Академія наук
Української
РСР

Інститут теоретичної фізики

ITP-91-28E

V.V.Peresypkin, E.T.Ibraeva,
V.I.Kukulin

PROTON ELASTIC AND QUASI-ELASTIC (p,p'd) KNOCK OUT REACTIONS ON ^{6}Li NUCLEUS

Київ

УДК 539.171, 539.166.2

В.В.Пересыпкин, Е.Т.Ибраева, В.И.Кукулин

Реакции упругого рассеяния протонов и квазиупругого выбивания (p,p'd) на ядре ^{6}Li

В рамках теории Глаубера-Ситенко исследованы процессы упругого рассеяния протонов при энергии 0.2, 0.6 и 1.0 ГэВ и квазиупругого выбивания (p,p'd) на ядре ^{6}Li с использованием реалистических волновых функций ядра-мишени. Рассчитанные дифференциальные сечения упругого рассеяния хорошо согласуются с экспериментальными данными. Дифференциальные сечения реакции ^{6}Li(p,pd)^{4}He в некомпланарной геометрии в рамках плосковолнового приближения качественно согласуются с экспериментальными данными. Исследована зависимость сечения от вида волновой функции ядра-мишени.

V.V.Peresypkin, E.T.Ibraeva, V.I.Kukulin

Proton Elastic and Quasi-Elastic (p,p'd) Knock Out Reactions on ^{6}Li Nucleus

The elastic proton scattering at energies 0.2, 0.6 and 1.0 GeV and quasi-elastic (p,p'd) knock out reaction on ^{6}Li nucleus are investigated within Glauber-Sitenko theory using the realistic wave functions of a target nucleus. The calculated elastic scattering differential cross-sections agree well with experimental data. The ^{6}Li(p,pd)^{4}He differential cross-sections in noncoplanar geometry within the framework of the plane-wave approximation agree qualitatively with experimental data. The cross-section dependence on the target nucleus wave function form is investigated.

Academy of Sciences of the Ukrainian SSR
Institute for Theoretical Physics

Preprint
ITP-91-28E

V.V.Peresypkin, E.T.Ibraeva,
V.I.Kukulin

PROTON ELASTIC AND QUASI-ELASTIC (p,p'd) KNOCK OUT REACTIONS ON ^{6}Li NUCLEUS

Kiev - 1991

1. INTRODUCTION

Reactions of particles strongly interacting with nuclei make it possible to derive from experimental data the nucleon distribution density in nuclei, multiparticle correlations and the other important characteristics of nuclei and also to study the hadron-nuclei interaction mechanisms. In analising the elastic or inelastic hadron scattering at intermediate energies one usually employs the approach [1] where either (density-dependent) effective N-N force or the averaged G-matrix is weighted by the density function of the target nucleus which is derived from the data on fast electron scattering. Thus, the information about multi-particle correlations and mechanisms of the incident hadron-target nucleus interaction either does not appear explicitly, in general, or incomes implicitly through the effective interaction constants. In essence with this theoretical interpretation of experiments no new information on intra-nuclear correlations, on specific mechanisms of the fast hadron-nucleus interaction can be produced.

On the contrary, we use quite a different approach [2] proceeding from the nuclear wave functions calculated theoretically within the framework of a multi-particle dynamic model of the light nuclei [3] and studying the influence of multiparticle correlations on the cross-sections of the elastic, inelastic and also quasi-elastic fast hadron scattering by certain expecially chosen nuclei. Then, in contrast to a standard interpretation, given at the beginning, (i.e. with use made of the measured experimentally charge density) we can connect on the basis of a single model a set of the phenomena and experiments of different types including the strong, electromagnetic and weak interaction. It is then very informative to compare the theoretic predictions and experimental data for the electron and hadron scattering ($\pi^{\pm}$, p etc.) since a complete information is, thus, obtained. A simultaneous analysis of the quasi-elastic scattering within the same model makes it possible, in principle, to estimate the contribution of distortions in the finite state and also that of the processes of the spectator knock out.

In this paper we consider the elastic scattering on ^6Li and the reaction of deuteron knock out $^6Li(p,p'd)\alpha$ in the intermediate energy range. To describe the nuclear reactions in this energy range a Glauber-Sitenko multiple diffraction scattering theory is now successfully employed [2].

