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EXPERIMENTAL OBSERVATION OF NEUTRON-NEUTRON CORRELATIONS IN NUCLEUS ^{6}He FROM ^{3}H(α, pα)nn REACTION

The projections of two-dimensional spectra of p-α coincidences from the four-particle reaction of ^{3}H (α, pα)nn with the energy of alpha-particles 27.2 MeV on the energy axis of alpha-particles for six pairs of angles are analyzed. The results of the Monte Carlo parameterization show that in the case of the decay of the first excited state of ^{6}He, the configuration of the “alpha-particle + dineutron” dominates only in a limited phase-space domain, while in other kinematics and for the second and third excited states, the configurations of “alpha-particles + dineutron” and “alpha-particles + cigars” are present in different ratios.

Keywords: ^{6}He excited states, two-dimensional spectrum of p-α coincidences, four-particle reaction, neutron-neutron correlation, “dineutron”, cigars.

1. Introduction

The excitation spectrum of the neutron-enriched ^{6}He nucleus, which manifests itself both as a three-particle continuous spectrum, and as the formation of resonance states in this continuum, is quite difficult to study both experimentally and theoretically. If we analyze the investigations of the spectrum of the excitation of the ^{6}He nucleus in the energy gap between the energies of the decay thresholds (0.973 MeV< E < 12.203 MeV) on three (α + n + n) and two (t + t) particles, then the experimental results, as well as the theory of these studies, are quite controversial. There is no doubt only for the energy characteristics of the 2^+ first excited state (E* = 1.797 MeV). The only compilation [1] shows 4 excited states in the interval between these two threshold energies. The compilations [2, 3] show only one narrow 1.8 MeV excited state, while the compilation [4] shows the presence of the 5.6 MeV excited states.

It should be noted that recent experiments with using the accelerated radioactive ^{8}He isotope beam [5], as well as the nuclear reactions caused by the interaction of pions with boron isotopes [6], allowed to obtain more information about the excitation spectrum of the ^{6}He nucleus.

The ^{6}He nucleus belongs to the so-called Borominian type nuclei with a two-neutron halo, in which any two-particle system is not bound. The reason why the two-body subsystems are unbound while the three-body system is bound is entirely due to the effective (in-medium) two-nucleon correlations. The study of correlations of two neutrons in neutron halo nuclei is one of the most interesting problems of the physics of neutron-enriched systems. Halos-nuclei characterized by low coupling energies of valence neutrons are investigated using a model of “core plus valence neutrons” [7 - 10]. It is assumed in two-neutron halo nuclei that the correlations between two neutron halo are responsible for the small two neutron energies of the separation and large radii of the nucleus. Calculations using the “core + n + n” model also suggest that n-n correlations in halo nuclei for two neutrons are characterized by spatial localization in the density distribution, the so-called “cigar” and “dineutron” [9].

Theory [10] considers two prominent configurations of its halo-dineutron configuration with two neutrons located compactly (R_{nn} ~ 2 fm) outside the core at the distance R_h ~ 3 fm, and cigar-like configuration with valence neutrons positioned on opposite sides of the core (R_{nn} ~ 4 - 5 fm, R_h~ 1 - 1.5 fm). Despite the fact that the ^{6}He nucleus is the object of numerous theoretical investigations [7 - 10], the issue of clustering of neutrons in this nucleus remains actual, namely, which configuration – “cigar” or “dineutron” is dominated?

The numerous publications devoted to the study of ^{6}He (both theoretical and experimental) include studies aimed at establishing the energy location and lifetime of the excited levels of the ^{6}He nucleus [5, 6, 26 - 29], and attempts to theoretically predict [30, 31] the same characteristics of the excitation spectrum. They include numerous attempts to theoretically explain [7 - 10] the existence of an abnormally large neutron halo in the ^{6}He nucleus, as well as an attempt to respond to the manifestation of the above phenomenon by conducting complex correlation experiments [23 - 25].

The presented work is a continuation of publication devoted to the study of the ^{6}He nucleus, which began with the measurement of the angular distributions of p, d, t, alpha-particles from ^{6}He and ^{6}Li caused by α + t interaction [18] using the investigations of the mechanisms of formation and decay of unbound levels of ^{6}He nuclei by the method of two-particle coincidences measurement four-particle break-up ^{3}H(α, pα)nn reaction [11, 16]. The study was a correlation kinematically incomplete experiment.

So, in the first stage of interaction, the particle – spectator proton and nucleus ^{6}He* in the excited state are formed, which in the second stage is decayed into three particles (^{6}He* $\rightarrow \alpha$ + n + n). The experimental values of the excitation energies and the widths of the levels of the nucleus ^{6}He* can be obtained, if we detect the proton (spectator) in the coincidence with one of the particles from the decay of the nucleus ^{6}He*, for example, α-particle. The information on the structure of these three-particle states will be obtained in kinematically incomplete correlation experiment ^{3}H(α, pα)2n.

