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U. Abbondanno, F. Demanins and G. Nardelli

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U. Abbondanno, F. Demanins

Istituto di Fisica, Università di Trieste

Istituto Nazionale di Fisica Nucleare, Sezione di Trieste

G. Nardelli

Istituto di Fisica, Università di Padova

Istituto Nazionale di Fisica Nucleare, Sezione di Padova

ABSTRACT

A measurement of the angular distributions of neutrons emitted in the two-proton transfer reaction $T(^3He,n)^5Li$ is described. The experimental data for the neutrons from the ground state ($J^\pi = 3/2^-$) and first-excited state ($J^\pi = 1/2^-$, $E_x = 10.21$ MeV, $\Gamma = 2.82$ MeV) of ^5Li are compared to the theoretical curves calculated assuming an angular momentum transfer $J_T = 1$. The use of this reaction is proposed to study the excited levels of ^6Li in the excitation energy region of about 18 MeV.

1. - INTRODUCTION

During the last years the (^3He,n) reaction has been often used on medium and light nuclei as source of spectroscopic information about the residual nuclei and about the reaction mechanism. For this purpose the experimental results have been compared with the results of the direct-reaction theory of two nucleon stripping and with the compound nucleus calculations.[1,2]

While the use of this reaction is limited by the experimental problems connected with the requirement of a refined neutron spectrometry in presence of a strong gamma background, the (^3He,n) reaction allows one to reach residual nuclei that are two proton removed from a stable target and to study nuclear levels with two excited nucleons, that cannot be populated by means of reactions like one-nucleon transfer or inelastic-scattering. Moreover, the two-nucleon stripping is remarkably selective, thus enhancing the formation of states with a strong parentage with the ground state of the target nucleus.

In the (^3He,n) reaction, the angular distribution is characterized by the angular momentum transferred by two protons, but for a transferred angular momentum there are various possible proton configurations. The result can be a constructive coherence enhancing some transitions, while the residual part of the interaction, independent from the coherent effects, depends from the configuration mixing. This situation favours the two nucleon transfer reaction in respect to the one nucleon transfer reaction in the detailed study of nuclear wave functions. It becomes clear from these considerations the interest of the comparison between experimental data and theoretical models of two nucleon transfer reactions as an important tool in the study of the spectroscopy of the residual and compound nucleus and of the reaction mechanism.

A particular case of (^3He,n) reaction concerns very light targets with unstable residual nuclei, as in the study presented in this report. In the T(^3He,n)^5Li reaction the ^3He-T interaction induces the following processes[3]:

(I)	$^3He + T \rightarrow {}^5Li + n \rightarrow \alpha + p + n$	Q = 10.138 MeV
(II)	$\rightarrow {}^5He + p \rightarrow \alpha + p + n$	Q = 10.138 MeV
(III)	$\rightarrow \alpha + p + n$	Q = 12.095 MeV
(IV)	$\rightarrow {}^4He + d$	Q = 14.32 MeV
(V)	$\rightarrow {}^6Li + \gamma$	Q = 15.79 MeV
(VI)	$\rightarrow {}^3He + T$	

It is clear that the experimental study of the reaction (I) will be complicated by the presence of the reactions (II) and (III), that produce neutrons in the exit channel. In fact, neutrons will arise both from the ^5He disintegration (reaction I) and from the three body reaction (III). For these reasons the $T(^3He,n)^5Li$ reaction has been in the past the object of a few studies concerning only the neutrons from the ground state of ^5Li (4,5).

For so light a target nucleus, there are some difficulties in the interpretation of the experimental results in terms of the direct-reaction formalism of the Distorted Wave Born Approximation (DWBA). At first, the potential parameters for the short-living residual nucleus are not obtainable (as usually made) by means of elastic scattering measurements. Moreover, in the case of two very similar nuclei as T and ^3He, the reaction can proceed both through the transfer of two protons from ^3He to T (and in this case the observed neutron comes from ^3He with a double stripping process), and by emission of the neutron from T with a knock-out process. The aim of the present work is to study the angular distributions of neutrons from the ground and first excited state of ^5Li, to determine the excitation energy and width of this level, and to test the reaction mechanisms and their probability in the limits of the present knowledge of them. The experimental data have been collected for an angular interval of the differential cross sections from 0^o to 160^o, and for incident ^3He energies between 2 and 5.5 MeV.

2. - EXPERIMENTAL ARRANGEMENT

The measurements have been performed using the pulsed, singly charged ^3He beam of the 5.5 MeV Van de Graaff accelerator of the "Laboratori Nazionali di Legnaro". A detailed description of the experimental arrangement has been reported elsewhere(2,6).

The targets had a medium density of 2.10^{18} nuclei of Tritium per square centimeter. Tritium was absorbed in 0.155 mg/cm^2 of Titanium on a Copper backing 0.25 mm thick. The neutron spectra were measured to obtain the angular distributions at the energies of ^3He of 2, -2.5, -3, -3.5, -4, -4.5 and 5.5 MeV.

A typical neutron spectrum (taken at $E_{^3He}$ = 3.5 MeV and at an angle $\theta_L = 20^o$ in the laboratory system L.S.) is reported in Fig. 1. In this figure one can see the peaks corresponding to the neutrons from the ground state (n_o) and from the first-excited state (n_1) of ^5Li, superimposed to the continuum neutron spectrum arising from the above mentioned competing reactions.

3. - DATA ANALYSIS

It is clear from Fig. 1 that it is necessary to subtract the contribution arising from other neutron producing reactions (II and III) before extracting the angular distributions for the n_o and n_1 neutron groups from the $T(^3He,n)^5Li$ reaction.

