ISSN 1818-331X ЯДЕРНА ФІЗИКА ТА ЕНЕРГЕТИКА 2012 Т. 13 № 4

ЯДЕРНА ФІЗИКА

УДК 539.172.17

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DEUTERON AND TRITON DECAYS OF ^{5}He RESONANCES IN THE REACTION ^{7}Li(d, α)^{5}He*

The processes of excitation and decay of high excited ^{5}He resonances into the d + t channel have been studied in the reaction ^{7}Li(d, α)^{5}He* at the energy of deuteron beam E_d = 37 MeV. In the inclusive spectra of α-particles in addition to the contributions of well known ^{5}He resonances, the high excited states with excitation energies $E_x \sim 19$ and $E_x > 20$ MeV were observed. Cluster decay of these resonances was also identified in αd- and αt-coincidence spectra. For the first time, the decay into the d + t channel was observed for ^{5}He resonances with E_x = 22 and 26 MeV. The determined resonance energy and width are partly agreed with the R-matrix analysis of data obtained at the study of d + ^{3}H and n + ^{4}He binary reactions. The possible Coulomb effects in three-particle channels of reaction ^{7}Li(d, α)^{5}He* are also analyzed for different conditions of observation of high excited ^{5}He resonances.

Keywords: three-particle nuclear reaction, kinematically complete experiment, coincidence spectra, high excited resonances, decay channels, Coulomb interaction, resonance parameters.

Introduction

The properties of light nuclei may essentially differ depending on the number of neutrons. It is striking illustrated by the chain of helium isotopes where the increasing the neutron number leads to the transformation of stable ^{4}He nucleus in unbound ^{5}He. Then we have weakly bound ^{6}He, unbound ^{7}He, weakly bound ^{8}He and unbound ^{9}He nucleus [1]. The properties of resonances of light nuclei and their cluster structure attend considerably to research, that is promoted by modern possibilities of correlation measurements [2, 3]. But this time, cluster decay and structure of high excited states of light nuclei, including the ^{5}He nucleus, are insufficiently studied.

In this work the processes of excitation and decay of ^{5}He* resonances into the d + t channel have been investigated in the reaction ^{7}Li(d, α)^{5}He* at the energy of deuteron beam of 37 MeV, which value allowes to study the excitation spectrum of ^{5}He up to $E_x \sim 40$ MeV.

Besides well known ^{5}He resonances [4], the high excited states with excitation energies $E_x \sim 19$ and $E_x > 20$ MeV were observed in the inclusive spectra of α-particles from reaction ^{7}Li(d, α)^{5}He (see also [5]). Analysis of α-particle's inclusive spectra for this reaction is rather complicated because of very large background caused by different accompanying three- and four-particle reaction channels [5]. The most reliable data can be obtained by correlation measurements that provide the full determination of kinematics of three-particle reactions. In this work cluster decay of a number of ^{5}He* resonances was observed in αd- and αt-coincidence spectra.

Experimental method

The differential cross sections of reaction ^{7}Li(d, α)^{5}He have been measured at the cyclotron U-240 of the Institute for Nuclear Research at deuteron beam energy of 37 MeV. The target with the thickness of 1.5 mg/cm^2 has been produced by rolling of lithium film with natural content of ^{7}Li. The reaction products have been detected by Δ*E*-*E*-method using four Δ*E*–*E*-telescopes of silicon detectors with the thickness of ~ 50 μm for Δ*E*- and 550 μm for *E*-detectors. The thickness of Δ*E*-detectors have been specified in a way to have a low energy threshold of registration preserving appropriate mass resolution. Solid angles of detector telescopes were $\Omega_1 = 0.92 \cdot 10^{-3}$ sr and $\Omega_2 = 1.82 \cdot 10^{-2}$ sr. Total energy resolution of reaction products registration was mainly determined by the dispersion of the beam energy, solid angles of detectors and energy losses of particles in the target and approximately consists of 1.5 % of the beam energy. The signals from the detectors were processed for multi-parameter measurements of inclusive and coincidence spectra of reaction products in the same manner as described in details in [6]. Data analysis has been performed using different procedure with two- and one-dimensional histograms for particle identification, determination of their energies and selection of reaction channels [6].

Fig. 1, *a* shows typical *E*–Δ*E*-spectrum measured by one telescope in coincidences with the reaction products registered by the second telescope which was placed at the opposite side from the beam. As it is shown the range of energy measurements for protons and deuterons was restricted by the thickness of E-detectors, which was insufficient to stop these high energy particles.

