DETERMINATION OF THE ENERGY PARAMETERS OF THE UNBOUND STATES OF ^{6}Li UP TO AN EXCITATION ENERGY OF 6 MeV

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We have analyzed projections of the matrices of pα-coincidences from the three-body ^{3}He(α,pα)d reaction running upon the interaction of α-particles with an energy of 27.2 MeV with a titanium-tritium target, where the accumulation of ^{3}He nuclei of the radiogenic origin has occurred. The energy parameters of excited states of ^{6}Li are obtained.

1. Introduction

The majority of excited levels of one of the lightest nuclei, ^{6}Li, with the exception of the second state at an excitation energy of 3.56 MeV, is unstable to the disintegration into clusters and nucleons. Depending on the excitation energy and configuration of excited states, they decay with the emission of an alpha-particle and a deuteron in the case of the first (E_1^*=2.18 MeV), third (E_3^*=4.31 MeV), and fifth (E_5^*=5.65 MeV) excited levels or an alpha-particle, a proton, and a neutron in the case of the fourth excited state (E_4^*=5.35 MeV), whose isospin equals 1 and the disintegration into an alpha-particle and a deuteron is forbidden. But if the excitation energy exceeds the threshold energy, the excited levels disintegrate into ^{3}H + ^{3}He.

2. Problem and the Research Purpose

We will consider the scheme of the energy levels of ^{6}Li in the range of excitation energies up to 6 MeV, which is most investigated for this nucleus. According to the literature data (see [1] and the references therein), to study the first five excited levels, more than 40 different types of nuclear transformations were applied. As an example, Table 1 shows the energy characteristics of 5 levels and nuclear reactions which were used to this end [1]. As seen, there are no significant differences in the energy levels derived in different experiments, but the energy widths of levels, excluding the narrow first state,

T a b l e 1. Parameters of excited levels of ^{6}Li, E* < 6 MeV

Excitation energy, MeV±keV	Energy width, keV	Reaction
2.185 ± 3	20.0 ± 2.8	^{4}He(d,d)^{4}He
2.187 ± 3		^{4}He(d,d)^{4}He
2.188±8	24 ± 2	^{6}Li(p,p$'$),(d,d$'$)
2.203±6		^{7}Li(d,t)^{6}Li
		^{9}Be(p,α)^{6}Li
3.56288±0.10	$(8.2 \pm 0.2) \times 10^{-3}$	^{6}Li(γ,γ)^{6}Li
4.36 ± 40	1320 ± 40	^{4}He(d,d)^{4}He
4.27 ± 40		^{6}Li(e,e$'$)^{6}Li
	1044 ± 58	^{6}Li(e,e$'$)^{6}Li
4.40 ± 120	1490 ± 150	^{6}Li(p,p$'$)^{6}Li
4.32 ± 40	1820 ± 110	^{6}Li(d,d$'$)^{6}Li
4.3 ± 100	600 ± 100	^{7}Li(^{3}He,α)^{6}Li
4.3 ± 200	1600 ± 300	^{7}Li(^{3}He,αd)^{4}He
4.3	1600 ± 120	^{7}Li(^{3}He,αd)^{4}He
4.3±10	850 ± 50 480 ± 80	^{9}Be(p, α)^{6}Li
5,379±17	540 ± 20	^{6}Li(e,e$'$)^{6}Li
	546 ± 36	^{6}Li(e,e$'$)^{6}Li
5.33 ± 80	540^{+340}_{-100}	^{6}Li(p,p$'$)^{6}Li
5.34 ± 20	560 ± 40	^{7}Li(^{3}He,α)^{6}Li
5.325 ± 5	270 ± 12	^{9}Be(p,α)^{6}Li
5.65 ± 50	1900 ± 100	^{4}He(d,d)4He
5.7	1000^{+600}_{-400}	^{6}Li(p,p$'$)^{6}Li
5.65 ± 200	1650 ± 300	^{7}Li(^{3}He,αd)^{4}He
5.65 ± 40	900 ± 300, 1260 ± 120	^{9}Be(p, α)^{6}Li