The neutron yield from the ^5He disintegration (reaction II) is negligible: in fact the calculated spectral shapes do not agree with the experimental data, and the yield is surely smaller than the experimental indetermination of the data. To the contrary, the angular distribution of the neutrons in the continuum spectrum can be reproduced by the angular and energy distributions calculated for the three body process (reaction III). For this reaction, the differential cross section for a neutron with an energy E_n can be written(7)

$$(1) \qquad \frac{d^2\sigma}{d\Omega\, dE_n} = \frac{8\pi^2}{\hbar^2} \quad \frac{\mu}{K} \quad <|M|>^2 \quad \rho(E_n)$$

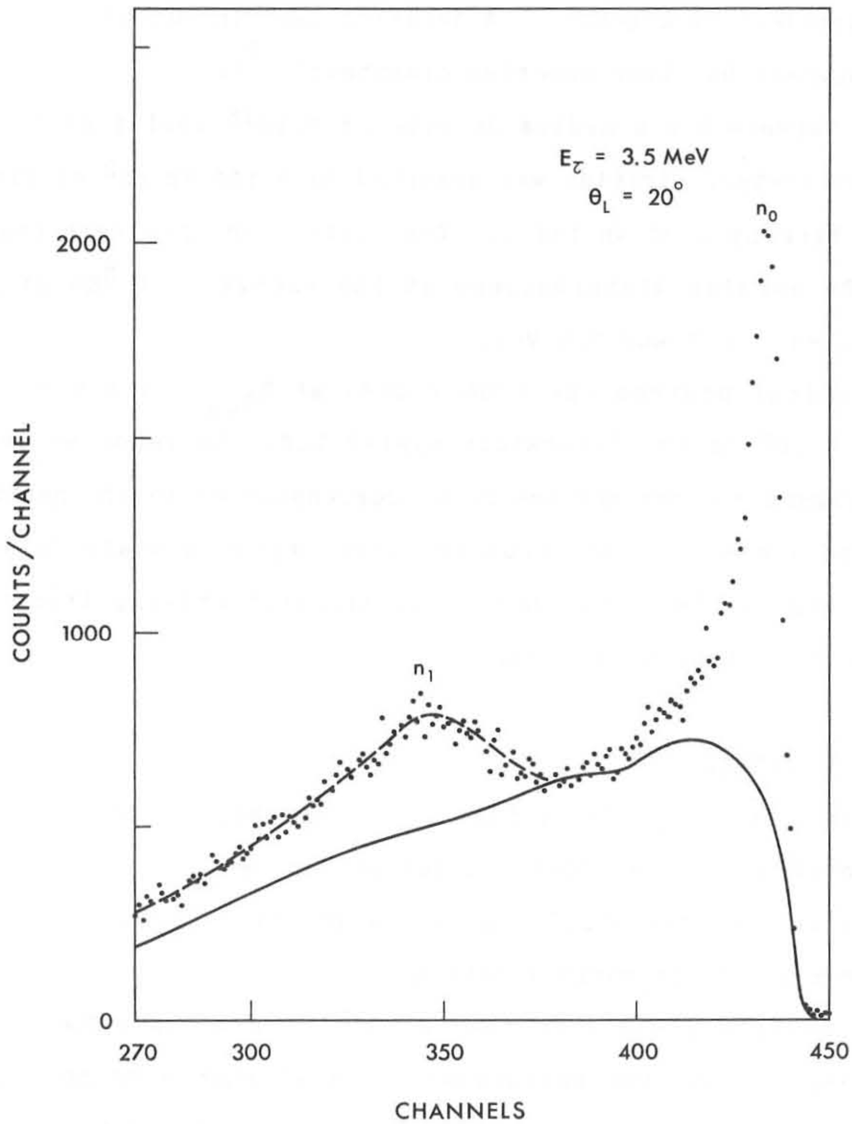

Fig. 1 - Time of flight spectrum (0,5 ns/channel) obtained at $E_{^3He}$ = 3.5 MeV and $\theta_{L.S.}$ = 20°. n_o is the neutron group from the ground state and n_1 from the first excited state of ^5Li. The dashed line is the calculated continuous spectrum of neutrons.

where $\mu = \frac{m_{^3He}\, m_T}{m_{^3He}+m_T}$

$\hbar K$ is the relative momentum of ^3He and T

<|M|> is the matrix element composed by the initial status vector, by the interaction Hamiltonian and by the final state vector, averaged on the whole solid angle

m_i are the masses of the various particles.

In the expression (1) the term $\rho(E_n)$ represents the density of the final states. That can be written in the L.S., for an observation angle θ:

$$(2) \qquad \rho(E_n) = A[E_n(E_o-E_n + 2B^{1/2}\, E_n^{1/2} \cos\theta - B)]^{1/2}$$

with $A = \frac{2(m_n + m_p + m_\alpha)^{1/2}\,(m_n\, m_p\, m_\alpha)^{3/2}}{h^6(m_p + m_\alpha)^2}$

$$B = \frac{m_n\, m_{^3He}}{(m_{^3He}+m_T)^2}\, E_{^3He}$$

$$C = (Q + \frac{m_T}{m_{^3He}+m_T}\, E_{^3He})\ (1 + \frac{m_n}{m_p+m_\alpha})^{-1}$$

The neutron spectra calculated according (1) and (2) at the angles and energies embraced by the present measurement agree fairly well with the measured data and have been used to subtract to the experimental neutron spectra the continuous contribution.

The intensities of the n_o and n_1 neutron groups obtained in this way have been used to determine the angular distributions reported in Figs. 2-6. In obtaining these angular distributions the width of the rows has been taken into account determining a characteristic shape for the two neutron groups. The spectral variation of the shape for both neutron groups has been obtained (at the above mentioned energies and angles) from kinematic considerations only.