The three-particle resonances observed from two-particle coincidences in four-particle breakdown reactions will be manifested on a two-dimensional spectrum in the form of strips parallel to the energy axis of a resonant particle [11]. In the case of studying four-body ^{3}H(α, pα)2n reaction according to [11], the population of excited states ^{6}He* and its decay into an alpha-particle and two neutrons in a two-dimensional $E_p \times E_\alpha$ spectrum of p-α coincidences will be manifested in the form of strips parallel to the energy axes of alpha-particles.

The events of the p-α coincidences lying within the above-mentioned bands are carriers of information about the energy characteristics (lifetime and excitation energy) of excited three-particle levels ^{6}He and the role of neutron correlations in the structure of these unbound three-body excitations.

2. Investigation of the excitation spectrum ^{6}He* nucleus from four-particle ^{3}H(^{4}He, pα)nn reaction

The excitation spectra of ^{6}He were investigated by the reaction ^{3}H(α, pα)nn using an alpha-particle beam with energy 27.2 MeV ($0 < E_{ex} < 3.5$ MeV) on classical cyclotron U-120 [12] and so 67.2 MeV ($0 < E_{ex} < 20$ MeV) on isochronous cyclotron U-240 [13]. In addition, we investigated the excitation spectrum of the ^{6}He above its energy decay threshold on t + t (E_{thr} = 12.203 MeV) by using the kinematical complete experimental study of other three-particle ^{3}H(α, tt)p and ^{3}H(α, pt)t [14] reactions.

In order to study ^{3}H(α, pα)2n reaction by the analysis of (E_p, E_α) two-dimensional spectra, we used the scheme of experiment described in our previous work [12, 17] where the target was titanium backing (2.6 mg/cm^2 thick) saturated by tritium (equivalent to the thickness of about 0.15 mg/cm^2) was used. The ^{4}He-particle beam of 27.2 ± 0.15 MeV was produced by the cyclotron U-120 of the Institute for Nuclear Research, National Academy of Sciences of Ukraine (Kyiv) in the present experiment. There is the assumption that the formation of proton, alpha-particles, and two neutrons in the outgoing channel of the four-particle nuclear ^{3}H(^{4}He, pα)2n reaction is mainly due to the two-stage mechanism reaction. In the first phase, there is the formation of proton and exciting nucleus ^{6}He, which in the second stage is decayed into three parts - two neutrons and alpha-particle. Taking into account the preliminary experimental data [18], the proton registration angle, under which there is a sufficient output of ^{6}He* nuclei in the first excited state, was chosen between 10 and 40° in the laboratory coordinate system. Proton detectors are located at angles from 28.5 to 36° to reduce the photon detector load from elastic scattering and taking into account the features of the experimental scattering camera (a minimum angle between two proton telescopes is 7 - 8°). The minimum angle of alpha-detector which was used to obtain two-dimensional p-α coincidence spectra were selected closely as possible to the angle of the maximum output of ^{6}He nuclei in the first excited state (calculated from the kinematics of the binary ^{3}H(α, p)^{6}He*$_{(1.8\ \mathrm{MeV})}$ reaction). The maximum angle of the location of the detector of alpha-particles was determined by the value of the alpha-particle departure angle, at which it is still possible to form the first excited state ^{6}He for the chosen proton registration angle. Thus, the angles were chosen for the alpha-particles detectors: 10, 13, 16.5, and 19.5° for each of the two positions of the photon detector. As a result, two-dimensional $E_p \times E_\alpha$ coincidence spectra for the following pairs of angles (θ_p/θ_α) of proton and alpha-particles detectors were obtained: θ_p/θ_α = 36°/19.5°; 36°/16.5°; 36°/13.0°; 28.5°/19.5°; 28.5°/16.5°; 28.5°/13.0°.

The processing of experimental two-dimensional spectra obtained in the plane ($E_1 \times E_2$) of the energies of registered particles was carried out by the Monte Carlo method [12, 19] in order to take into account the real dimensions of the solid angles of the detectors and the location of the nuclear reaction, with the determination of the real energy losses of the energy of the beam and formed in the target reaction products. In calculations using this method, all experimental conditions are taken into account, namely: the value of the energy of accelerated particles and its energy dissipation in the beam, the target thickness, the size of the conditional reflection of the beam on the target, the size of the defining diaphragms preceding the detectors, and their distance to the target, the energy detector resolution. In this procedure, in the first stage, the experimental two-dimensional quasi-three-particle reaction spectra are recalculated by randomly sampling the laboratory values of the energies of the particles registered in the E_1 and E_2 coincidences within their experimental errors. Then, using the obtained particle values of the energies E_{1i} and E_{2i} and the known values of the angles under which particles 1 and 2 – θ_1 and θ_2 were registered, the energy of the third unregistered particle E_{3i} and the angles of its departure, the values of relative energies E_{12i}, E_{23i}, E_{13i} for the three output pairs of particles, the quantities $Q_{3i} = E_{1i} + E_{2i} + E_{3i} - E_{ai}$ and the value of multiplier of phase space ρ_i were obtained. The developed method was used to analyze the two-dimensional spectra of pα-coinciding obtained from $^3H(\alpha, p\alpha)2n$ reaction. For further analysis, the two-dimensional spectra are projected onto one of the energy axes: on the axes of the protons, to see the position of the exciting levels, and on the axes of alpha-particles, to determine the structure of these excitations. The design procedure consists of summing the point events of the corresponding locus within a cell of a given size, which allows obtaining projections of the branches of two-dimensional energy loci on the energy axis with the arbitrary step of the channel's price.