Choosing the nucleus ^6Li as a target is not accidental. This nucleus contains a sufficient number of nucleons for the cluster correlations to be manifest in its properties. On the other hand, a relatively small number of nucleons that compose ^6Li allows one to calculate with good accuracy the wave function of such a system. As it is known neither shell, nor ordinary cluster $\alpha + d$ wave functions of ^6Li can describe the entire set of the available experimental data. In recent years a multicluster dynamic model of light nuclei with Pauli-projection (MLNP) has been developed in [3]. It is based on the pair microscopically substantiated intercluster interaction potentials included the forbidden (by Pauli principle) bound states with further exclusion of their contribution from the exact eigenfunctions of a multicluster Hamiltonian. To this end a specific technique of orthogonal projection was developed [4] and for obtaining the eigenfunctions of multicluster Hamiltonian a convenient method [3] of multidimensional Gauss expansions of the desired multi-dimensional nuclear wave functions was worked out. A detailed study within the MLNP was done for nuclei A=6 (^6He-^6Li-^6Be) [3-6]. Here we make use of the wave functions of ^6Li found [3,5] within the three-body model: α + N + N. To describe the NN- and Nα-interactions both realistic and simplified interaction potentials were used: model 1 - the potential V_{NN} was chosen as a square well, and for the $N\alpha$-interaction the known Sak-Bidenharn-Breit (SBB) potential was exploited, the model 2: V_{NN} is the Reid soft core potential and for $V_{N\alpha}$, use was made of the potential constructed by V.Pomerantsev taking into account the even-even splitting which is equivalent to the account of the exchange effects in each $N\alpha$ subsystem. The corresponding wave functions of ^6Li will further be denoted through 1,2 . These functions reproduce well the mean-square radius, the magnetic moment of nucleus, the longitudinal and transverse electromagnetic formfactors and reproduce reasonably the energy spectrum [3]. It is, thus, of interest to calculate the crossections of nuclear reactions using the wave functions 1,2 and to compare the results obtained with the available experimental data.

2. ELASTIC p^6Li-SCATTERING

Within the diffraction theory [2] the amplitude of the elastic proton scattering by the nucleus ^{6}Li in the c.m.s. is determined by

$$F(q)=\frac{i\bar{p}_1}{2\pi}\int d^2\rho\, e^{i\vec{q}\vec{\rho}}\int\prod_{j=1}^{6}d^3r_j\,|\Psi_0|^2\,\delta(\vec{R}_6)\,\Omega(\vec{\rho},\vec{r}_1,\ldots,\vec{r}_6), \qquad (1)$$

where Ψ_0 is the nucleus wave function, $\vec{q}$ is the transferred momentum, $\bar{p}_1$ is the incident proton momentum in the c.m.s.; $\vec{R}_6$ are the coordinates of c.m. of a nucleus, Ω is the total profile function expressed through nucleon-nucleon profile functions ω_{pN}:

$$\Omega=1-\prod_{j=1}^{6}\left(1-\omega_{pj}(\vec{\rho}-\vec{\rho}_j)\right), \qquad (2)$$

where $\vec{\rho}_j$ is the radius-vector of j-th nucleon in the plane of an impact parameter. The profile function ω_{pj} is connected with pN amplitude of the elastic scattering $f_j(\vec{q})$ by a two-dimensional Fourier transformation

$$\omega_{pj}(\vec{\rho})=\frac{1}{2\pi i\bar{p}_1}\int d^2q\, e^{-i\vec{q}\vec{\rho}} f_j(\vec{q}). \qquad (3)$$

The experimental data on the elastic pN-scattering at intermediate energies in the small transferred momenta region are well reproduced by the choice of pN-amplitude as

$$f_j(\vec{q})=\frac{i\bar{p}_1\sigma_j}{4\pi}\left\{\exp\left(-\frac{a_j q^2}{2}\right)-i\gamma_j\exp\left(-\frac{a_j' q^2}{2}\right)\right\}. \qquad (4)$$

As the wave function of the ground state of ^{6}Li we choose, in accordance with [3], the dominating $^3S_1$-component (with its corresponding renormalization to 1) in the form of [3]

$$\Psi_0=\sum_{n,m}C_{nm}\exp\left(-\alpha_n r^2-\beta_m R^2\right)\Phi_\alpha, \qquad (5)$$

where the values of C_{nm}, α_n and β_m for each of the models concerned are determined in [5,6], the coordinates $\vec{r}=\vec{r}_5-\vec{r}_6$, $\vec{R}=\vec{R}_\alpha-\frac{\vec{r}_5+\vec{r}_6}{2}$, $R_\alpha=\sum_{i=1}^{4}\vec{r}_i/4$ and Φ_α -wave function of an α-particle chosen, are chosen, for simplicity, in the Gauss form

$$\Phi_\alpha = \left(\frac{t}{\pi}\right)^{9/4} \cdot \frac{1}{2\sqrt{2}} \cdot \exp\left\{-\frac{t}{2}\sum_{i=1}^{4}(\vec{r}_i - \vec{R}_\alpha)^2\right\}. \qquad (6)$$

The parameter t is determined by the mean-square charged radius of an α -particle which is equal to 1.63 Fm.