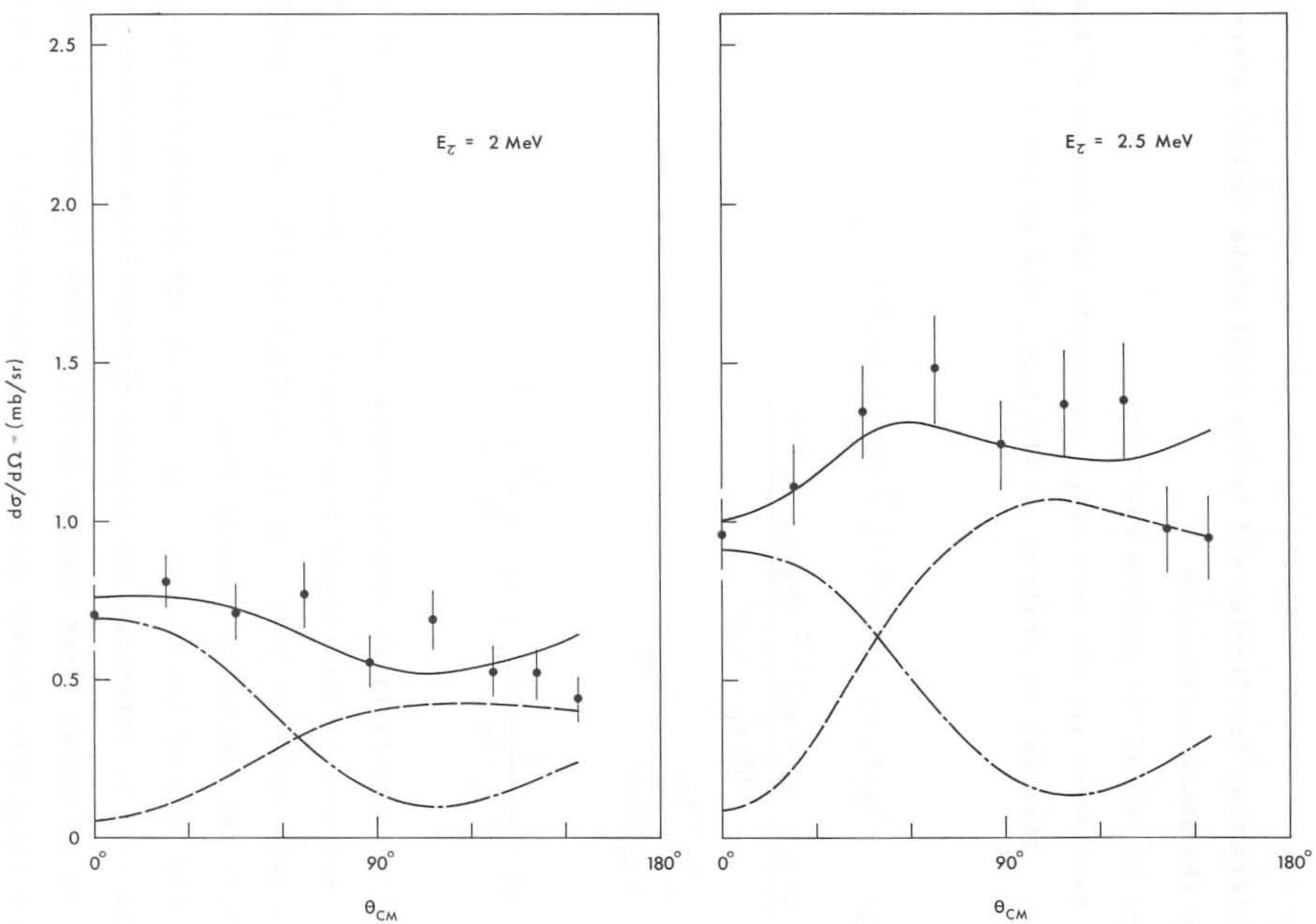

Fig. 2 - Experimental differential cross sections and calculated angular distributions at $E_{^3He}$ = 2,0 MeV and $E_{^3He}$ = 2,5 MeV for the n_0 neutron group. The dashed-dotted line represents the D.S. contribution and the dashed line the K.O. contribution. The solid line is the sum of the two contributions.

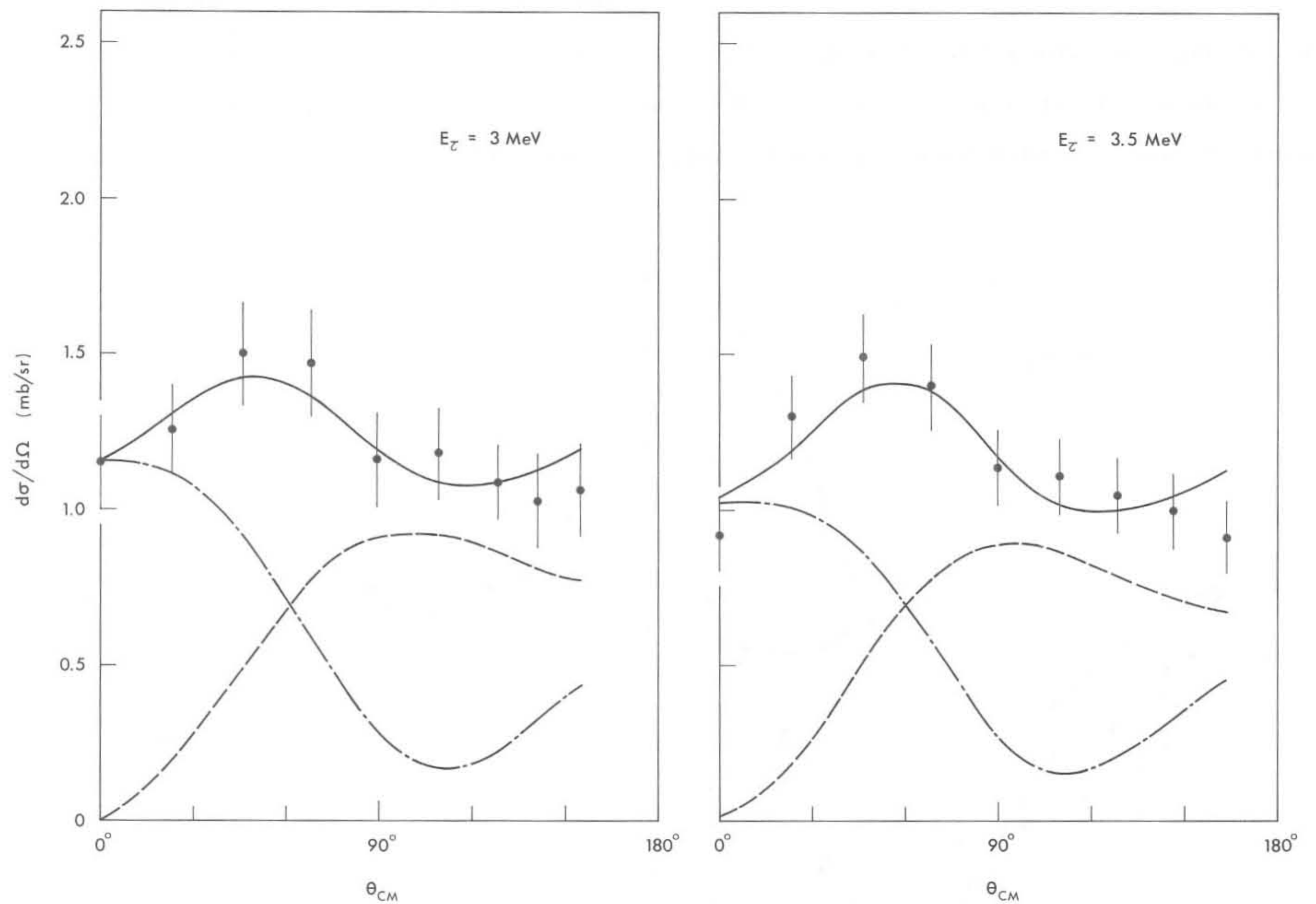

Fig. 3 - Experimental differential cross sections and calculated angular distributions at $E_{^3He}$ = 3,0 MeV and $E_{^3He}$ = 3,5 MeV for the n_0 neutron group. The dashed-dotted line represents the D.S. contribution and the dashed line the K.O. contribution. The solid line is the sum of the two contributions.