Fig. 1, *b* shows a typical two-dimensional ($E_p \times E_\alpha$) spectrum for proton registration angle 28.5º and alpha-particles 16.5º. In all registered ($E_p \times E_\alpha$) two-dimensional spectra, one can observe strips parallel to the axes of alpha-particles energy, which consist of events from the process of excitation and decay ^6He. These strips were identified as manifestations of excited states (marked as 1-ex, 2-ex, and 3-ex) and their subsequent decay into three $\alpha + n + n$ components and they carry all information about the energy parameters of unbound excited states and their structure.

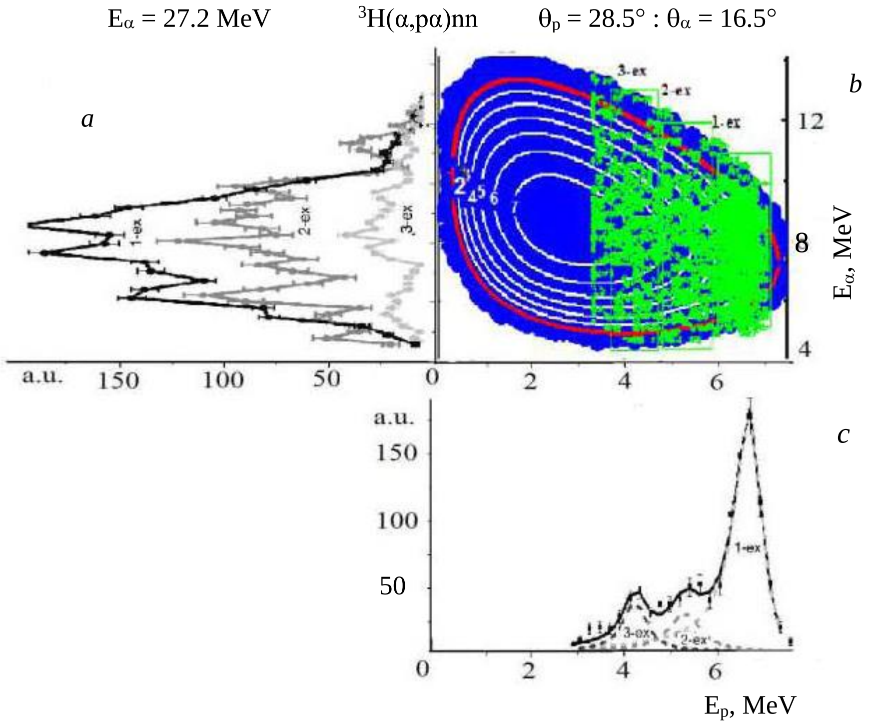


Fig. 1. *a* – projection of the selected vertical bands in the spectrum (*b*) on the axis of E_α. *b* – two-dimensional spectrum of p-α coincidences caused by $\alpha + t$ interaction at E_α = 27.2 MeV. The drawn (green dots) experimental two-dimensional spectrum and corresponded kinematical calculations (blue background) – Monte Carlo simulation, red solid lines – kinematic loci for the hypothetical $^3H(^4He, p)$<2n>reaction. *c* – projection of two-dimensional spectrum of pα-coincidences (*b*) on the axis of E_p. (See color Figure on the journal website.)

When the two neutrons are emitted in the same direction with the same energy, they appear as one-particle <2n> ("dineutron") and the kinematic loci of the p-α coincidence events are placed along the line of the $^3H(\alpha, p\alpha)$<2n> kinematic three-body reaction calculations in the frame of a punctual geometry represented in Fig. 1, *b* by solid red lines marked as 1. The portion of (E_p, E_α) plane contained inside the three-body kinematic line1 is the region of the two-dimensional (E_p, E_α) plane where all events due to investigation $^3H(\alpha, p\alpha)2n$ in the frame of a punctual geometry of experiment can take place. If we take into account the real experimental conditions, using the Monte Carlo simulation method then the portion of (E_p, E_α) plane where the p-α coincidence events from investigation $^3H(\alpha, p\alpha)2n$ may take place will increase (see Fig. 1, *b* blue background).

At fixed angles of alpha-particles and protons with an increase of relative energy of two neutrons E_{nn} that are emitted and not detected (drawn by white curves, marked as 2 (E_{nn} = 0.2 MeV), 3 (E_{nn} = 0.4 MeV), 4 (E_{nn} = 0.6 MeV), 5 (E_{nn} = 0.8 MeV), 6 (E_{nn} = = 1.0 MeV) and 7 (E_{nn} = 1.2 MeV) at the Fig. 1, *b*), events from the p-α coincidences are located in the more interior part ($E_p \times E_\alpha$) of the plane.