Two-dimensional spectrum of alpha-particle coincidences with tritons is shown in the Fig. 1, *b*. The events located in the upper part of this spectrum correspond to the three-particle reaction channel d + ^{7}Li → α + t + d. The events in the below region of spectrum are caused by four-particle reaction d + ^{7}Li → α + t + p + n.

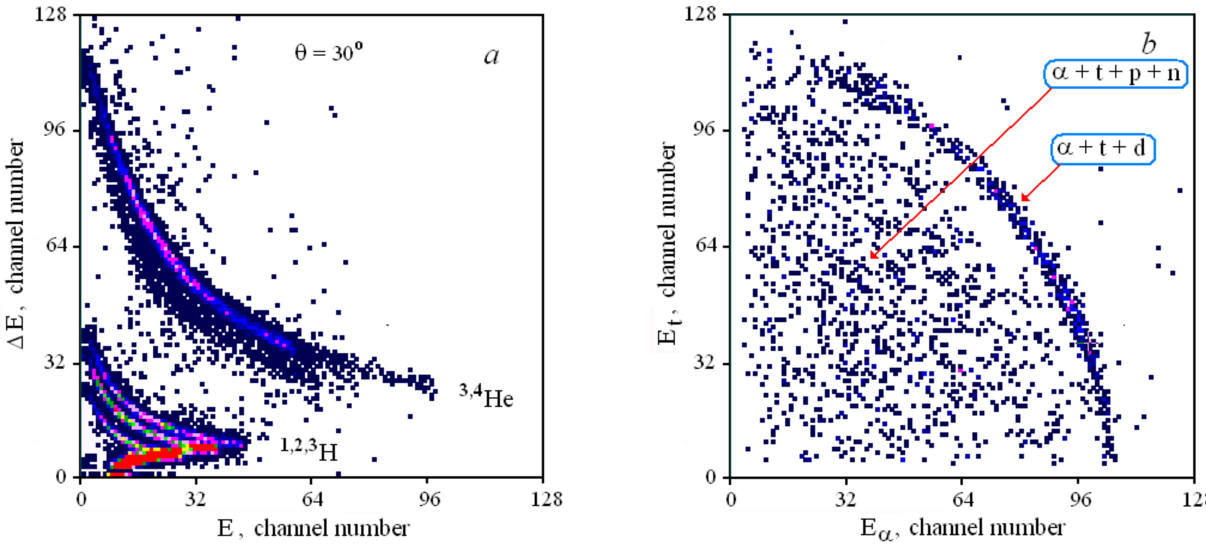

Fig. 1. ΔE-E-spectrum measured at the angles θ_1 = 30°, φ_1 = 180° in coincidences with all products of reaction d + ^{7}Li which were registered at the angles θ_2 = 79°, φ_2 = 0° (*a*). Two-dimensional plot of energy spectrum of αt-coincidences in the exit reaction channels d + ^{7}Li → α + t + d and d + ^{7}Li → α + t + p + n, which were measured at the angles θ_α = 30°, θ_t = 79°, $\varphi_1 - \varphi_2$ = 180° (*b*). Arrows indicate the location of three- and four-particle reaction channels.

The measurements of time coincidence spectra have been also used for evaluation of background which was caused by the registration of random coincidence events (Fig. 2). Peaks marked by number 1 correspond to the registration of two reaction products induced by deuteron interaction from one bunch of deuteron beam and contain real coincidence events and random time coincidences. Peaks marked by number 2 correspond to the registration of two reaction products from two different bunches of beam and contain only random coincidence events. As it is shown, the contributions of random coincidences in time spectra, which correspond to the registration of all reaction products (see Fig. 2, *a*), as well as in the spectra of coincidences of α-particles with tritons (see Fig. 2, *b*) are rather small. The ratio of random to real coincidence events is equal 0.25 and 0.05 for the spectra in Fig. 2, *a* and *b*, respectively. This ratio for events corresponding the three-particle exit channels α + t + d (see Fig. 1, *b*) and α + d + t is equal ~ 0.01. Thus, the background contribution of random coincidences can be neglected for reaction channels ^{7}Li(d, αt)d and ^{7}Li(d, αd)t.