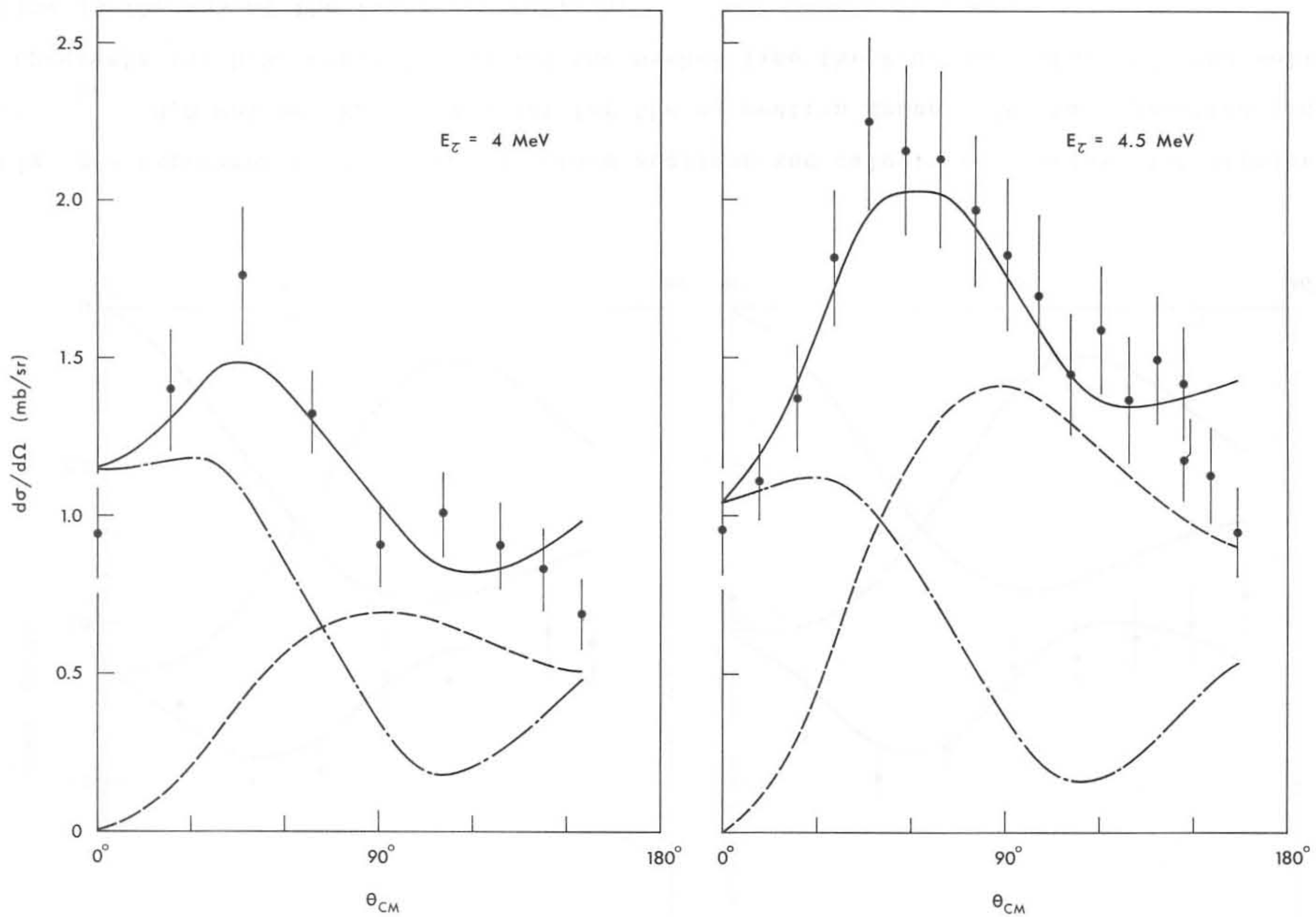

Fig. 4 - Experimental differential cross sections and calculated angular distributions at $E_{^3He}$ = 4,0 MeV and $E_{^3He}$ = 4,5 MeV for the n_o neutron group. The dashed-dotted line represents the D.S. contribution and the dashed line the K.O. contribution. The solid line is the sum of the two contributions.

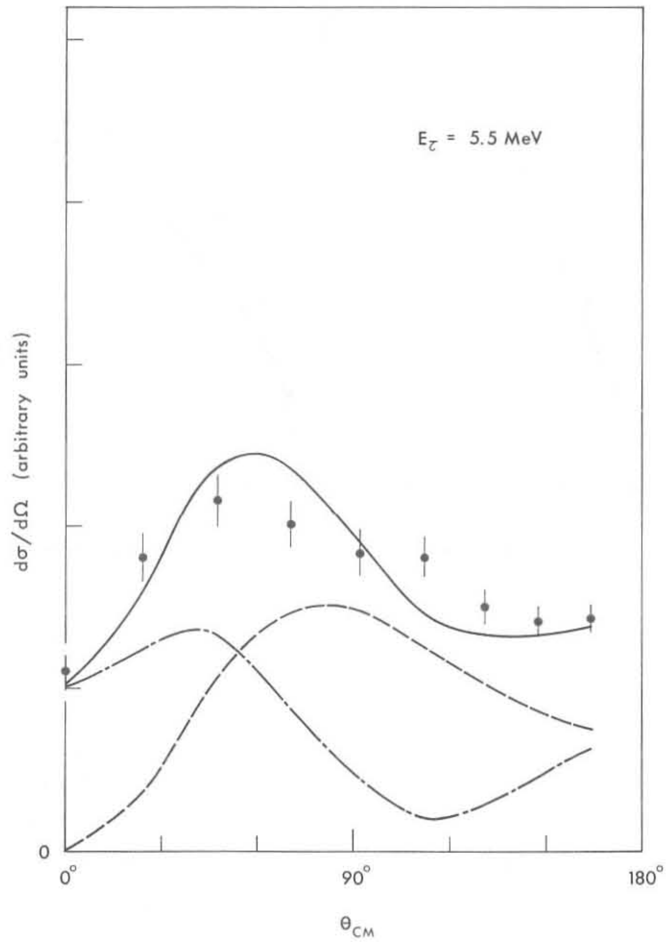

Fig. 5 - Experimental and calculated angular distributions at $E_{^3He}$ = 5,5 MeV for the n_0 neutron group. The dashed-dotted line represents the D.S. contribution and the dashed line the K.O. contribution. The solid line is the sum of the two contributions.