It was found in [12] that the main contribution to E_p > 3.7 MeV in the part of the plane ($E_p \times E_\alpha$) gives to the events from the protons and alpha-particle coincidences formed by two-staged mechanisms of passing the four-particle reaction ^{3}H(α, pα)<2n> with the population and subsequent decay of excited three-particle states of the ^{6}He nucleus.

The next stage of processing is to get projected events for each of the energy axes. From the analysis of the projection of the two-dimensional spectrum on the energy axis of the proton strips corresponding to the population of unbound excited states (see Fig. 1, *c*), the energy and energy width of these states are determined, and from the projection onto the energy axis of the alpha-particles we obtain information on relative energies and neutron correlations, which are not detected (see Fig. 1, *a*).

The projections of two-dimensional spectra on the protons energy axis were parameterized using the Breit - Wigner formula [21]. Obtained energy positions and widths of the excited states of the ^{6}He nucleus are given in Table 1. Table 1 shows the energy parameters of the three excited states that were observed at low energies [12] (up to the excitation energy of 0 < E_{ex} < 3.5 MeV) and ten at an energy of 67.2 MeV (0 < E_{ex} < 20 MeV) [13]. And also from our measurements of the t-t and p-t coincidence events in the ^{3}H(α, tt) and ^{3}H(α, pt)t reactions [14] the excited states with energy parameters close to those of our levels No. 8, 9, and 10 [13].

It should be noted that most of the resonances are rather narrow, their total width varies from 0.4 ± 0.2 to 2.3 ± 1.0 MeV. Two new exciting levels were obtained: E_{ex} = 2.5 ± 0.2 MeV, Γ = 0.4 ± 0.2 MeV and E_{ex} = 3.1 ± 0.3 MeV, Γ = 0.4 ± 0.2 MeV.

Table 1. **Energy parameters of excited states ^{6}He**

E_α = 67.2 MeV ^{3}H(α, pα)nn [13]			E_α = 27.2 MeV ^{3}H(α, pα)nn [12]		
No.	E*, MeV	Γ, MeV	No.	E*, MeV	Γ, MeV
1	1.7 ± 0.2	0.65 ± 0.15	1	1.8 ± 0.2	0.3 ± 0.15
2	2.5 ± 0.2	0.4 ± 0.2	2	2.4 ± 0.2	0.4 ± 0.2
3	3.1 ± 0.3	0.4 ± 0.2	3	3.0 ± 0.2	0.6 ± 0.2
4	4.1 ± 0.3	0.9 ± 0.3	E_α = 67.2 MeV ^{3}H(α, tt)p [14]		
5	6.1 ± 0.3	1.6 ± 0.3			
6	8.8 ± 0.4	2.0 ± 0.6	10	18.3 ± 0.2	0.4 ± 0.2
7	11.6. ± 0.4	2.0 ± 0.7	E_α = 67.2 MeV ^{3}H(α, pt)t [14]		
8	14.6 ±0.4	2.3 ± 1.0	8	14.0 ± 0.4	0.6 ± 0.4
9	16.4 ± 0.4	1.4 ± 0.9	9	16.1 ± 0.4	0.8 ± 0.4
10	18.5 ± 0.4	1.7 ± 0.6	10	18.4 ± 0.4	1.0 ± 0.4

3. Observation of neutron-neutron correlations in the ^{6}He nucleus by using four-particle ^{3}H(^{4}He, pα)nn reactions

The next stage in the analysis of two-dimensional ($E_p \times E_\alpha$) spectra was to obtain projections of vertical stripes corresponding to the population of unbound three-particle exciting levels of the ^{6}He nucleus on the energy axes of alpha-particles (see Fig. 1, *a*). Projections of two-dimensional ($E_p \times E_\alpha$) spectra on the energy axis of alpha-particles were analyzed using the Monte Carlo method in the assumption that two neutrons as a whole revolve around the alpha-particle with orbital moments L_{nn} = 0 and $L_{\alpha\text{-}nn}$ = 2 (“dineutron”) or with moments L_{nn} = 2, $L_{\alpha\text{-}nn}$ = 0 (“cigar”). The Monte Carlo modeling scheme for these processes presented in [20].

The four-particle ^{3}H(α, pα)nn reactions were reduced to two quasi three-particle ^{3}H(α, pα)<2n> (E_{nn} = 0) and ^{3}H(α, pα)<2n> (E_{nn} = 1 MeV), which are treated as two-stage reaction. Let’s consider the ^{3}H(α, pα)<2n> reaction (E_{nn} = 0). The first stage is a quasi-two-part process of formation of proton and, accordingly, ^{6}He nucleus in an excited state. To describe this process, it is necessary to draw both the energy and geometric conditions of nuclear interaction, namely: the place of nuclear interaction in the target (position on the spot from the beam and in the thickness), the place of registration in the detector of protons, the primary energy of the incident beam to the interaction of E_{pi}. It must first draw out the value of the excitation energy of the ^{6}He nucleus in the range from the minimum to the maximum possible E^*_i.