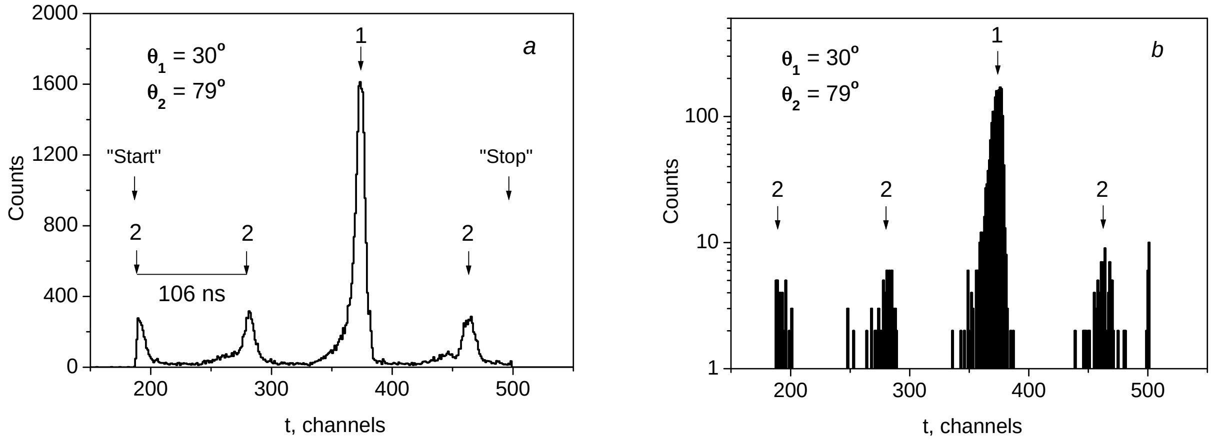

Fig. 2. Total time coincidence spectrum measured by two telescopes at the registration of all products of reaction d + ^{7}Li at the angles θ_1 = 30°, θ_2 = 79°, $\varphi_1 - \varphi_2$ = 180° (*a*). Time spectrum of αt-coincidences measured at the same angles (*b*). Peaks in the spectra marked as 1 and 2 correspond to the events from neighboring bunch of deuteron beam.

Analysis and results

Alpha-particle energy spectra measured in coincidences with deuterons and tritons are shown in the Fig. 3. These spectra (triple differential cross section) were obtained from two-dimensional spectra of αt- (see Fig. 1, *b*) and αd-coincidences using usual procedures [6]. Correlation spectra have been decomposed in some Breit - Wigner curves which correspond to the contributions of ^{5}He resonances:

$$\frac{d^3\sigma}{d\Omega_\alpha d\Omega_{d(t)} dE_\alpha} = \frac{C_i}{(E_{d-t} - E_R)^2 + \Gamma^2/4}\rho(E_\alpha), \quad (1)$$

where $E_R = E_x - E_{b(dt)}$ and Γ are resonance energy and width, $E_{b(dt)}$ is bound energy of deuteron and triton in ^{5}He nucleus, $E_{d\text{-}t} = f(E_\alpha)$ is relative energy in (d-t)-subsystem depending on the alpha-particle energy E_α, $\rho(E_\alpha)$ is the phase space factor [7] for three-particle reaction ^{7}Li(d, αd)t or ^{7}Li(d, αt)d, C_i is the coefficient which determines the intensity of resonance with number *i*.

Besides ^{5}He resonances the excitation and decay of ^{6}Li and ^{7}Li resonances can be also observed in coincidence spectra from reactions ^{7}Li(d, αd)t and ^{7}Li(d, αt)d. These resonances are formed in accompanying reaction channels ^{7}Li(d, d)^{7}Li* and ^{7}Li(d, t) ^{6}Li*. The position of possible contributions of ^{6}Li and ^{7}Li resonances can be calculated using the kinematical dependencies of relative energies in (α–d)- and (α–t)-subsystems on the alpha-particle energy E_α. The dependencies of excitation energy of ^{5}He, ^{6}Li and ^{7}Li resonances on the energy of one of the reaction products can be obtained using simple equation: $E_x = E_{rel} + E_b$, where E_{rel}, E_b are the relative energy and bound energy of one of the cluster in corresponding subsystem, respectively. As it shown in Fig. 4, the known resonances of ^{6}Li and ^{7}Li [4] do not contribute to the high energy part of measured coincidence spectra ($E_\alpha > 19$ MeV). The well known "thermonuclear" resonance of ^{5}He with excitation energy $E_x = 16.75$ MeV cannot be also observed in the analyzed spectra.