Using the functions (5) simplifies much the calculation of the amplitude of elastic $p\,^6Li$ scattering $F(\vec{q})$ and results in simple, although, cumbersome purely analytic expressions[x)]. The differential cross-section of the elastic proton scattering by ^6Li equals

$$\frac{d\sigma}{d\Omega} = \left|F(\vec{q})\right|^2. \qquad (7)$$

Figures 1 and 2 show the calculated differential cross-sections of the elastic $p\,^6Li$ -scattering $d\sigma/d\Omega$ at incident proton energies 0.2 and 0.6 GeV, respectively. The experimental data at T_p =0.2 GeV are taken from [7] and at T_p =0.6 GeV - from Ref. [8]. The NN amplitude parameters at T_p =0.2 GeV were set to be equal to: σ_p =2.5 Fm^2, σ_n =4.74 Fm^2, a_p =0.530 Fm^2, a_n =0.697 Fm^2, a'_p =0.942 Fm^2, a'_n =0.973 Fm^2, γ_p =1.22, γ_n =0.84 [9], at T_p =0.6 GeV - σ_p =3.61 Fm^2, σ_n =3.60 Fm^2, $a_p = a'_p$ =0.1 Fm^2, $a_n = a'_n$ =0.11 Fm^2, γ_p =0.378, γ_n =0.205 [10]. A solid line corresponds to the calculation with the ^6Li wave function of model 1. The calculation with the wave function of model 2 in the given scale is not distiquished from the results of calculation with model 1.

The calculations performed in Figs.1 and 2, as it should be expected, reflect the fact that with increasing energy of incident protons the diffraction scattering mechanism is manifest essentially. The absence of the diffraction minimum filling in the differential cross-section at T_p =0.6 GeV can be due to several reasons. For instance, it is known that in the case of the elastic pd-scattering the diffraction minimum filling is often associated with the D-wave contribution. Thus, probably, the account of the neglected components of ^6Li wave function whose weight does not exceed 10% can give at least partial filling. The filling of the diffraction minimum depends much on the value of the parameter γ_j and the account of spin terms in the nucleon-nucleon elastic scattering amplitude (4).

---
x) Details of calculation are given to all who needs them.

We've also calculated the elastic p^6Li -scattering at the incident proton energy T_p =1.0 GeV. The NN amplitude parameters (4) were set to be equal to: σ_p =4.75 Fm^2, σ_n =4.04 Fm^2, $a_p = a'_p = a'_n$=0.17 Fm^2, γ_p=-0.1, γ_n =-0.4 [11]. A comparison of the calculated differential cross-sections for the different wave functions of ^{6}Li with the available experimental data [8] leads to the results similar to those shown in Fig.2, i.e. there exists almost complete coincidence of the calculated differential cross-sections with the wave functions of models 1 and 2. A single distinction of the calculated differential cross-sections at energies T_p =1.0 GeV from the results given in Fig.2 implies that at T_p= =1.0 GeV the diffraction minimum is smoothed out significantly. This is associated, probably, with the fact that at this energy the scattering is accompanied by larger, than at lower energies, momentum transmissions and, correspondingly, the increase in contribution of small, highest in orbital moments, components to the total wave functions of target nucleus, which are correspondent to, however, more rigid momentum distributions. These momentum distributions and, also, the corresponding pair correlations of particles should be well enough manifeste in the reactions of quasi-elastic knock out of deuterons $(p,p'd)$, especially at large relative momenta of intranuclear "deuteron" and spectator. We emphasize that in a three-particle model $\alpha+N+N$ no assumptions on the produced intranuclear deuteron are set. Thus, the deuteron knocked out from ^{6}Li is formed in our approach during multiple scattering by means of the correlation in the finite state of two knocked out nucleons with a small relative momentum. Therefore, it is interesting to consider the reaction ^{6}Li(p,p'd)α using the realistic wave functions of ^{6}Li.

3. INELASTIC (QUASI-ELASTIC) PROTON SCATTERING BY ^{6}Li

Because of small geometric dimension of α -cluster ($\langle r_\alpha^2\rangle^{1/2}$ = = 1.4 Fm) with respect to the mean distribution radius of two external nucleons ($\langle r_{^6Li}^2\rangle^{1/2} \simeq$ 2.55 Fm) and dense enough nucleon "packing" inside α -cluster the contribution of knock out from α -cluster can here be neglected, although for analysis of rigid NN-correlations in the knock out process $(p,p'd)$ certain account of this contribution is necessary.

We consider in L -system the inelastic proton scattering (of particle 1) by the nucleus ^{6}Li (of particle 2) with formation of three particles in the finite state

$$1 + 2 \rightarrow 1' + 2' + 3'; \qquad (8)$$

where $1'$ is the proton scattered inelastically, 2' and 3'-deuteron and α - a particle, respectively. We assume the cross-section magnitude of this process, the energy of 1 and 2' particles, and also the 1' and 2' particle scattering angles to be known from experimental data. We write the differential cross-section of the process (8) through the known magnitudes.