To sample geometric conditions, we were taking into account the loss of energy of the beam in the target E^*_{pi}. By calculating the value of the departure angle of the generated proton θ_{1i}, we determine the kinetic energy of this proton E_{1i} and the kinetic energy and the departure angle of the ^{6}He nucleus with the excitation energy E^*_i - E_{kin} and θ_{6He^*}.

The second stage is the decay of this excited state of the ^{6}He nucleus is due to the departure of the alpha-particle and the <nn> ("dineutron"). For this step, we calculate the energy of the α-particle E_{2i} from the decay and sample the angle of departure of the alpha-particle in the system of the central mass, assuming that the decay is isotropic, and determine whether this α-particle is in the second detector. If it is found, then using the laws of conservation of energy and momentum for a three-particle reaction, we determine the energy and the departure angle of the third unregistered particle <nn> ("dineutron") E_{3i} and θ_{3i}.

Also, we calculate, if necessary, other kinematic relationships – the relative energy of the output particles E_{12i}, E_{23i}, and E_{13i}. We start a new simulation act, repeating it all the above operations. If alpha-particle from the decay of the excited state does not fall into the second detector, we start again. The number of simulated events must be at least 10^6. In the same way, we carry out calculations for the second mode of decay – "cigars", for the quasi-three-particle ^{3}H(α, pα)<2n> (E_{nn} = 1 MeV) reaction, where the first stage is the same, but at the second are formed α-particle and two- neutrons with relative energy E_{nn} = 1 MeV.