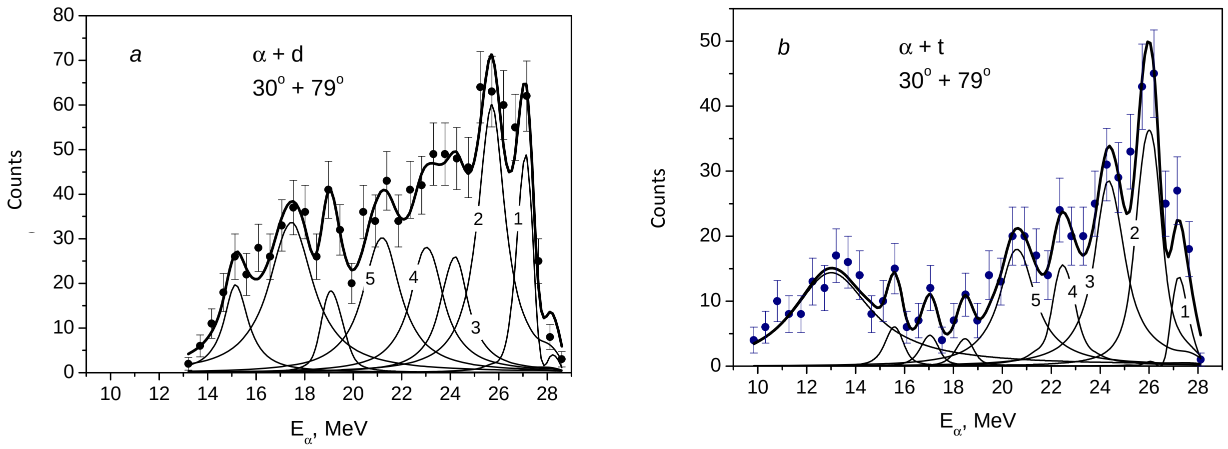

Fig. 3. Energy spectra of alpha-particle measured in coincidences with deuterons (*a*) and tritons (*b*) for reactions ^{7}Li(d, αd)t and ^{7}Li(d, αt)d at $E_d = 37$ MeV, $\theta_\alpha = 30°$, $\theta_{d(t)} = 79°$, $\varphi_\alpha - \varphi_{d(t)} = 180°$. Solid lines represent the results of the fit by equation (1) for each resonance (see Table). Thick line corresponds to the sum of all resonance contributions.

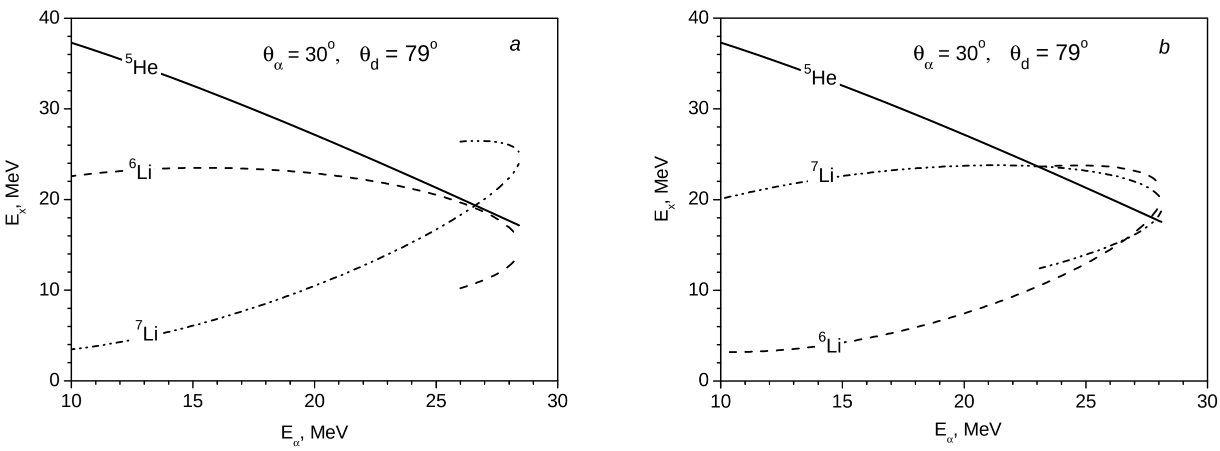

Fig. 4. The dependencies of excitation energy of ^{5}He, ^{6}Li and ^{7}Li resonances, which can be observed in the reactions ^{7}Li(d, αd)t (*a*) and ^{7}Li(d, αt)d (*b*), on the alpha-particle energy E_α. Calculations were performed under kinematical conditions specified in the capture of Fig. 3.