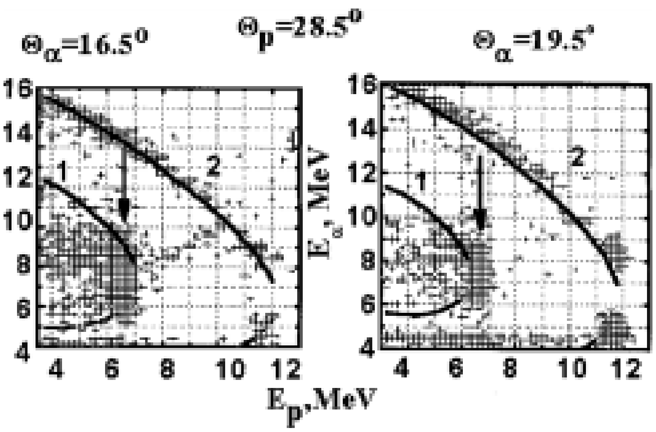

Fig. 1. The matrices of αp-coincidences for the interaction of the α-particle beam (E_α = 27.2 MeV) with a titanium-tritium target. *1,2* — kinematical calculations of the position of loci of the three-body ^{3}He(α,pα)2n and ^{3}H(α,pα)2d reactions accordingly. The formation and decay of the first excited state of ^{6}He are shown by arrows

differ considerably. Such disagreements are due to the complexity of the procedure of determination of the energy parameters, the overlapping of levels due to their width, the influence of the continium of nonresonance processes, and model assumptions as for the structure of levels.

For example, only during two nuclear transformations from those represented in Table 1 (namely in the inelastic p+^{6}Li scattering and in the ^{9}Be(p,α)^{6}Li reaction), all possible four levels ^{6}Li are excited at once. However, we note that, in the first transformation, the energy parameters were determined in essence from the analysis of the inclusive proton spectra of the three-body reaction ^{6}Li(p,p$'$)αd, because the experiments were conducted at the energies of protons higher than the threshold energy of the disintegration of ^{6}Li on α + d, and the contribution of protons from the formation and decay of the ^{5}Li(p+α) resonance could be substantial. In the other case, the inclusive α-particle spectra showed the population of the excited states of ^{6}Li and the presence of alpha-particles generated in the decay of the excited levels of ^{8}Be by the reaction ^{9}Be(p,d) ^{8}Be.

This drawback can be avoided in two ways. Firstly, one can study the three-body ^{6}Li(p,pα)d and ^{9}Be(p,$\alpha\alpha$)d reactions in the kinematically complete experiment. Secondly, in the case of the first reaction by the choice of the angles of registration of outgoing particles, one can study those sections of the phase space, where it is possible to satisfy the conditions under which the interaction of the "deuteron + alpha-particle" pair at the c.m.s. energy from 0.5 to 5—6 MeV would take place at the relative energies in other pair, p and α, which do not meet the conditions for the formation of ^{5}Li resonance. As for the ^{9}Be(p,$\alpha\alpha$)d reaction, the registration angles of two α-particles should be chosen such that the formation and disintegration of ^{8}Be do not occur. However, such experiments have not been performed. It would be desirable to execute the kinematically complete experiment and to choose such an interaction, at which all four states decaying with the emission of an alpha-particle would become excited. Then it is possible to choose the kinematical conditions, under which the probability of the formation of other accompanying resonance levels would be negligible.

3. Experimental Procedure and Results

For the study of the excited states of nucleus ^{6}Li, it is perspective to investigate the interaction ^{3}He+α, because, as a result of a low Coulomb barrier, the different outgoing channels of this interaction are characterized by considerable cross-sections, which is confirmed by the experimental investigation of the binary ^{3}He(α,p)^{6}Li* reaction [2]. In addition, at such an interaction, the influence of the continuum is minimized and can be controlled. But ^{3}He and ^{4}He are gases, and the interaction of projectiles with the nuclei of a gaseous target takes place in the volume of an incident beam, which complicates the observance of the necessary kinematical conditions. This situation is obviously different from that with solid targets, in which the localization of nuclear reaction is defined by the size of the incident beam on a target.