We introduce the following notations: p_i (i =1,2) are the incoming particles momenta, p'_j (j =1,2,3) are the momenta of outgoing particles, ε_i (ε_j) are the particle energies in the initial (finite) state. Using the relativistic kinematics and the energy-momentum conservation law, the differential cross-section of the process (8) can be written as [12]:

$$\frac{d\sigma}{d\varepsilon'_2\, d\Omega'_1\, d\Omega'_2} = \frac{1}{(2\pi)^5} \cdot \frac{\varepsilon_1 \varepsilon'_2 \epsilon k p'_2 (\varepsilon_1 + m_2 - \epsilon - \varepsilon'_2)}{p_1 [k(E+\epsilon) - \epsilon\Delta]} |T_{fi}|^2, \qquad (9)$$

where T_{fi} is the transition matrix magnitude k, E and Δ are determined by

$$k = \sqrt{\epsilon^2 - m_1'^2}; \quad \Delta = p_1 \cos(\widehat{\vec{p}_1 \vec{p}'_1}) - p'_2 \cos(\widehat{\vec{p}'_1 \vec{p}'_2});$$
$$E = \left[\epsilon^2 - 2k\Delta + (\vec{p}_1 - \vec{p}'_2)^2 + m_3'^2 - m_1'^2\right]^{1/2}; \qquad (10)$$

and the magnitude ϵ is the root of the equation

$$\epsilon + \varepsilon'_2 + E = \varepsilon_1 + \varepsilon_2. \qquad (11)$$

If the 3-momentum of an incident proton p_1 is much larger than the averaged nucleon momentum in the nucleus, then, according to the approximations used in [13], the differential cross-section of the process concerned can be expressed through the amplitude of the reaction in the c.m. system - proton-nucleus ^{6}Li M_{fi}:

$$\frac{d\sigma}{d\varepsilon'_2\, d\Omega'_1\, d\Omega'_2} = \frac{m_1(m_1+\varepsilon_1)\bar{\varepsilon}_2 \bar{\varepsilon}'_2 \bar{E} k^2 p'_2 |M_{fi}|^2}{4\pi^3(\bar{\varepsilon}_A - \bar{\varepsilon}_1 - \bar{\epsilon})\bar{E}_A m_2 p_1 |k(E+\epsilon) - \epsilon\Delta|}, \qquad (12)$$

where $\bar{\varepsilon}_1$ and $\bar{\varepsilon}_2$ are the energies of particles 1 and 2 in their c.m. system

$$\bar{\varepsilon} = \frac{\varepsilon - Vk\cos(\hat{\vec{p}_1 \vec{p}_1'})}{\sqrt{1-V^2}}; \qquad \bar{\varepsilon}_2' = \frac{\varepsilon_2' - Vp_2'\cos(\hat{\vec{p}_1 \vec{p}_1'})}{\sqrt{1-V^2}},$$

$$\bar{E}' = \frac{E - V\sqrt{E^2 - m_3'^2}\cos(\hat{\vec{p}_1 \vec{p}_3'})}{\sqrt{1-V^2}}; \quad V = \frac{p_1}{\varepsilon_1 + m_2}; \quad \varepsilon_A = \sqrt{\frac{\bar{p}_1^2}{A^2} + m_1^2}. \tag{13}$$

The angle between the vectors $\vec{p}_1$ and $\vec{p}_3'$ is found from the momentum concervation law

$$\cos(\hat{\vec{p}_1 \vec{p}_3'}) = \frac{p_1 - k\cos(\hat{\vec{p}_1 \vec{p}_1'}) - p_2'\cos(\hat{\vec{p}_1' \vec{p}_2'})}{\sqrt{E^2 - m_3'^2}}. \tag{14}$$

The amplitude of the process (8) within the diffraction approximation can be written as

$$M_{fi}(\vec{q},\vec{\varkappa}) = \frac{i\vec{p}_1}{2\pi}\int d^2\rho \prod_{j=1}^{6} d^3 r_j\, e^{i\vec{q}\vec{\rho}}\, \psi^*_{\vec{\varkappa}}\, \Omega_{in} \Psi_0 \delta(\vec{R}_6), \tag{15}$$

where $\vec{q}$ is the transferred momentum, $\vec{\varkappa}$ is the momentum of the relative motion of particles 2' and 3' in the c.m.s. of particles 1 and 2. The total profile function for the inelastic process (8) Ω_{in} has the form [13]:

$$\Omega_{in} = \Omega_d e^{iq_\parallel Z_d} + \Omega_\alpha e^{iq_\parallel Z_\alpha} - \frac{1}{2}\Omega_d \Omega_\alpha \left[e^{iq_\parallel Z_\alpha} + e^{iq_\parallel Z_d}\right], \tag{16}$$

where the operator

$$\Omega_d = 1 - \prod_{j=5}^{6}(1-\omega_j), \tag{17}$$

corresponds to the incident hadron interaction with deuterons (or, more exactly, two-nucleon) target-nucleus cluster, and the operator

$$\Omega_\alpha = 1 - \prod_{j=1}^{4}(1-\omega_j) \tag{18}$$

corresponds to the interaction with α (or four-nucleon) - the target-nucleus cluster, $q_\parallel$ is longitudinal component of the transferred momentum.