Extracted values of ^{5}He resonance parameters are given in the Table. Some resonances which contributions can be overlapped with accompanying resonances of ^{6}Li and ^{7}Li have been excluded from consideration. Resonances with $E_x \sim 19$ MeV have been previously identified at the study of reactions ^{2}H(α, pd)^{3}H [8] and ^{3}H(α, dd)^{3}H [9] in kinematically complete experiments. The results of many inclusive experiments indicate the presence only one broad level with $E_x \sim 20$ MeV [4]. Existence of three resonances with $E_x = 19.14$, 19.26, 19.31 MeV, approximately equal width Γ = 3.56, 3.96, 3.02 MeV and different spin follows from multichannel R-matrix analysis of experimental data for binary reactions d + ^{3}H and n + ^{4}He [10].

The parameters obtained for the second resonance with $E_x \sim 20$ MeV are agreed well with R-matrix analysis of binary reactions ($E_x = 19.96$ MeV, Γ = 1.92 MeV [10]) and reaction ^{2}H(^{6}He, dt)^{3}H ($E_x = 19.7 \pm 0.3$ MeV [11]). Third resonance with $E_x = 22$ MeV and Γ = 1.7 MeV have not been observed at the study of binary reaction [10]. R-matrix analysis [10] has suggested the presence of two broad (Γ ~ 5 MeV) resonances with approximately equal excitation energy $E_x = 23.97$ and 24.06 MeV and different spins. We identified more narrow resonance (Γ ~ 1.2 – 1.9 MeV) with excitation energy $E_x \sim 24$ MeV and the resonance with $E_x \sim 26$ MeV (Γ ~ 2 MeV) which has not been previously observed.

^{5}He resonance parameters obtained for reactions ^{7}Li(d, αd)t and ^{7}Li(d, αt)d. Numbers in the first column correspond to the numbers of lines in Fig. 3

Resonance number	Reaction ^{7}Li(d, αd)t		Reaction ^{7}Li(d, αt)d	
	E_x, MeV	Γ, MeV	E_x, MeV	Γ, MeV
1	18.7 ± 0.1	0.5 ± 0.2	18.5 ± 0.2	0.7 ± 0.2
2	20.4 ± 0.2	1.7 ± 0.6	20.3 ± 0.2	1.8 ± 0.5
3	22.2 ± 0.4	1.7 ± 0.5	22.0 ± 0.2	1.7 ± 0.5
4	23.6 ± 0.4	1.9 ± 0.5	24.2 ± 0.2	1.2 ± 0.5
5	25.7 ± 0.3	2.1 ± 0.8	26.4 ± 0.3	2.0 ± 0.8

Coulomb effects at the decay of ^{5}He resonances in the reaction ^{7}Li(d, α)^{5}He*

All the products of studied reactions are charged. In this case the observable parameters of ^{5}He resonance can be modified by three-body Coulomb effects [12 - 15]. The following expression for the squared modulus of the amplitude of reaction

$$p + T \rightarrow k + R \rightarrow k + i + j \qquad (2)$$

can be used to estimate the influence of the Coulomb field of accompanying fragment k on the decay of resonance R into the channel $i + j$ [13]:

$$\left|T\,(\vec{k}_{ij}\vec{p}_k)\right|^2 = \frac{2\pi\xi}{e^{2\pi\xi}-1}\cdot\frac{e^{2\xi Arcctg\varepsilon}}{1+\varepsilon^2}\cdot\left|F\right|^2\left|\chi_{ij}(\vec{k}_{ij})\right|^2, \qquad (3)$$

$$\varepsilon = 2(E_{ij} - E_R^0)/\Gamma^0, \quad \xi = \eta - \nu, \qquad (4)$$

$$\eta = \eta_{ki} + \eta_{kj} = Z_k Z_i \mu_{ki}/k_{ki} + Z_k Z_j \mu_{kj}/k_{kj}, \qquad (5)$$

where E_{ij} is relative energy of particles i and j; E_R^0, Γ^0 are the position and width of isolated resonance R formed in binary reactions; ν, η are the parameters corresponding the Coulomb interaction of accompanied particle k with resonance R as a whole system and with decay products, respectively; Z_k, Z_i, Z_j are the particle's charges; μ_{ki}, μ_{kj}, k_{ki}, k_{kj} are the reduced masses and relative momenta of the particles k and $i(j)$, respectively; F is the function depending on the angular momenta; $\chi_{ij}(\vec{k}_{ij})$ is the decay vertex function. In general case the parameter ν is the complex value $\nu = \nu_1 - i\nu_2$ [14, 15]. For resonances far from decay threshold ($E_R^0 >> \Gamma^0$) the value ν_2 is negligible small and parameter ν can be simply determined as $\nu = Z_k Z_R \mu_{kR}/k_{kR}$.