The difficulties related to the use of a gaseous target can be avoided, in particular in the investigation of the interaction of alpha particles with tritium in the correlation experiment, by using solid titanium-tritium targets. It turns out that, after the irradiation and the subsequent long-term storage, these targets accumulate radiogenic nuclei of ^{3}He, that is due to β-decay of tritium nuclei.

The analysis of the experimental information about the interaction of a beam of alpha-particles with an energy of 27.2 MeV with tritium revealed the following. Besides the events which correspond to the formation and disintegration of ^{6}He from the ^{3}H(α,pα)2n reaction [3] and lie on the calculated kinematical curve marked by number *1* in Fig. 1, we observed a locus which correspond to the three-body reaction ^{3}He(α,pα)d, for which the results of kinematical calculations are marked by number *2* in Fig. 1. We used titanium-tritium targets with a thickness of 2.7 mg/cm^2 and with the ratio between the numbers of sorbed tritium atoms and titanium atoms of a foil to be close to 1.

Events from the three-body reaction ^{3}He(α,pα)d were observed upon the irradiation of titanium-tritium targets which were used earlier, and the time of storage of which exceeded two years. The authenticity of this phenomenon is testified by the fact that the loci of this three-body reaction were observed in the matrices of pα-coincidence for different pairs of the detection angles. In order to estimate the amount of the accumulated atoms of ^{3}He in the tritium targets, we analyzed the inclusive proton spectra derived before on different titanium-tritium targets [4] just made and with the time of storage of near two years. It is established that the peaks in the analyzed spectra, which correspond to the reaction ^{3}He(α,p)^{6}Li$_{\rm o.c}$(^{6}Li$^*_{2.18}$), are manifested only when alpha-particles bombard the old targets, and the angular distributions of protons corresponding to the formation of ^{6}Li in the ground and first excited states have the form identical to that of the angular distributions which were derived with the use of a gaseous ^{3}He target in the investigation of the ^{3}He(α,p)^{6}Li$_{\rm o.c}$(^{6}Li$^*_{2,18}$) reaction at E_α = 26.5 MeV [2]. From the comparison of the cross-sections of these distributions with regard for the production time and the half-life of β-decaying tritium nuclei, we estimated the number of accumulated atoms of ^{3}He in titanium-tritium targets [5]. The share of the atoms of ^{3}He detained by a titanium foil in the complete number of atoms of these isotopes formed as a result of the β-decay of tritium from titanium-tritium targets is (30±20)%.

The matrices of p-α coincidences were got with the use of four semiconductor silicon $\Delta E - E$ telescopes. The thicknesses of ΔE detectors were 60—100 mm, and those of E detectors were 1—1.5 mm. The telescopes of detectors were located in pairs on the left and right to the beam direction of incident alpha-particles. The solid angles of left telescopes were 1.30 and 3.67 msr, and the solid angles of right telescopes were 1.44 and 3.61 msr.

The pairs of the detection angles of protons and alpha-particles were θ_p/θ_α= 28.5°/10, 13, 16.5° and θ_p/θ_α= 36°/10, 13, 16.5°. All two-dimensional spectra show the loci corresponding to the three-particle ^{3}He(α,pα)d reaction.