The wave function of the finite state $\psi_{\vec{\varkappa}}$ involves the wave function of an α-particle φ_α - the wave function of a

deuteron Φ_d and the function of their relative motion $\varphi_{\vec{\varkappa}}$
In performing specific calculations the wave function of a free deuteron Φ_d in the finite state was also chosen in the Gauss form [14]:

$$\Phi_d(\vec{r}) = \sum_{j=1}^{3} A_j \exp(-c_j r^2), \qquad (19)$$

As a first approximation we choose the wave function of the relative motion of an α-particle and deuteron $\varphi_{\vec{\varkappa}}$ as the plane wave. We, thus, take into account distorsions in the initial channel and do not take them into account in the finite state. Since for large relative momenta in α-d degrees of freedom the relative kinetic energy in this channel in the finite state should also be large, the role of distortions in the finite state is reduced mainly to introducing the strong absorption, and this will decrease much the incident deuteron flux (the deuterons are usually registered in the regime of coincidence with a scattered hadron). As a result theoretical absolute cross-sections of quasi-elastic knock out $(p,p'd)$ are excessive by several times. Nevertheless, all qualitative characteristic peculiarities of the angular and momentum distributions are then conserved, and this makes the approximation quite reasonable.

At the present time there are the experimental data on the $^6Li(p,p'd)\alpha$ reaction at T_p =0.2 GeV [15] in a noncoplanar geometry where the role of deformations in the finite state is indicated above. Thus, not claiming for a quantitative description of the experimental data within the framework of the approach concerned, one can expect a qualitative agreement of the calculated cross-section of the reaction with its experimental value. We note that the calculation of cross-section of $^6Li(p,p'd)\alpha$ reaction used in [15] and based on a traditional method of the deformed waves (more exactly, the impulse distortive wave approximation with an α -particle as a spectator) does not give a quantitative description of the experimental data. Thus, using the general formulas (13)-(19) and also (5),(6) after cumbersome enough calculations we've obtained the cross-section of the $^6Li(p,p'd)\alpha$.

In Warner's et al. paper [15] to increase the relative momentum in α-d channel at the given (relatively moderate) initial energy of the incident protons T_p =200 MeV the measurements were performed under the condition of noncoplanar geometry when a knocked out deuteron and α -particle-fragment outgo not in the plane of the reaction given by the momenta of incident and scattered proton, and the deuteron momentum escapes from this plane at certain noncoplanarity angle φ' . The latter in Warners' et al. experiments changes within the interval $0 \leq \varphi' \leq 36°$. A zero angle corresponds then to the usual kinematics of quasi-elastic deuteron knock out when the finite momenta of scattered proton and knocked out deuteron are oppositely directed (i.e. to the right and to the left) from the proton momentum. However, in calculations it is convenient to count off all asimuthal angles φ' from a single axis (say OX if OZ is the direction of incident protons) as in the usual polar coordinate system. With this choice all angles φ from Ref. [5] are recounted in a simple way into a general system of coordinates by changing the angles φ (Warner et al.) $\to 270° + \varphi'$.

Figs.3-6 give the results of calculations of the reaction cross-section at different noncoplanarity angles φ . A solid line - model 1 of ^{6}Li nucleus, and a dashed curve - model 2 .

All calculated cross-sections in Figs.3-6 are normalized by the coefficient 0.2. We analized the contributions of all multiplicities of the re-scattering to the cross-section value of deuteron knock out. It turned out that the account of all multiplicities leads to reducing twice the cross-section. We note that in Ref. [15] the ^{6}Li(p,pd)^{4}He reaction cross-sections were calculated on the basis of the known DWIA approximation which is one of the versions of the spectator model. Comparing theoretical calculations with experimental data the authors of Ref. [15] had to introduce different normalization factors N_φ for the different nocoplanarity angles. Thus, the relation $R = N_{\varphi=270°}/N_{\varphi=282°}$ in Ref. [15] equals $\simeq 3$. In our paper R=1. Besides that, the absence of the "prepared" deuteron in a three-particle (α + 2N) wave function of ^{6}Li and also a correct account of the c.m. correlations in the reaction amplitude prove to be a principle distinction of our approach from the spectator model. In other words, within a consistent approach similar to ours even in the absence of incident proton rescattering by α -particle the reaction cross-section is not described by the spectator model that neglects such multiparticle correlations.

4. CONCLUSION

As is seen from the results of calculations given in Figs.1 and 2, the experimental data on the proton elastic scattering by ^{6}Li in the region T_p =0.2 and 0.6 GeV do not present a sufficient scope of information allowing one to judge about the details of the structure of ^{6}Li.

In contrast to this the study of inelastic proton reactions with ^{6}Li is an important source of information even at the proton energy T_p = 0.2 GeV as it follows from the results of calculations given in Figs.3-6.The calculations performed in the plane wave approximation indicate the available existing dependence of the ^{6}Li(p,pd)^{4}He reaction cross-section not only on the utilized model wave function of ^{6}Li but also on the value of coplanarity angle. Thus, studying the inelastic (quasi-elastic) proton scattering reactions by ^{6}Li is an important source of information on its structure. Especially informative in this respect should be studies of quasi-elastic reactions with polarized nuclei ^{6}Li which makes it possible to divide the contribution of S and D -components of the ground 1^+ state of ^{6}Li and estimate the contribution of interferential terms.