The resonance curves, which can be observed in kinematically complete experiments at the study of reaction ^{7}Li(d, αd)t at different angles of deuteron decay θ_d in the ^{5}He resonance center of mass, have been calculated in accordance with the parameterization of reaction amplitude (3). The decay into α + n channel in the reaction ^{7}Li(d, αα)n is also considered with the aim to estimate the integrated Coulomb effects which can be observed in the inclusive spectra of α-particles from reaction ^{7}Li(d, α)^{5}He*.

The calculations for ^{5}He resonance with excitation energy E_x = 19,96 MeV and width Γ^0 = 1,92 MeV are shown in Fig. 5. The parameters $E_R^0 = E_x - E_b$ and Γ^0, which were used in the calculations for both decay channels, correspond to the values obtained for isolated ^{5}He resonance formed in the binary reactions d + ^{3}H and n + ^{4}He [10].

At the decay of short lived resonances with $\Gamma^0 > 1$ MeV in the reactions like (2) the scattering of accompanying particle on the resonance as a whole system can be neglected. In this approach, the effective Coulomb parameter ξ is determined by the interaction of accompanying α-particle only with decay products ($\xi = \eta$). As it is shown from Fig. 5, such approach predicts greater shift and broadening of resonance curve than approximation with the Coulomb parameter $\xi = \eta - \nu$.

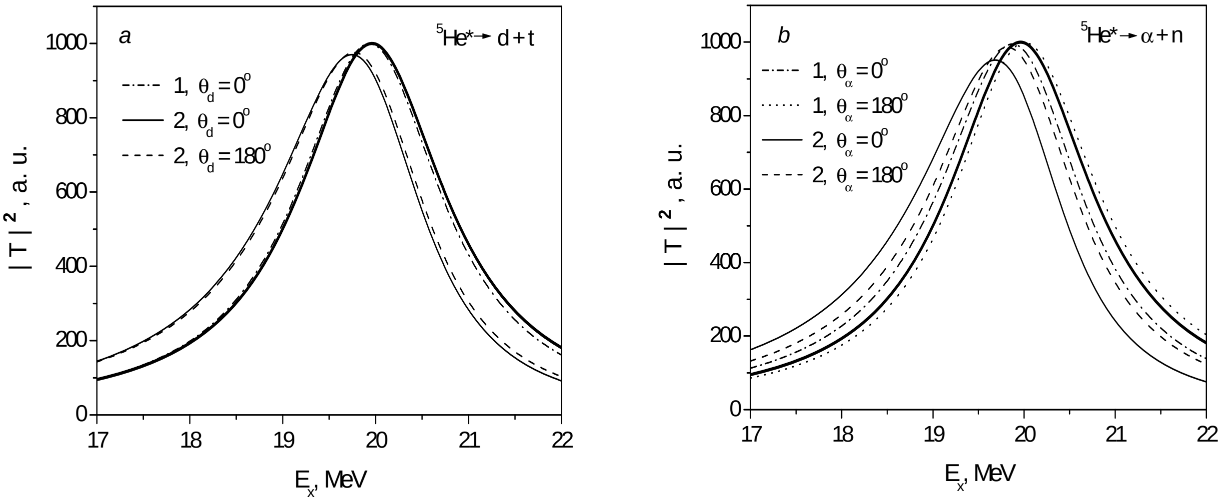

Fig. 5. The calculations of the resonance curves corresponding the excitation and decay of ^{5}He* resonance with E_x = 19.96 MeV and Γ^0 = 1.92 MeV [10] in the reaction ^{7}Li(d, αd)t (*a*) and ^{7}Li(d, αα)n (*b*) at E_d = 37 MeV. Thick solid line corresponds to the calculation for isolated ^{5}He* resonance ($\xi = 0$). Other lines represent the calculations in both approach (see text) according to which the Coulomb parameter is defined as $\xi = \eta - \nu$ (lines 1) and $\xi = \eta$ (lines 2). The angles $\theta_{d(\alpha)}$ = 0° and $\theta_{d(\alpha)}$ = 180° correspond to the deuteron or α-particle decay in the resonance center of mass in the direction towards the accompanying α-particle and vice versa, respectively. The calculation for the decay angle θ_d = 180° in the approximation $\xi = \eta - \nu$ almost coincides with the curve corresponding the isolated decay of ^{5}He*, so it is not shown in the Figure.