4. Analysis of Results

Alpha-particles and protons detected on coincidence can appear as a result of the mechanism of sequential decays of the unbound states of ^{5}Li and ^{6}Li, namely: ^{3}He+α →^{5}Li + d → p + α + d, or ^{3}He +α →^{6}Li + p → p + α + d, and due to the quasifree α-p scattering, in which the role of "spectator" plays a deuteron. The analysis executed with the use of the calculated energies of three particles and the relative energies in α-p and α-d pairs and the account of kinematical features of the formation of the excited states of ^{5}Li and ^{6}Li on the first stage, allowed us to to select the matrices of α-p coincidences for a few pairs detection angles of protons and alpha-particles, namely: θ_p/θ_α = 28.5/10, 13°; 36/19.5°, in which the mechanism of sequential decay of the unbound states of ^{6}Li was dominant. By the way, for some chosen detection angles of protons (for example, θ_p = 28.5°), the detection angles of alpha-particles corresponding to them coincided (θ_α=10, 13°) or were close to the escape angle of ^{6}Li* in the binary reaction ^{3}He(α,p)^{6}Li*. Such a choice of angles predetermines the presence of the second excited state in the matrix of p-α coincidences. The angles of the detectors for registration of alpha-particles and protons and their angle overlapping were such that both the products of the binary ^{3}He(α,p)^{6}Li$_{3.56}$ reaction were detected for some pairs of angles fully or partly in coincidence. The life-time of ^{6}Li$^*_{3.56}$ was sufficient in order to fly to the detector and not to decay through the emission of γ-quantum. Because the trigger signals for the electronic layout of fast-slow coincidences were taken from ΔE detectors and the coincidence matrices contained the part of events which were detected only in ΔE detectors, the loci corresponding to the three-body ^{3}He(α,pα)d reaction revealed the peak related to the state of ^{6}Li* with an excitation energy of 3.56 MeV which is stable relative to the decay into clusters and nucleons. Exactly this circumstance was used upon the determination and account of the experimental energy resolution of the presented investigation.

As known, the cross-section of the three-body reaction T(p, 12)3 can be expressed as [6]:

$$\frac{d^3\sigma}{d\Omega_1 d\Omega_2 dE_{\rm ex}} = \frac{2\,(\pi)^4}{\hbar v_{\rm in}} |T_{if}|^2 \rho\,(\Omega_1\Omega_2 E_{23})\,, \qquad (1)$$

where the T_{if} is the transition matrix element, ρ is the density of final states and is the three-body phase-space factor, $E_{23}(\equiv E_{23}(E_{\rm ex}))$ stands for relative energy of particles 2 and 3 which corresponds to the energy of

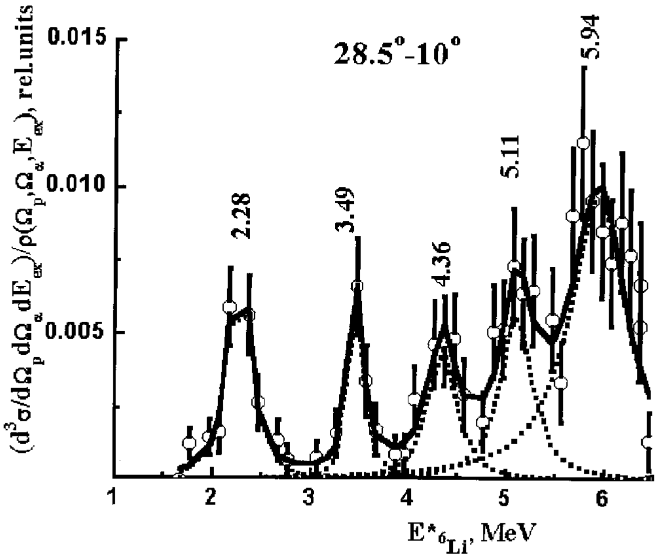

Fig. 2. Spectrum of excitation of ^{6}Li obtained from the matrix of p-coincidences. The dotted lines represented the contributions of separate states. The solid line is their sum. The approximation was obtained by using expression (7)

excitation of the system 2+3, and $v_{\rm in}$ is the relative velocity in the entrance channel.