Comparing the reaction cross-sections, calculated in this paper, with experimental data points out to a significant contribution of $d\alpha$ distortion to the finite state. The calculations taking into account the contribution of this distortion to the finite state will be represented in the next paper. And, finally, in analising the contributions of different multiplicities of the fast hadron rescattering to the cross-section of quasi-elastic deuteron knock out we've found out a significant contribution of high multiplicities rescattering to the high-energy part of the knocked out deuteron spectrum. Undoubtedly, quite analogous processes of the spectator excitation or knock out of the fragments from the latter will give contribution to the low-energy part of the knocked out particle spectrum in any quasi-elastic experiment, say ^{16}O(p,p'α)^{12}C .

REFERENCES

1. L.Rikus, von Geramb H.V. Microscopic analyses of proton scattering from lead//Nucl. Phys.-1984.-A426,N3.-P.496-514.
2. Ситенко А.Г. К теории ядерных реакций с участием сложных частиц// УФЖ.-1959.-4,№2.-С.152-163.
   Glauber R.J. Lectures in Theoretical Physics, ed. W.Brittin and L.Dunham.-Interscience Publishers, New York, 1959.-P.315.
3. Voronchev V.T., Krasnopolsky V.M., Kukulin V.I. A variational study of the ground and excited states of light nuclei in a three-body model on the complete basis. I. General formalism// J.Phys.G: Nucl. Phys.-1982.-8,N5.-P.649-666.
   Voronchev V.T., Krasnopolsky V.M., Kukulin V.I. The structure of ^{6}He-^{6}Li-^{6}Be nuclei in the $\alpha+2N$ model// ibid.-P.667-678.
   Kukulin V.I., Voronchev V.T., Krasnopolsky V.M., Sazonov P.B. Detailed study of the cluster structure of light nuclei in a three-body model(I)//Nucl. Phys.-1984.-A417,N1.-P.128-156.
4. Kukulin V.I., Pomerantsev V.M. The orthogonal projection method in scattering theory//Ann. Phys.-1978.-111, N2.-P.333-366.
5. Krasnopolsky V.M., Kukulin V.I., Sazonov P.B., Voronchev V.T. The ground and excited state wave function of A=6 nuclei in terms of three-body model//Phys.Lett.-1983.-121B,N2,3.-P.96-101.
   Kukulin V.I., Voronchev V.T., Krasnopolsky V.M., Sazonov P.B. Detailed study of the cluster structure of light nuclei in a three-body model. (II)//Nucl.Phys.-1986.-A453,N3.-P.365-388.
6. Ворончев В.Т., Каипов Т.Д., Краснопольский В.М., Кукулин В.И., Эрамжян Р.А. Структура и электромагнитные свойства ядер с A=6, рассчитанные на основе $\alpha+2N$ модели//Препринт ИЯИ АН СССР, 1986,П-0472, 48 с.
   Воронсв В.Т., Каинов Т.Д., Краснопольский В.М., Кукулин В.И., Эрамжян Р.А. Электромагнитные характеристики ядра ^{6}Li в динамической $\alpha+2N$ модели. Результаты расчетов и сравнение с экспериментом//Препринт ИЯИ АН СССР, П-0488, 1986, 23 с.
7. Hutcheon R.M., Sundberg O., Tibell G. 185 MeV proton scattering from ^{6}Li and the impulse approximation//Nucl.Phys.-1970.-A154,N2.-P.261-272.
8. Bruge G.J. Scattering and reaction cross-sections measured at SPESI//J. de Phys.-1979.-40.-P.635-655.

9. Ситенко А.Г., Доценко И.С. К теории дифракционного рассеяния //ЯФ.-1973.-17,вып.1.-С.63-74.
10. Igo G.J. Some recent intermediate and high-energy proton-nucleus research//Rev. Mod. Phys.-1978.-50,N3.-P.523-560.
11. Алхазов Г.Д., Белостоцкий С.А., Волков С.С. и др. Упругое рассеяние протонов с энергией 1 ГэВ на ядрах ^{3}He//Препринт ЛИЯФ.
12. Гольдбергер М., Ватсон К. Теория столкновений.-М.:Мир,1967, 823 с. 1978.-№449.-12 с.
13. Фурса А.Д., Пересыпкин В.В. Дифракционное описание реакции двухчастичного расщепления ^{3}He в некомпланарной геометрии// ЯФ.-1978.-27,вып.1.-С.123-130.
14. Alberi G., Rosa L.P., Thome Z.D. Comment on double-scattering effect in deuteron break up reactions//Phys.Rev.Lett.-1975.-34,N8.-P.503-506.
15. Warner R.E. et al. Comparison of the noncoplanar ^{6}Li(p,pd)^{4}He reactions at 120 and 200 MeV//Nucl.Phys.-1985.-A443, N1.-P.64-76.