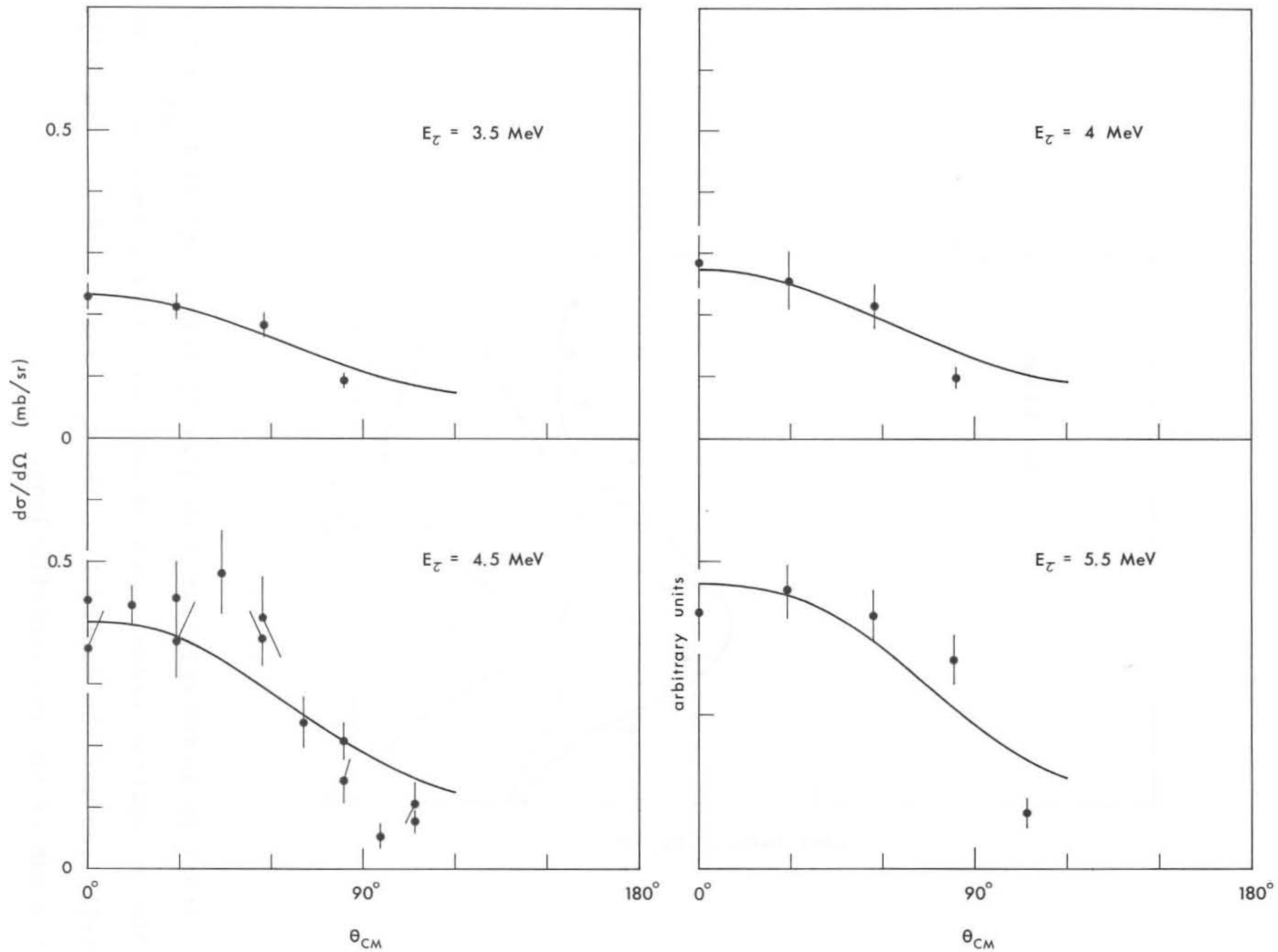

Fig. 6 - Measured differential cross sections at $E_{^3He}$ = 3,5 - 4,0 - 4,5 MeV, experimental angular distribution at $E_{^3He}$ = 5,5 MeV and angular distributions calculated for the D.S. reaction mechanism for the n_1 neutron group.

The errors reported in Figs. 2-6 take into account the error due to the counting statistics, to the efficiency determination, to the monitor uncertainties, and to the background and continuous contribution subtraction. All measurements (except at 5.5 MeV) are absolute, and the values in Figs. 2-5 are therefore the differential cross sections.

4. - RESULTS AND DISCUSSION

4.1. Angular distributions analysis.

The measured neutron angular distributions have been compared with calculaded curves obtained by describing the two-proton stripping (D.S.) in terms of the DWBA(8) and the knock-out process (K.O.) in terms of the Plane Wave Born Approximation (PWBA)(9), according to

$$(3) \qquad \left(\frac{d\,\sigma}{d\,\Omega}\right)_{exp} = C\left[D^2 \frac{(2J_Y+1)}{(2J_X+1)(2J_T+1)} \frac{d\,\sigma}{d\,\Omega}\right]_{DS} + F\left(\frac{d\,\sigma}{d\,\Omega}\right)_{KO} .$$

In this expression the term in the square brackets represents the D.S. angular distribution calculaded with the DWBA for the $X(^3He,n)Y$ reaction; the term $\left(\frac{d\,\sigma}{d\,\Omega}\right)_{KO}$ represents the angular distribution calculated for the KO process; and J_X, J_Y and J_T are the initial, final and transferred angular momenta, respectively. Both for the DS process (where the spectroscopic factor D^2 is unknown) and for the KO process, one can obtain the shapes of the angular distribution but cannot calculate the differential cross section. In order to reproduce the experimental data, the quantities C (for an assumed value $D^2 = 1$) and F have been considered as parameters of a fit, weighting the contribution of the two reaction mechanisms.