Therefore, the maximal shift and width change of resonance curves caused by the Coulomb field of accompanying α-particles exceed the value of 200 – 300 keV. For example, the contribution of ^{5}He*(19.96 MeV) decay into α + n channel provides the broadening of resonance curves to the value Γ = 2.4 MeV. This value is in consistent with data obtained from the inclusive spectra of α-particles, which were measured for the reaction ^{7}Li(d, α)^{5}He at the same energy of deuteron beam E_d = 37 MeV [5], as well as with compilation data for different three-particle reactions [4]. Similar changes of resonance parameters should be observed at the decay of other high excited ^{5}He resonances in the reaction ^{7}Li(d, α)^{5}He*.

Conclusions

The decay of high excited ^{5}He resonances with E_x > 17 MeV into the d + t channel have been studied in the three-particle reactions ^{7}Li(d, αd)t and ^{7}Li(d, αt)d at deuteron beam energy E_d = 37 MeV. In kinematically complete experiments a new data for ^{5}He resonance energies and widths have been obtained. The data within experimental error are consistent partly with those obtained by other authors (see [4, 8 - 11]), but the decay of resonances with E_x ~ 22 and 26 MeV into the d + t channel was observed for the first time. Determined parameters for some resonances are also agreed with the extended R-matrix analysis of data for binary reactions d + ^{3}H and n + ^{4}He [10].

Performed calculations show that three-particle Coulomb effects are quite observable in the studied reactions for ^{5}He resonances with E_x ~ 18 - 26 MeV. The different resonance position and width can be observed in kinematically complete experiments at the different angles of resonance decay. This results the broadening of resonances in the inclusive spectra of accompanying particle in which the integrated over decay angles and decay channels effect is observed.

Obtained results will be useful to clarify the causes of inconsistency between an existing data as well as to test the various theoretical models.

REFERENCES

1. *Golovkov M.S., Grigorenko L.V., Fomichev A.S. et al.* New insight into the low-energy ^{9}He spectrum // Phys. Rev. C. - 2007. - Vol. 76, No. 2. - P. 021605 (1 - 5).
2. *Grenier F., Chbihi A., Roy R. et al.* Multi-particle correlation function to study short-lived nuclei // Nucl. Phys. A. - 2008. - Vol. 811, No. 3-4. - P. 233 - 243.
3. *Caamano M., Cortina-Gil D., Mittig W. et al.* Experimental study of resonance states in ^{7}H and ^{6}H // Phys. Rev. C. - 2008. - Vol. 78, No. 4. - P. 044001 (1 - 8).
4. *Ajzenberg-Selove F.* Energy levels of light nuclei A = 5 - 10 // Nucl. Phys. A. - 1988. - Vol. 490, No. 1. - P. 1 - 225.
5. *Pavlenko Yu.N., Gorpynych O.K., Dobrikov V.N. et al.* Experimental study of the excited states of helium isotopes in the reactions ^{7}Li(d,^{3,4,6}He) at deuteron energy of 37 MeV // Nucl. Phys. At. Energy. - 2006. - No. 2(18). - P. 16 - 27.
6. *Pavlenko Yu.N., Kiva V.O., Kolomiets I.N. et al.* The methods of multiparameter correlation measurements for the study of nuclear reactions // Scient. papers of the Inst. for Nucl. Res. - 2005. - No. 2(15). - P. 151 - 161.
7. *Ohlsen G.G.* Kinematic relations in reactions of the form A + B→C + D + E // Nucl. Instr. and Meth. - 1965. - Vol. 37. - P. 240 - 248.
8. *Treado P.A., Lambert J.M., Kane R.J. et al.* Excited States of ^{4}He and ^{5}He from Sequential α + d Reactions at E_α = 70 MeV // Phys. Rev. C. - 1973. - Vol. 7, No. 5. - P. 1742 - 1750.
9. *Gorpinich O.K., Povoroznyk O.M., Yachmeniov A.A.* The structure of high excited states of ^{5}He nucleus // Izv. RAN. Ser. Phys. - 2005. - Vol. 69. - P. 745 - 747.
10. *Tilley D.R., Cheves C.M., Godwin J.L. et al.* Energy levels of light nuclei A = 5, 6, 7 // Nucl. Phys. A. - 2002. - Vol. 708, No. 1. - P. 3 - 163.
11. *Ter-Akopian G.M., Fomichev A.S., Golovkov M.S. et al.* New insights into the resonance states of ^{5}H and ^{5}He // Eur. Phys. J. - 2005. - Vol. A25. - P. 315 - 320.
12. *Komarov V.V., Popova A.M., Karmanov F.I. et al.* Scattering properties of two-fragment systems produced by many-particle reactions // Phys. of Elem. Part. and Atom. Nucl. - 1992. - Vol. 23, No. 4. - P. 1035 - 1087.
13. *Komarov V.V., Popova A.M., Shablov V.L.* Dynamics of the systems of few quantum particles. - Moscow University. - M., 1996. - 276 p.
14. *Shablov V.L., Tyras I.A.* Modeling the dynamics of the final state interaction in nuclear reactions with charged particles // Izv. Vuzov. Ser. Nucl. Energetic. - 2007. - Vol. 3, No. 2. - P. 127 - 131.
15. *Pavlenko Yu.N., Dobrikov V.N., Doroshko N.L. et al.* Decay properties of short lived resonances of light nuclei in many-particle nuclear reactions // Int. Journal of Modern Physics E. - 2010. - Vol. 19, Issue 5 - 6. - P. 1220 - 1226.