Received April 5, 1991

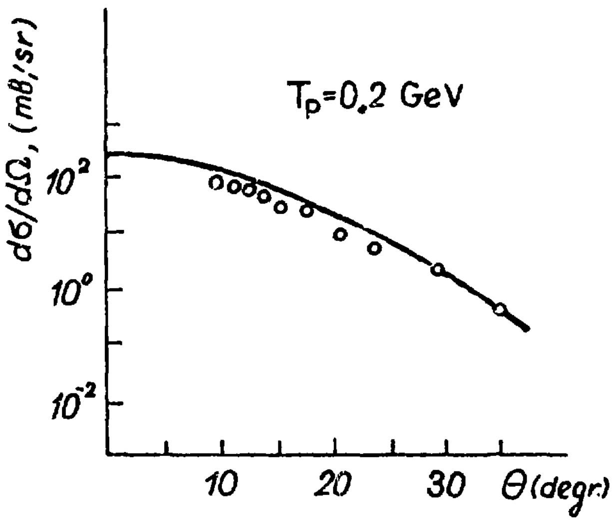
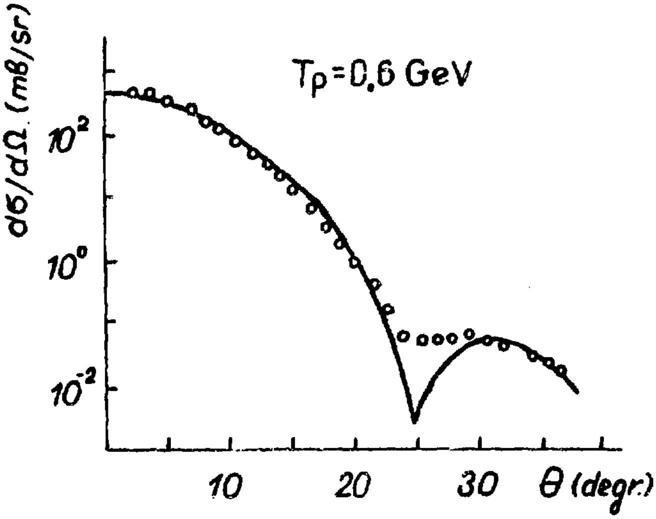
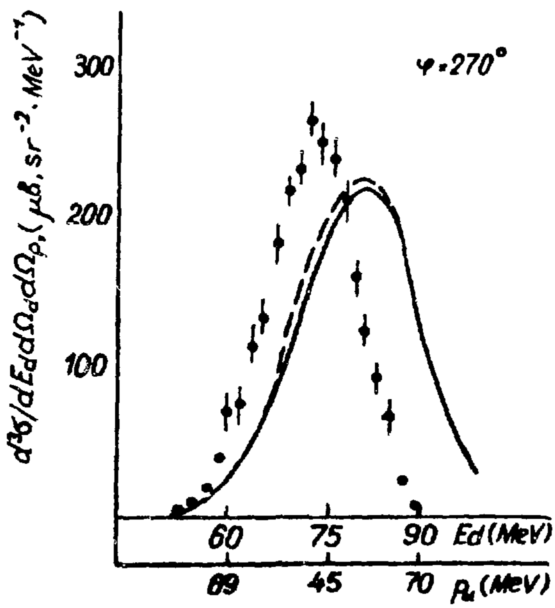


Fig.1



Tp=0,6 GeV
dσ/dΩ (mb/sr)
10^2
10^0
10^-2
10
20
30
θ (degr.)

Fig.2



φ=270°
d³σ/dE_d dΩ_d dΩ_p, (μb, sr^-2, MeV^-1)
300
200
100
60
75
90
Ed(MeV)
89
45
70
P_s(MeV)

Fig.3

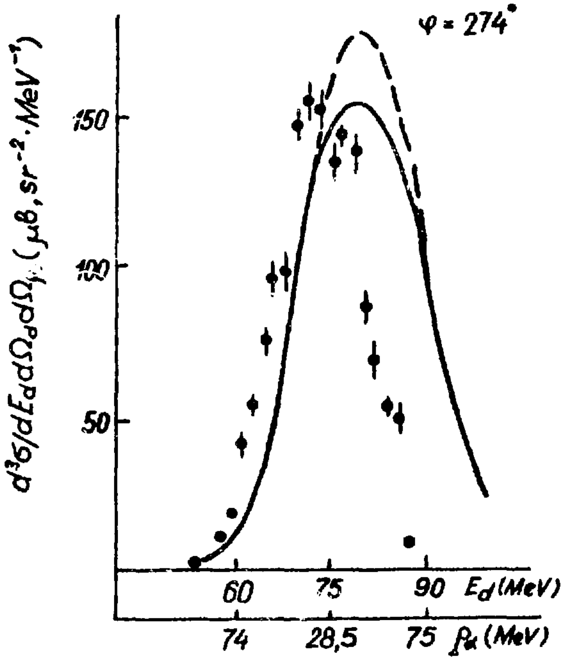

φ = 274°
d³σ/dE_d dΩ_d dΩ_p (μb, sr⁻²·MeV⁻¹)
150
100
50
60
75
90
E_d (MeV)
74
28,5
75
p_α (MeV)