The D.S. angular distributions have been calculated by means of the zero-range two-nucleon transfer option of the DWBA computer programme DWUCK(10). The adopted configurations for the two protons transferred to ^5Li were $1s_{1/2}$ and $1p_{3/2}$. The proton in the $1p_{3/2}$ shell was thought as having a little binding energy (50 keV). Only the J_T=1 transferred angular momentum has been considered, as required by the selection rules for a $1/2^+ \rightarrow 3/2^-$ $(1/2^-)$ transition from the ground state of $T(J^{\pi}=1/2^{+})$ to the ^{5}Li ground $(J^{\pi}=3/2^{-})$ and first-excited $(J^{\pi}=1/2^{-})$ state. The following option for the optical model potential has been chosen in the DWUCK programme:

$$(4) \qquad U(r) = U_c(r) + Vf(X_R) + iWf(X_i) + V_{SO} \frac{df(X_R)}{dr} \frac{\vec{L}.\vec{S}}{r}$$

where $U_c(r)$ is the Coulomb potential (thought to be due to a uniform charged sphere with a radius $R = r_c A^{1/3}$) and the function $f(X_i)$ has the expression

$$(5) \qquad f(X_i) = [1 + \exp (\frac{r-R_{oi}A^{1/3}}{a_i})]^{-1} \quad .$$

The factor describing the Thomas spin-orbit term was taken equal to 25 MeV in all calculations. In Table I the optical-model parameters which have been used as particle data for entrance and exit channels are reported.

These parameters were obtained starting from the parameters reported by Klopcic and Darden(5) and in a first step of the analysis only the DS process was taken into account. The optical model parameters were then modified in order to obtain agreement between measured and calculated quantities both for the n_0 and the n_1 neutron group, according to (3). This kind of analysis was preferred to the fit of the angular distributions of neutrons from the ^{5}Li ground state only, in spite of the better agreement obtainable in this case with the experimental data. It should be noticed that the optical model parameter set reported in Table I is not capable of well describing the elastic data for the entrance channel reported in the literature(11). On the other hand, the use of parameters able to reproduce the $T(^{3}He,^{3}He)T$ elastic data destroys completely the agreement of the calculated curves with the reaction data under consideration.

The K.O. angular distributions were calculated with the theory of Newns(9). In this case the values of $J_T = 1$ and $J_T = 3$ were taken into

TABLE I - OPTICAL MODEL PARAMETERS

Parameter	^3He - T	n - ^5Li
V (MeV)	145	$55.23 - 1.843\ E_{n_{(CM)}}$ (MeV)
r_o (fm)	1.2	1.4
a (fm)	0.4	0.25
r_c (fm)	1.2	1.0
W (MeV)	10	0
r'_o (fm)	1.2	1.4
a' (fm)	0.6	0.6
W' (MeV)	10	8
V_{so} (MeV)	5	16

TABLE II - FIT PARAMETERS

$E_{^3He}$ (MeV)	C	F	C/F
2	1	1	1
2.5	1.32	2.50	0.53
3	1.79	2.16	0.83
3.5	1.76	2.11	0.83
4	2.25	1.63	1.37
4.5	2.37	3.33	0.71
5.5	--	--	0.92

account, but the fit of the experimental data indicated that there is no $J_T = 3$ contribution to the angular distributions. The best results were obtained with an interaction radius of 5.5 fm.

The values of the parameters C and F and of their ratio C/F (as obtained from the fitting procedure) are reported in Table II. According to the arbitrariety of the absolute values, C and F were taken equal to unity in the angular distribution obtained at $E_{^3He} = 2$ MeV; all the values are then relative to this normalization.

4.2. - Results

The angular distributions of the n_o neutron group from the ^5Li ground state were calculated considering that the incident ^3He particle populates a $J^\pi = 3/2^-$ level in its interaction with the T target ($J^\pi_x = 1/2^+$). That allows (taking into account the parity change) only a value $J_T = 1$ for the angular momentum transfer in the D.S. reaction mechanism and the values $J_T = 1$ or $J_T = 3$ for the K.O. reaction mechanism.

As already explained the configuration $1s_{1/2}$ and $1p_{3/2}$ (with the proton weakly bound in this last configuration) were assumed for the calculation of the D.S. process contribution. The shapes of the angular distributions calculated in this way did not appreciably depend from the binding energy of $1p_{3/2}$ proton.

The part of reaction that proceeds via the K.O. process (described in terms of PWBA) was calculated assuming in the relation (3) the interaction radius r_{KO} as a further fit parameter. The best result was obtained for a value $r_{KO} = 5.5$ fm.

The experimental data and the angular distributions calculated for the two reaction mechanisms are reported in Figs. 2-5. The numerical values of the measured cross-sections are listed in Table III. In the figures, the dash-dotted line represents the D.S. contribution and the dashed line the K.O. contribution. The solid line represents the sum of the two contributions, each weighted with the fit parameters reported

TABLE III - CROSS SECTIONS FOR THE $T(^{3}He,n_{o})^{5}Li$ REACTION ($\mu b/sr$).

θ_{LAB}	$E_{^3He}$ = 2 MeV $\sigma(20^\circ)$ = 809 μb		$E_{^3He}$ = 2.5 MeV $\sigma(20^\circ)$ = 1113 μb		$E_{^3He}$ = 3 MeV $\sigma(20^\circ)$ = 1262 μb		$E_{^3He}$ = 3.5 MeV $\sigma(20^\circ)$ = 1300 μb		$E_{^3He}$ = 4 MeV $\sigma(20^\circ)$ = 1395 μb		$E_{^3He}$ = 4.5 MeV $\sigma(20^\circ)$ = 1375 μb		$E_{^3He}$ = 5.5 MeV Arbitrary units	
	$\theta_{c.m.}$	$\frac{d\sigma}{d\Omega}$	$\theta_{c.m.}$	$\frac{d\sigma}{d\Omega}$	$\theta_{c.m.}$	$\frac{d\sigma}{d\Omega}$	$\theta_{c.m.}$	$\frac{d\sigma}{d\Omega}$	$\theta_{c.m.}$	$\frac{d\sigma}{d\Omega}$	$\theta_{c.m.}$	$\frac{d\sigma}{d\Omega}$	$\theta_{c.m.}$	$\frac{d\sigma}{d\Omega}$
0°	0	713 ± 89	0	969 ± 113	0	1147 ± 147	0	920 ± 115	0	942 ± 138	0	960 ± 147	0	55233 ± 4519
10°											11.91	1116 ± 117		
20°	22.63	809 ± 79	22.91	1113 ± 122	23.16	1262 ± 145	23.40	1300 ± 133	23.56	1395 ± 189	23.77	1375 ± 172	24.07	90724 ± 6729
30°											35.52	1816 ± 214		
40°	44.95	712 ± 95	45.47	1345 ± 143	45.95	1499 ± 167	46.39	1495 ± 141	46.71	1764 ± 219	47.10	2253 ± 279	47.66	108235 ± 7970
50°											58.47	2162 ± 273		
60°	66.67	770 ± 98	67.38	1481 ± 170	68.03	1471 ± 169	68.63	1401 ± 135	69.05	1327 ± 131	69.59	2130 ± 278	70.35	100838 ± 7308
70°											80.41	1974 ± 239		
80°	87.59	556 ± 83	88.40	1241 ± 145	89.14	1160 ± 149	89.82	1141 ± 124	90.31	904 ± 130	90.92	1828 ± 245	91.78	92248 ± 6767
90°											101.09	1698 ± 248		
100°	107.58	692 ± 94	108.40	1370 ± 171	109.14	1179 ± 145	109.82	1108 ± 121	110.31	1005 ± 135	110.92	1451 ± 192	111.78	90524 ± 6587
110°											120.41	1593 ± 204		
120°	126.67	531 ± 82	127.38	1382 ± 183	128.03	1090 ± 164	128.63	1051 ± 121	129.05	906 ± 133	129.59	1369 ± 197	130.75	75184 ± 5512
130°											138.47	1494 ± 205		
135°	140.44	521 ± 84	141.02	974 ± 138	141.55	1034 ± 152			142.38	828 ± 128				
140°							146.39	1004 ± 119			147.10	{1186 ± 136 1420 ± 180	147.66	70599 ± 5273
150°	153.85	437 ± 72	154.25	951 ± 127	154.62	1065 ± 146			155.21	692 ± 111	155.52	1133 ± 150		
160°							163.40	913 ± 116			163.77	954 ± 143	164.07	71891 ± 4592