It is assumed that the process is a sequential one. That is, the formation of three particles in the outgoing channel takes place in two steps. On the first step, the nucleus r is formed in the state j unstable to the particle emission,

$$\mathrm{p} + \mathrm{T} \to \mathrm{d} + \mathrm{r}, \tag{2}$$

and sequentially decays through

$$\mathrm{r} \to \mathrm{c}_1 + \mathrm{c}_2. \tag{3}$$

Here, c_1 and c_2 are two of particles 1, 2, and 3. The first step can be interpreted as a two-body reaction, and the transition matrix element can be expressed in this case as a product of two terms:

$$T_{if}^{j}\left(k, E_{23}\right) = F\left(k\right) \mathrm{X}^{j}\left(E_{23}\right). \tag{4}$$

Here, the first term $F(k)$ describes the formation amplitude of the nucleus r in the state j. The second term $\mathrm{X}^J(E_{23})$ describes its decay and is taken, as a rule, in the form of a Breit—Wigner resonance

$$\mathrm{X}^{j}\left(E_{23}\right) = \frac{1/2\Gamma_j}{E_j - E_{23} + i\Gamma_j/2}. \tag{5}$$

Here, E_{23} is the relative energy of the pair of particles 2—3, E_j is the position of the resonance level relative to the decay threshold of r into particles 2+3, and Γ_j is the energy width of resonance levels.

For a few excited levels, (1) acquires the form

$$\frac{d^3\sigma}{d\Omega_1 d\Omega_2 dE_{\rm ex}} \sim \rho\left(\Omega_1, \Omega_2, E_{\rm ex}\right) \times$$

$$\times \sum_j^n C_j \frac{1/2\Gamma_j}{\left(E_j - E_{23}\right)^2 + \left(\Gamma_j/2\right)^2}, \tag{6}$$

where C_j are the formation amplitude of the excited state j.

Let us divide expression (6) by the three-body phase-space factor calculated for these kinematical conditions and represent it as a function of the excitation energy of ^{6}Li. Then we get

$$\frac{d^3\sigma}{d\Omega_p d\Omega_\alpha dE_{\rm ex}} / \rho\left(\Omega_p, \Omega_\alpha, E_{\rm ex}\right) =$$

$$= \sum_j^n C_j \frac{1/2\Gamma_j}{\left(E_{^6{\rm Li}_j^*} - E_{\rm ex}\right)^2 + \left(\Gamma_j/2\right)^2} =$$

$$= \sum_j^n C_j BW^j\left(E_{\rm ex}\right). \tag{7}$$

Here, the excitation energy of ^{6}Li is determined as a sum of the calculated relative energy in the α—d pair and the threshold energy of the decay of this nuclei into aa α-particle and a deuteron ($E_{\rm th}$=1.475MeV). That is, $E_{\rm ex} = E_{23} + E_{\rm th} = E_{\alpha d} + E_{\rm th}$, and the energy positions of excited levels of ^{6}Li are defined as $E_{^6Li_j^*} = E_j + E_{\rm th}$.

Fig. 2 presents the transformed projections of the upper branch of the matrix of p—α coincidences derived for the detection angles of protons and α-particles to be, respectively, −28.5° and 10°. The solid line shows the approximation of experimental data in the point geometry by expression (7) with the use of the least-squares method, and the contributions of separate excited states populated due to the $\tau + \alpha$ interaction are marked by the dotted lines. A similar procedure was conducted for the experimental data derived for the other pairs of the detection angles for protons and α-particles. Upon such an approximation in the procedure of adjustment of the obtained projections of branches of the matrices of coincidences, the energy resolution was not taken into account. By constructing the convolution of the term $BW^J(E_{\rm ex})$ in (7) used for the description of the resonance contribution of an excited state with a function that describes the energy resolution $q(\varepsilon,\sigma)$, we get the quantity which already contains the dependence on energy resolution:

$$BW^{j}_{\text{mod}}\,(E_{\text{ex}}) = \int\limits_{-5\sigma}^{5\sigma} BW^{J}\,(E_{\text{ex}}+\varepsilon)\,q\,(\varepsilon,\sigma)\,d\varepsilon. \qquad (8)$$