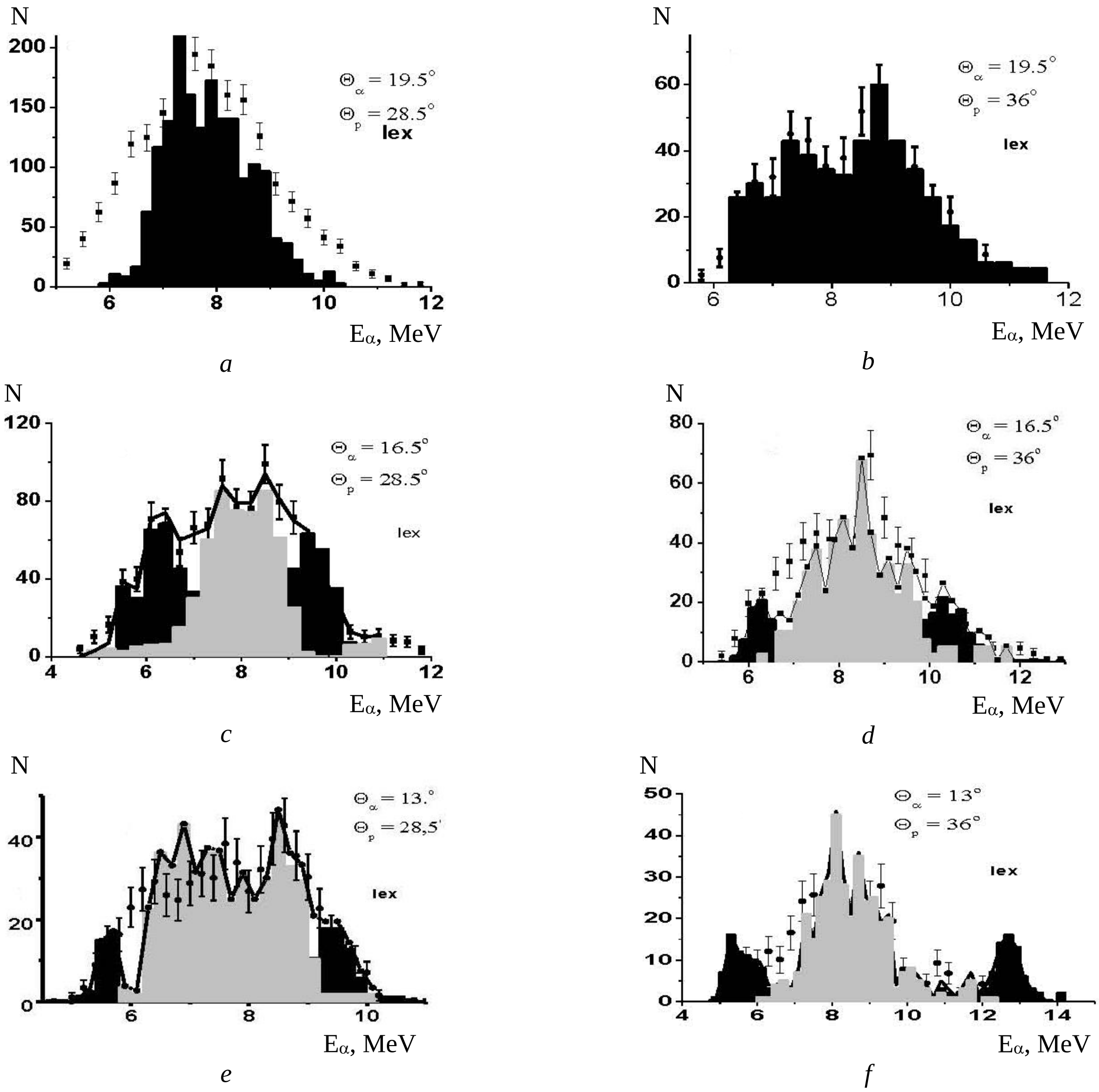


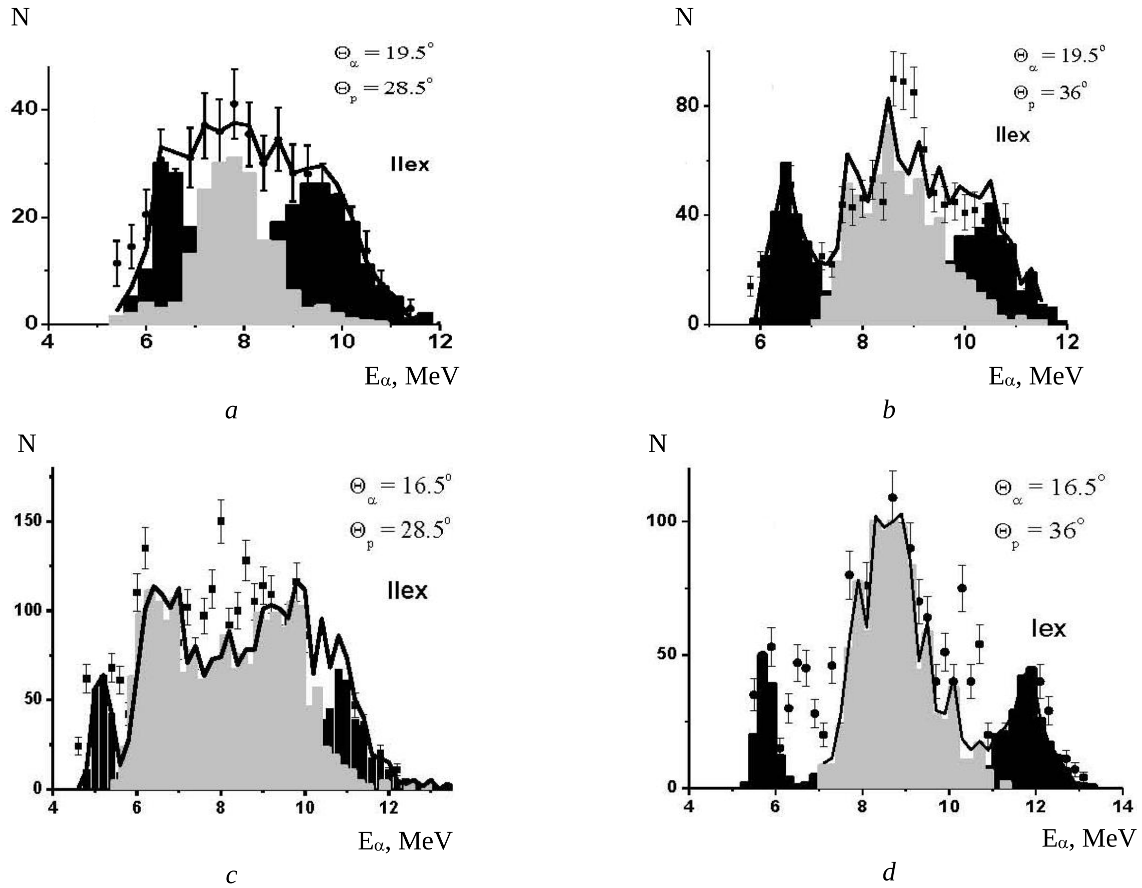
Fig. 2, (*a* - *f*). Projections of vertical strips of the two-dimensional ($E_p \times E_\alpha$) spectra on the energy axes of alpha-particles for the first excited state of the ^{6}He nucleus. Black dots – experimental data. Parameterizations by the Monte Carlo method: black columns – configuration "dineutron", gray light columns – "cigar". The solid black line – its sum.