in Table II.

The angular distributions of the n_1 neutron group from the first-excited level of $^5Li(J^{\pi}_Y = 1/2^-)$ were interpreted with the D.S. mechanism only. In fact, the fit performed according to (3) gave as result that the K.O. process does not contribute to the n_1 differential cross-section.

The configurations $1s_{1/2}$ and $1p_{3/2}$ were again assumed for the transferred protons. In this case also the change of parity between the ground state of $T(J^{\pi}_X = 1/2^+)$ and the first-excited level of $^5Li(J^{\pi} = 1/2^-)$ allows only odd values of the transferred angular momentum. The assumed value $J_T = 1$ results from simple considerations on the spin of the interested levels.

The angular distributions calculated for the n_1 group (with the same optical model parameters for the ^3He-T and n-^5Li channels used in the case of the n_0 group) are compared with the experimental data in Fig. 6. The numerical values of the differential cross-sections are listed in Table IV.

The analysis of the neutron spectra obtained in the present measurement has assigned to the first-excited level of ^5Li an excitation energy of $E_x = (10.21 \pm 0.28)$ MeV and a width $\Gamma = (2.28 \pm 0.58)$ MeV. These values are quite different from the data reported in the literature[3,12] (E_x = 5-10 MeV, Γ = 3-5 MeV), obtained by means of a phase-shift analysis of the $^4He(p,p)^4He$ excitation function. There is no doubt that the n_1 group observed in the present measurement arises from a ^5Li level, because simple kinematic considerations allow to surely identify it. To the contrary, in the phase-shift analysis reported in ref.[12], the smooth variation of the $p_{1/2}$ phase shift as function of energy did not permit an exact evaluation of the excitation energy and of the width of the level.

It must be also noticed that the trend of the excitation function for the neutrons of the n_0 group at ^3He energies above 4MeV, suggest (Fig.7) the presence, at an energy of about 4-4.5 MeV, of a broad reso-

TABLE IV - CROSS SECTIONS FOR THE $T(^3He,n_1)^5Li$ REACTION ($\mu b/sr$).

θ_{LAB}	$E_{^3He}$ = 3.5 MeV		$E_{^3He}$ = 4 MeV		$E_{^3He}$ = 4.5 MeV		$E_{^3He}$ = 5.5 MeV	
	$\theta_{c.m.}$	$\frac{d\sigma}{d\Omega}$	$\theta_{c.m.}$	$\frac{d\sigma}{d\Omega}$	$\theta_{c.m.}$	$\frac{d\sigma}{d\Omega}$	$\theta_{c.m.}$	$\frac{d\sigma}{d\Omega}$ (arbitrary units)
0	0	231 ± 22	0	287 ± 41	0	359 ± 62	0	8268 ± 983
10					14.55	428 ± 32		
20	29.06	214 ± 22	29.02	254 ± 44	29.00	371 ± 62	28.97	9103 ± 935
30					43.21	482 ± 68		
40	57.22	187 ± 19	57.13	214 ± 36	57.09	409 ± 66	57.05	8309 ± 888
50					70.50	239 ± 41		
60	83.50	96 ± 10	83.38	99 ± 11	83.32	145 ± 35	83.26	6807 ± 799
70					95.44	55 ± 20		
80					106.76	107 ± 34	106.69	1793 ± 516