Then we have

$$\frac{d^3\sigma}{d\Omega_p d\Omega_\alpha dE_{\text{ex}}}/\rho\,(\Omega_p,\Omega_\alpha,E_{\text{ex}}) == \sum_{j}^{5} C_j BW^{J}_{\text{mod}}\,(E_{\text{ex}}), \qquad (9)$$

The function $q(\varepsilon,\sigma)$ in (8) is chosen in the form of a Gaussian

$$q\,(\varepsilon,\sigma) = \frac{1}{(2\pi)^{1/2}\,\sigma}\exp\left(-\varepsilon^2/2\sigma^2\right), \qquad (10)$$

where the parameter σ is determined from the fitting of a very narrow peak which corresponds to the second excited state of ^{6}Li from the two-body ^{3}He(α,p)^{6}Li$^*_{3.56}$ reactions and manifests itself due to the simultaneous detection on coincidence of protons and nuclei ^{6}Li excited to an energy of 3.56 MeV. As a result, we get σ=200±50 keV which was used in subsequent calculations. With the use of this procedure, we fit the line form for every j-th excited state. Then, by varying only the amplitudes C_j in expression (9) within the least-squares method, we constructed the summary curve which practically coincides, on the scale of the figure, with the solid curve in Fig. 2 derived by the calculation in the point geometry (7). The contributions of separate levels are also in good agreement with experimenal data and therefore are not shown in Fig. 2.

Table 2 represents the energy positions and widths derived as a result of the fitting of experimental spectra for the three pairs of the detection angles both in the point geometry ($^*\theta_p/\theta_\alpha$= 36°/19.5°, 28.5°/13°, 28.5°/10°) and with regard for the experimental energy resolution (θ_p/θ_α =28.5°/10°).

As seen from Table 2, the energy parameters of the first five excited levels of ^{6}Li obtained in the assumption of the point geometry (7) and with regard for the experimental energy resolution (9) coincide and agree with the values derived by a number of different ways (see Table 1) within the limits of experimental errors. In this case, the account of the experimental energy resolution did not allow us to go beyond the scope of errors, although we got the somewhat lesser values for all the widths of states, which confirms the authenticity of the derived energy parameters of the unbound levels of ^{6}Li. Due to the fact that four from these five excited levels, except for the second one which manifests itself through the interplay of experimental conditions, decay through the emission of an alpha-particle first of all, we succeeded to get the energy parameters of these levels practically in one exposure by studying the three-body ^{3}He(α,pα)d reaction.

The experimental energy resolution (σ=200 keV) did not allow us to specify the energy width of the first excited state of ^{6}Li. The obtained estimation of this value with the use of expression (8) is Γ_1=(0.057±0.078) keV

It is known that the excited state with E^* = 5.36 MeV and with isospin T=1 can undergo only a three-body decay with the simultaneous emission of a proton, a neutron, and an alpha particle. The manifestation of the fourth excited state of ^{6}Li in the matrix of p-α coincidences testifies to that its decay after the settling due to the $\tau + \alpha$ interaction takes place through the emission, besides an alpha-particle, of a proton and a neutron with their relative energy being close to zero. If the part of decays with the emission of protons and neutrons with the relative energy different from zero would be higher, the matrix of p-α coincidences at the energy of protons which corresponds to the formation of this level would display a vertical strip similar to that which is observed upon the decay of nucleus ^{6}He(E^* = 1.8 MeV) under the $t + \alpha$ interaction and is marked by the arrow in Fig. 1.

T a b l e 2. Energy parameters of the excited states of ^{6}Li derived from the kinematically complete investigation of the ^{3}He(α,pα)d reaction at E_α=27.2 MeV