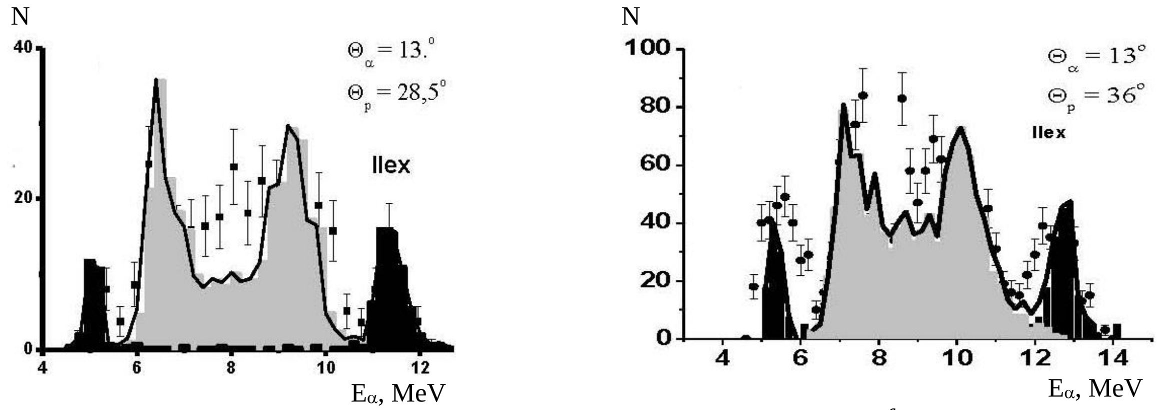
Fig. 2, (*a* - *e*) show projections of strips parallel to the energy axis of alpha-particles of the two-dimensional spectrum of the p-α coincidences (see Fig. 1, *a*) on the energy axis of alpha-particles, which correspond to the first excited state of the ^{6}He nucleus. The solid curve shows the spectral modeling performed within the framework of the Monte Carlo method, with black columns the contribution of the configuration "dineutron" is marked, and the light gray columns are "cigar". The only configuration “dineutron” is realized at the departure angles of alpha-particles and protons θ_p/θ_α = 36°/19.5° and 28.5°/19.5°, as can be seen from Fig. 2, *a, b*. This can be explained by the fact that in the case of an alpha-particle angle of departure, more than 19° are energy-banned, events of p-α coincidences for which the relative energy of two neutrons exceeds 0.3. And so we didn’t do Monte Carlo simulations for the configuration of the “cigar”. Therefore, the projection of the first excited state for the above-mentioned pairs of angles was described in the assumption that only the “alpha-particle + dineutron” configuration is formed.

Thus for all other kinematic conditions studied (Fig. 2, (*c - f*), the peak corresponding to the first excited state ^{6}He is described in the absence of energy forbidden, as a configuration of the “dineutron” and “cigars” in different ratios (see Fig. 2 and Table 2). And, only at θ_p = 36° and 28.5° and θ_α = 19.5° we observed with our description that the decay of the first excited state ^{6}He occurred only due to the departure “alpha-particle + dineutron”. In all other cases, there is an admixture of the configuration of the “cigar” in different ratios. From the analysis of the obtained results, it seems that the the observed difference in the structure of the first excited level of ^{6}He depends on the angles of registration of the proton and alpha-particle. But from these angles depends on the relative energy of the two neutrons E_{nn} that together with the alpha-particle form the first excited state.

Table 2. **The ratio of configurations depending on the kinematic conditions of excited states**

Registration angles θ_p/θ_α	I excited (1.8 MeV)		II excited (2.4 MeV)		III excited (2.9 MeV)	
	<nn>, %	“cigar”, %	<nn>, %	“cigar”, %	<nn>, %	“cigar”, %
36°/19.5°	87	-	46	44		-
36°/16.5°	33	54	30	63		
36°/13.0°	16	61	28	65		
28.5°/19.5°	95	-	59	37	42	55
28.5°/16.5°	50	50	21	76	25	65
28.5°/13.0°	20	69	20	78	12	25





e *f*

Fig. 3, (*a* - *f*). Projections of vertical strips of the two-dimensional ($E_p \times E_\alpha$) spectra on the energy axes of alpha-particles for the second excited state of the ^{6}He nucleus. Black dots – experimental data. Parameterizations by the Monte Carlo method: black columns – configuration “dineutron”, gray light columns – “cigar”. The solid black line – its sum.

Fig. 3, (*a* - *c*) shows projections of two-dimensional ($E_p \times E_\alpha$) spectra corresponding to the formation of the second exciting level with energy (2.5 ± 0.2) MeV. Unlike the first excited state, there are no areas of the phase space, where any configuration would dominate (see Table 2).

The same situation is observed in the case of the formation of the third excited state ^{6}He with energy (3.1 ± 0.3) MeV (Fig. 4).

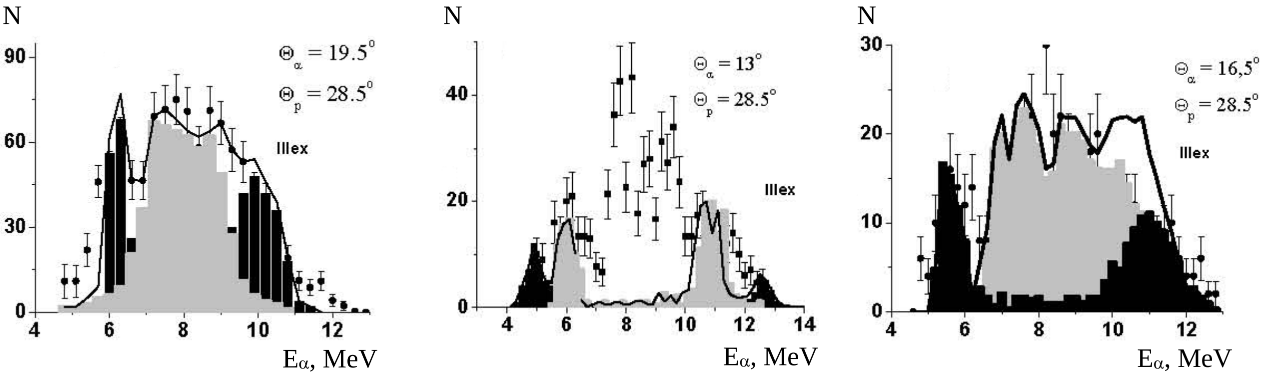


Fig. 4, (*a* - *c*). Projections of vertical strips of the two-dimensional ($E_p \times E_\alpha$) spectra on the energy axes of alpha-particles for the third excited state of the ^{6}He nucleus. Black dots – experimental data. Parameterizations by the Monte Carlo method: black columns – configuration “dineutron”, gray light columns – “cigar”. The solid black line – its sum.