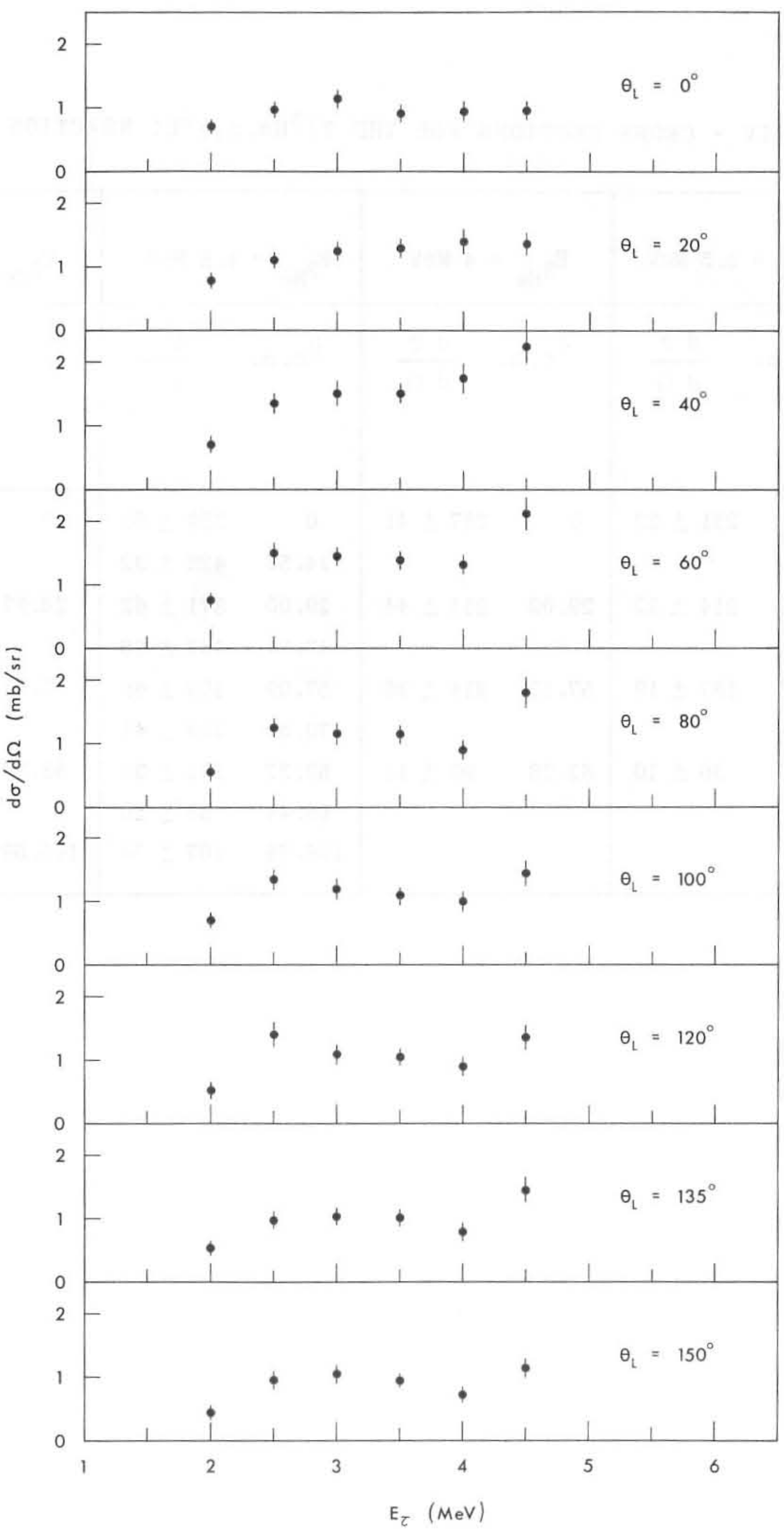

Fig. 7 - Energy excitation functions for the $T(^3He,n_o)^5Li$ reaction at various angles.

nance, corresponding to a level (or to some levels) at an excitation energy of about 18 MeV in the compound nucleus ^6Li. The lack of experimental data above 4-5 MeV does not permit at present a study of this experimental situation. The knowledge of more complete data, as those obtainable by means of finer energy steps in the excitation function measurements and by means of yield measurements at ^3He energies from ~ 4 to ~ 6.5 MeV would allow one to extract from the data the spectroscopic characteristic of the level. In fact, as usually made in the case of the elastic scattering(13), one can also insert the presence of a single level resonance as a compound nucleus contribution to the DWBA scattering amplitudes(14), and can then extract some spectroscopic information about the level under investigation by fitting the resonance parameters to the experimental data.

5. - CONCLUSIONS

The $T(^3He,n)^5Li$ reaction has been studied at incident ^3He energies from 2 to 5.5 MeV. The experimental angular distributions of the neutrons arising from the ^5Li ground state have be compared to theoretical curves calculated by assuming that the reaction can proceed both through the D.S. process and the K.O. process. The data concerning the neutrons from the ^5Li first-excited state have been described by means of only the D.S. mechanism. The agreement with the experimental data was reasonable in the whole energy interval. In both the cases the $J_T = 1$ was the only transferred angular momentum, and the quality of the results confirms in this way the previous spin and parity assignements for the ground and first-excited state of ^5Li. The energy excitation and the width of the first-excited level of ^5Li have been determined [$E_x = (10.21 \pm 0.28)$ MeV, $\Gamma = (2.82 \pm 0.58)$ MeV]. It has been shown that the $T(^3He,n)^5Li$ reaction can be useful to study the levels of the compound nucleus ^6Li at excitation energies of about 18 MeV.

This work will be then completed (a) by extending the energy range of the angular distribution measurements to a maximum energy of about

7 MeV for the incident ^{3}He particles and (b) by measuring in finer energy steps the excitation function and by analyzing them in the above described way in order to obtain information about the discussed level (or levels) of ^{6}Li.

R E F E R E N C E S

(1) M.P. Etten and G.H. Lenz, Nucl. Phys. A179, 448 (1972).

(2) U. Abbondanno, F. Demanins, M. Lagonegro and G. Nardelli, Il Nuovo Cimento 21A, 518 (1974).

(3) T. Lauritsen and F. Ajzenberg-Selove, Nucl. Phys. 78, 1 (1966).
F.Eveling, L.A. Koenig, J.H.E. Mattauch and A.H. Wapstra, Nuclear Data Tables, USAEC 1961.

(4) J.F. Barry, R. Batchelor and B.E.F. Macefield, in "Proceedings of the Rutherford Jubilee Conference", Manchester 1961, edited by J. Birks (Heywood and C. Ltd., London, 1962).

(5) J.T. Klopcic and S.E. Darden, Phys. Rev. C6, 2171 (1971).

(6) F. Demanins, L. Granata, G. Nardelli and G. Pauli, Report INFN/BE-73/2.

(7) G.G. Ohlsen, Nucl. Instr. and Meth. 37, 240 (1965).

(8) R.H. Bassel, R.M. Drisko and G.R. Satchler, ORNL 3240 (1962).
N.K. Glendenning, Phys. Rev. 137, B102 (1965).

(9) H.C. Newns, Proc. Phys. Soc. 76, 489 (1960).

(10) P.D. Kunz, University of Colorado, unpublished.

(11) M. Ivanovich, P.G. Young and G.G. Ohlsen, Nucl. Phys. A110, 441 (1968).
A.D. Bacher, R.J. Spiger and T.A. Tombrello, Nucl. Phys. A119, 481 (1968).

(12) A.C.L. Barnard, C.M. Jones and J.L. Weil, Nucl. Phys. 50, 604 (1964).

(13) W.J. Thompson, J.L. Adams and D. Robson, Phys. Rev. 173, 975 (1968).

(14) R.E. Benenson, I.J. Taylor, D.L. Bernard, H.H. Wolter and T. Tamura, Nucl. Phys. A197, 305 (1972).
S.K. Bose, A. Kogan and P.R. Bevington, Nucl. Phys. A219, 115 (1974).