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ДЕЙТРОННИЙ І ТРИТОННИЙ РОЗПАДИ РЕЗОНАНСІВ ^{5}He В РЕАКЦІЇ ^{7}Li(d, α)^{5}He

Процеси збудження та розпаду високозбуджених резонансів ^{5}He в канал d + t досліджено в реакції ^{7}Li(d, α)^{5}He при енергії пучка дейтронів E_d = 37 МеВ. В інклюзивних спектрах α-частинок, крім внесків добре відомих резонансів, спостерігалися високозбуджені стани з енергіями збудження E_x ~ 19 і E_x > 20 МеВ. Кластерний розпад цих резонансів також ідентифіковано в спектрах αd- і αt-збігів. Уперше спостерігався розпад у канал d + t резонансів ^{5}He з E_x = 22 і 26 МеВ. Визначені резонансні енергії та ширини частково узгоджуються з R-матричним аналізом даних, отриманих при дослідженні бінарних реакцій d + ^{3}H і n + ^{4}He. Аналізуються також можливі кулонівські ефекти для різних умов спостереження високозбуджених резонансів ^{5}He в реакції ^{7}Li(d, α)^{5}He.

Ключові слова: тричастинкова ядерна реакція, кінематично повний експеримент, спектри збігів, високозбуджені резонанси, канали розпаду, кулонівська взаємодія, резонансні параметри.

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ДЕЙТРОННЫЙ И ТРИТОННЫЙ РАСПАДЫ РЕЗОНАНСОВ ^{5}He В РЕАКЦИИ ^{7}Li(d, α)^{5}He

Процессы возбуждения и распада высоковозбужденных резонансов ^{5}He в канал d + t исследованы в реакции ^{7}Li(d, α)^{5}He при энергии пучка дейтронов E_d = 37 МэВ. В инклюзивных спектрах α-частиц, кроме вкладов хорошо известных резонансов, наблюдались высоковозбужденные состояния с энергиями возбуждения E_x ~ 19 и E_x > 20 МэВ. Кластерный распад этих резонансов также идентифицирован в спектрах αd- и αt-совпадений. Впервые наблюдался распад в канал d + t резонансов ^{5}He с E_x = 22 и 26 МэВ. Определенные резонансные энергии и ширины частично согласуются с R-матричным анализом данных, полученных при исследовании бинарных реакций d + ^{3}H и n + ^{4}He. Анализируются также возможные кулоновские эффекты для разных условий наблюдения высоковозбужденных резонансов ^{5}He в реакции ^{7}Li(d, α)^{5}He.

Ключевые слова: трехчастичная ядерная реакция, кинематически полный эксперимент, спектры совпадений, высоковозбужденные резонансы, каналы распада, кулоновское взаимодействие, резонансные параметры.

Надійшла 02.11.2012
Received 02.11.2012