N	$^*\theta_p/\theta_\alpha = 36°/19.5°$		$^*\theta_p/\theta_\alpha = 28.5°/13°$		$^*\theta_p/\theta_\alpha = 28.5°/10°$		$^{**}\theta_p/\theta_\alpha = 28.5°/10°; \sigma = 0.20$	
state	$E^* \pm \Delta E$, MeV	$\Gamma \pm \Delta\Gamma$, MeV	$E^* \pm \Delta E$, MeV	$\Gamma \pm \Delta\Gamma$, MeV	$E^* \pm \Delta E$, MeV	$\Gamma \pm \Delta\Gamma$, MeV	$E^* \pm \Delta E$, MeV	$\Gamma \pm \Delta\Gamma$, MeV
1	2.21±0.2	0.23±020	2.15 ±0.2	0.23±0.1	2.278±0.015	0.24±0.08	2.23±0.09	0.057±0.078
2	3.53±0.20				3.49±0.26	0.17±0.22	3.47±0.03	—
3	4.56±0.26	0.43±0.30	4.47±0.25	0.46±0.25	4.36±0.22	0.33±0.14	4.38±0.05	0.25±0.06
4	5.29±0.25	0.5±0.5	5.05±0.22	0.48±0.38	5.11±0.23	0.38±0.19	5.11±0.05	0.30±0.06
5			5.75±0.28	0.98±0.36	5.94±0.26	0.68±0.15	5.94±0.04	0.63±0.04

N o t e: *stands for the approximation by expression (7) without regard for the experimental energy resolution, **means the approximation with regard for the experimental energy resolution (9)

For the correction of features of the three-body nature of this excited state with $E^* = 5.36$ MeV, it is necessary to conduct a more detailed study of the section of the phase space which corresponds to the formation and decay of the excited state of ^{6}Li with $E^* = 5.36$ MeV.

5. Conclusion

While comparing the energy parameters of levels (Table 2) calculated by us with those in Table 1, we note that the excitation energies practically coincide with regard for experimental errors. But the energy widths of states obtained in this experiment are the low limits of widths of the array of parameters derived in all the experimental researches. It is worth noting that this result well agrees with the theoretical calculation [6] using a three-body model on the basis of the Faddeev equations, which includes the two-body separable nonlocal potentials of interacting particles.

The present work confirms the high informativeness of the kinematically complete investigation of the interaction of the lightest nuclei for the determination of the energy parameters of unbound excited states. The storage of ^{3}He nuclei of the radiogenic origin in the Ti—T targets allows us to hope for the possibility of the creation of solid targets with these nuclei, which, in turn, will extend our experimental possibilities to study few-body systems.

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1. *Tilley D.R., Cheves C.M., Godwinet J.L. et al.* //Nucl. Phys. A.— 2002.— **708**.— P.3.

2. *Nemets O.F., Ostashko V.V., Yasnogorodsky A.M.* // Pis'ma Zh. Eksp. Teor. Fiz.— 1980.— **32**, N6.— P.451.

3. *Gorpinich O.K., Povoroznyk O.M., Roznyuk Yu.S., Struzhko B.G.* // Zbirn. Nauk. Prats Inst. Yad. Dosl.— 2001.— N3(5).— P.53.

4. *Gorpinich O.K., Povoroznyk O.M., Pavlenko Yu.M. et al.* // Izv. AN. Ser. Fiz.— 2002.— **66**, N5.— P.743—745.

5. *Gorpinich O.K., Povoroznyk O.M., Roznyuk Yu.S. et al.* // Ibid.— 2003.— **67**, N11.— P.1585—1587.

6. *Eskandarian A., Afnan I.R.* // Phys.Rev.C.— 1992.— **46**, N6.— P.2344.

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ВИЗНАЧЕННЯ ЕНЕРГЕТИЧНИХ ПАРАМЕТРІВ НЕЗВ'ЯЗАНИХ СТАНІВ ЯДРА ^{6}Li ДО ЕНЕРГІЇ ЗБУДЖЕННЯ 6 МеВ

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Р е з ю м е

Проаналізовано проекції матриць рα-збігів тричастинкової ^{3}He(α,pα)d-реакції, що проходить при взаємодії α-частинок з енергією 27,2 МеВ з титан-тритієвою мішенню, в якій відбулося накопичення ядер ^{3}He радіогенного походження. Отримано значення енергетичних параметрів чотирьох станів ^{6}Li.