As shown in Table 2 and Figs. 2, 3 and 4 modeling of two-dimensional projection of the spectrum in Monte Carlo assuming configurations “dineutron” and “cigar” does not fully exhaust the experimental spectra. The difference is 28 % (maximum case) to 3 % (the minimum value) which indicated the presence of other decay configurations that were not taken into account. It can be the formation of ^{5}He with successive decay on α + n, “democratic” decay of the excited nucleus of ^{6}He, the contribution of configuration with different angles between two neutrons [22].

4. Conclusions

Thus, one could assert that the correlation complete and incomplete experiments with two-dimensional spectra measurements in the plane of the energies of the particles into which the unbound excited state decay is a powerful tool for the study of short-living excited states of light nuclei.

The advantage of this method is the ability to simultaneously observe both the energy characteristics and the spatial correlations of the constituents of particles, while with the help of kinematics, it is selected precisely the area of the phase space where the conditions for the formation of the state being studied are realized. This eliminates the presence of background contribution from the formation and excitation of states of other nuclei, as happens when measuring inclusive spectra. In the excitation spectrum of the ^{6}He nucleus, the existence of the second and third excited states at an excitation energy of ~ 2.4 and 2.9 MeV was confirmed, respectively, and only energy positions and widths of 10 excited states of the ^{6}He nucleus were obtained.

By simple parameterization of projections of two-dimensional ($E_p \times E_\alpha$) spectrums on the axis of the energy of alpha-particles by modeling using method of Monte Carlo spatial correlations of neutrons in ^{6}He nuclei excited states are confirmed. Namely, the first, second and third the excited states manifest configuration type "dineutron" (L_{nn} = 0 and $L_{\alpha\text{-}nn}$ = 2) or "cigar" (with moments L_{nn} = 2, $L_{\alpha\text{-}nn}$ = 0). In the case of the first excited state ^{6}He decayed with dominated configuration "alpha-particle + dineutron" only in a limited domain of the phase space, while with other kinematics and for the second and third excited states manifest configuration "alpha-particle + dineutron" and "alpha-particle + cigar" in different ratios. The ratio of the configurations is not a constant value for the excited states of the nucleus, but it is a dynamic value, which depends on the kinematic conditions of the formation of the ^{6}He nucleus.

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ЕКСПЕРИМЕНТАЛЬНЕ СПОСТЕРЕЖЕННЯ НЕЙТРОН-НЕЙТРОННИХ КОРЕЛЯЦІЙ У ЯДРІ ^{6}He З РЕАКЦІЇ ^{3}H(α, pα)nn

Проаналізовано проекції двовимірних спектрів p-α збігів із чотиричастинкової реакції ^{3}H(α, pα)nn при енергії альфа-частинок 27,2 МеВ (0 < E_{ex} < 3,5 МеВ) на вісь енергії альфа-частинок для шести пар кутів. Результати параметризації за методом Монте-Карло показали, що у випадку першого збудженого стану ^{6}He при розпаді домінує конфігурація «альфа-частинка + дінейтрон» тільки в обмеженій ділянці фазового простору, а при іншій кінематиці та для другого і третього збуджених станів проявляються конфігурації «альфа-частинка + дінейтрон» та «альфа-частинка + сигара» в різних співвідношеннях.

Ключові слова: збуджені стани ^{6}He, двовимірний спектр збігів, чотиричастинкова реакція, нейтрон-нейтронні кореляції, «дінейтрон», «сигара».

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ЭКСПЕРИМЕНТАЛЬНОЕ НАБЛЮДЕНИЕ НЕЙТРОН-НЕЙТРОННЫХ КОРРЕЛЯЦИЙ В ЯДРЕ ^{6}He ИЗ РЕАКЦИИ ^{3}H(α, pα)nn

Проанализированы проекции двухмерных спектров p-α совпадений из четырехчастичной реакции ^{3}H(α, pα)nn при энергии альфа-частиц 27,2 МэВ (0 < E_{ex} < 3,5 МэВ) на ось энергии альфа-частиц для шести пар углов. Результаты параметризации по методу Монте-Карло показали, что в случае первого возбужденного состояния ^{6}He при распаде только в ограниченном участке фазового пространства доминирует конфигурация «альфа-частица + динейтрон», а при другой кинематике и для второго и третьего возбужденных состояний проявляются конфигурации «альфа-частица + динейтрон» и «альфа-частица + сигара» в различных соотношениях.

Ключевые слова: возбужденные состояния ^{6}He, двухмерный спектр совпадений, четырехчастичная реакция, нейтрон-нейтронные корреляции, «динейтрон», «сигара».

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