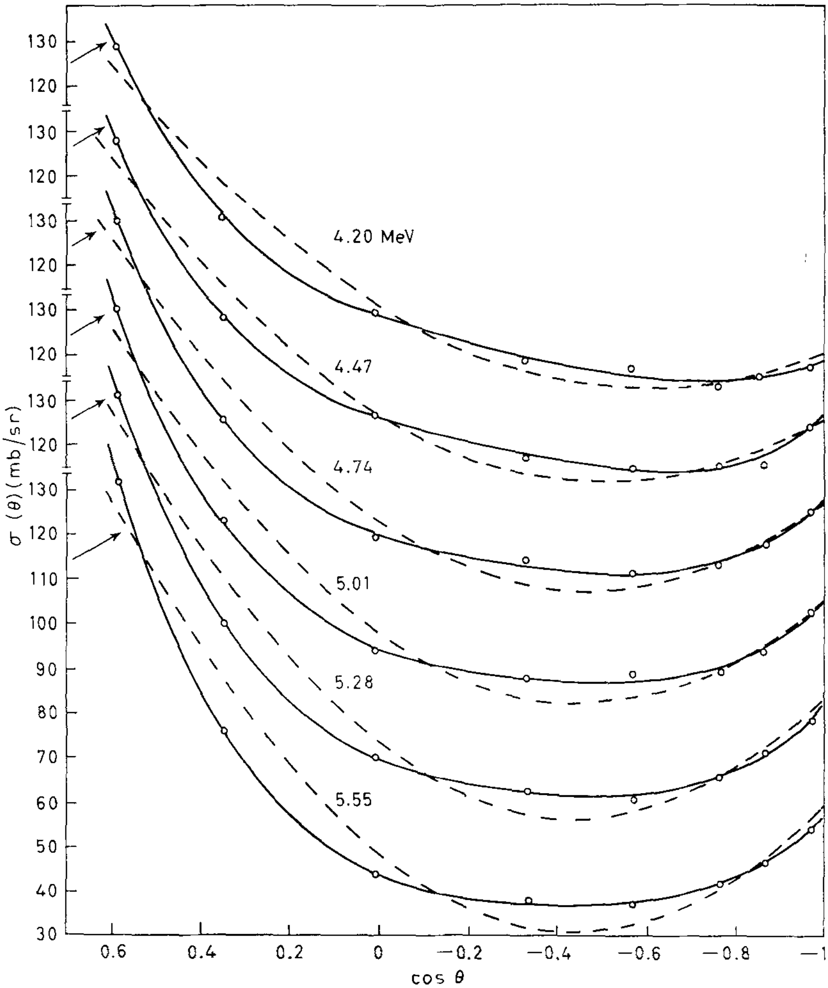

Fig. 2 *b*). – Angular distribution in the c.m.s. of the ^{6}Li(p, p)^{6}Li reaction. The curves have been obtained with the least square method, using second- and tourth-order polynomials (dashed and continuos lines, respectively).

resonance has been observed by HARRISON and WHITEHEAD (6).

studied by McCRAY (5) seems to belong to the $^4P_{\frac{5}{2}}$ configuration. Our data show a broad maximum around 4.6 MeV proton bombarding energy. The cos θ analysis of the angular distribution

(6) W. D. HARRISON and A. B. WHITEHEAD: *Phys. Rev.*, **132**, 2607 (1963).

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curves in this region indicate that the value of J should not exceed $\frac{5}{2}$; moreover their shape suggests a p-wave resonance. It is resonable to expect that this resonance belongs to $4P$ multiplet. As the $4P_{\frac{5}{2}}$ configuration has already been assigned to the resonance at 7.18 MeV (5) the more logical assignment for this resonance is $4P_{\frac{3}{2}}$. The shell-model prediction for the $4P_{\frac{3}{2}}$ state in the LS coupling is $L=1$ for the orbital angular momentum of the three nucleons in the unfilled shell, and $S=\frac{3}{2}$ for their spin. The reduced width for the decay of this state to the $^3He+^4He$, would have a small reduced width, since it implies a change of 1 unit in the spin. In fact in a previous work (3) on the $^6Li(p, ^4He)^3He$ reaction, we did not observe any structure of the total cross-section in this energy region. This fact corroborates our previous suggestion of $4P_{\frac{3}{2}}$ structure for the resonance at 4.6 MeV with $J=\frac{3}{2}^-$ (*).

(*) The same result was obtained by W. D. HARRISON in the study of elastic and inelastic scattering of protons by ^6Li. We express our thanks to him for having communicated his results to us before publication.