Fig.4

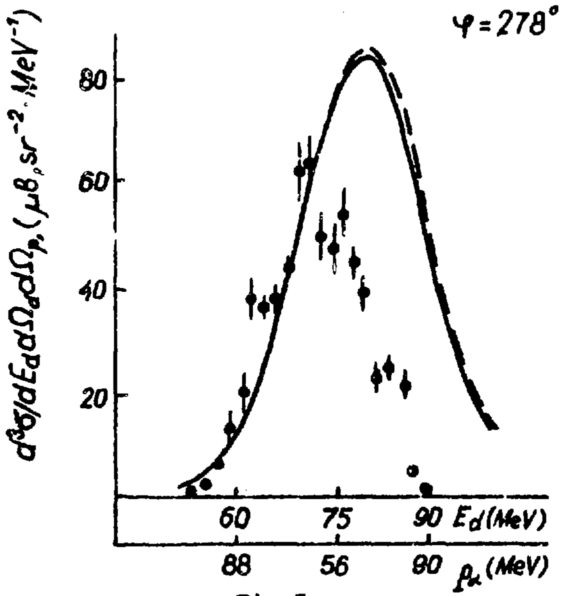

φ = 278°
d³σ/dE_d dΩ_d dΩ_p (μb, sr⁻²·MeV⁻¹)
80
60
40
20
60
75
90
E_d (MeV)
88
56
80
p_α (MeV)

Fig.5

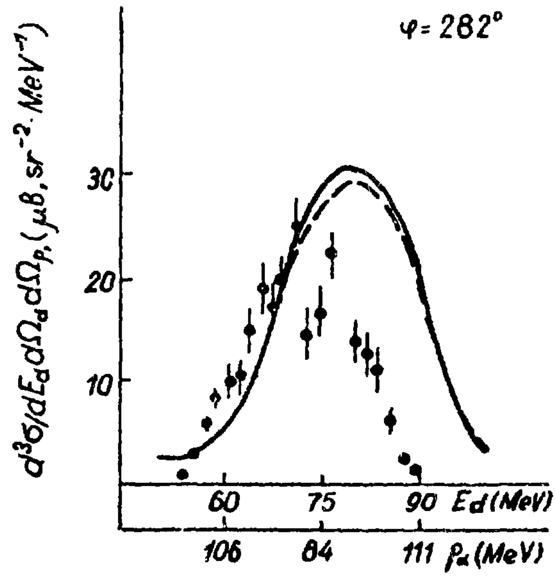


Fig.6

FIGURE CAPTIONS

Fig.1. Differential cross-section of p^6Li scattering at T_p =0.2 GeV. Solid line - calculation with ^6Li wave functions in models 1 and 2. Experimental data are taken from [4].

Fig.2. Differential cross-section of p^6Li-scattering at T_p = 0.6 GeV . Notations are the same as in Fig.1. Experimental data are taken from Ref.[5].

Fig.3. Cross-sections of $^6Li(p,p'd)^4He$ reaction at T_p = 0.2 GeV under the coplanar geometry. Solid line - model 1 of ^6Li wave function, dashed line - model 2. Experimental data are taken from Ref.[5].

Fig.4. Notations are the same as in Fig.3 at noncoplanarity angle φ = 274°.

Fig.5. Notations are the same as in Fig.3 at noncoplanarity angle φ = 278°.

Fig.6. Notations are the same as in Fig.3 at noncoplanarity angle $\varphi = 282°$.

Вадим Владимирович Пересыпкин
Елена Тулеубековна Ибраева
Владимир Иосифович Кукулин

Реакции упругого рассеяния и квазиупругого выбивания (p,p'd) на ядре ^{6}Li

Утверждено к печати ученым советом ИТФ АН УССР

Редактор А.А.Храброва Техн.редактор Е.А.Бунькова
Зак. 157 Формат 60х84/16. Уч.-изд.л. 0,93
Подписано к печати 9.04.1991 года. Тираж 200. Цена 5 коп.
Полиграфический участок Института теоретической физики АН УССР

5 kon.

Препринти Інституту теоретичної фізики АН УРСР
поширюються серед наукових установ та окремих вчених
шляхом взаємного обміну

252130, Київ–130, ІТФ АН УРСР
інформаційний відділ

The preprints of the Institute for Theoretical Rhysics
are distributed to scientific institutions and individual
scientists on the mutual exchange basis.

Information Department
Institute for Theoretical Rhysics
252130, Kiev-130, USSR
Fax 07044 2665998