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INCLUSIVE DEUTERON ELECTRODISINTEGRATION AT HIGH K^2 AND HIGH-MOMENTUM COMPONENT OF DEUTERON WAVE FUNCTION

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The reaction of inclusive deuteron electrodisintegration d(e,e')x has been investigated in the framework of the relativistic impulse approximation. The comparison of the model predictions with the measured at SLAC electron energy spectra of the d(e,e')x reaction at large k^2: $0.75\ \mathrm{GeV}^2 \leq |k^2| \leq 2.57\ \mathrm{GeV}^2$, has been carried out. The contribution of the real pion production to the spectra was approximated by a term describing the Δ-isobar excitation. The polarization observables in the $\vec{d}(\vec{e},e')np$ reaction have been investigated for the kinematical conditions of the SLAC experiment. The influence of the modification of the high-momentum component of the deuteron wave function on the polarization observables in the $\vec{d}(\vec{e},e')np$ reaction and on the spectrum in the d(e,e')x process has been studied. It turns out that the enhancement of the high-momentum component of the D-wave leads to essential decrease of discrepancy between the theory and experiment.

7 figs., 37 refs.

УДК 539.12

Рекало М.П., Гах Г.И., Рекало А.П. Инклюзивное электрорасщепление дейтрона при больших K^2 и высокоимпульсная компонента дейтронной волновой функции. Препринт ХФТИ 91-28. Харьков: ХФТИ, 1991. -17 с.

В релятивистском импульсном приближении исследована реакция инклюзивного электрорасщепления дейтрона, $d(e,e')X$. Проведено сравнение предсказаний модели с измеренными недавно в SLACe энергетическими спектрами электронов в реакции $d(e,e')X$ при больших K^2 ($0{,}75$ ГэВ$^2 \leq |K^2| \leq 2{,}57$ ГэВ^2). Вклад в спектры от процесса образования реальных пионов был аппроксимирован слагаемым, описывающим возбуждение Δ-изобары. Для кинематических условий эксперимента в SLACe исследованы поляризационные наблюдаемые в $\vec{d}(\vec{e},e')np$. Изучено влияние модификации высокоимпульсной компоненты дейтронной волновой функции на поляризационные наблюдаемые в реакции $\vec{d}(\vec{e},e')np$ и на спектр в процессе $d(e,e')X$. Оказывается, что усиление высокоимпульсной компоненты в D-волне приводит к существенному уменьшению различия между теорией и экспериментом.

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Introduction

Inelastic electron deuteron scattering is of great importance in understanding the nucleon-nucleon interaction. Experiments at large transfer momenta are especially important because they allow to investigate the deuteron structure at small distances where the nonnucleonic degrees of freedom (the meson exchange currents(MEC), the isobar configurations, six-quark clusters and so on) become essential. Furthermore in this region it is necessary to use relativistic models because here, in particular, the nonrelativistic expansion of the interaction operator in inverse power of the nucleon mass makes no sense.

Note that in the region of high transfered momenta the ambiguity arises in the theoretical description of corrections to the impulse approximation. For example, the existing experimental data on the $d(e,e')np$ reaction near the threshold have been better described by MEC models using F_1 as form factor (and this has been motivated by several theoretical arguments [1,2]). But it has been shown [3] that the use of both G_E and F_1 form factors can be justified in a nonrelativistic approach. Furthermore it has been shown [4] that the use of a parametrized Bonn potential with its low D-state probability can lead to the same large effect as the choice of either G_E or F_1 form factors.

In large K^2 region ($\geqslant 1$ GeV^2) the predictions of various models may rather largely differ. For example, the cross sections of the deuteron electrodisintegration near the threshold at large K^2 calculated within meson-nucleon [5-7] and hybrid quark-hadron [8-10] frameworks differ in order of magnitude.

As it is known, at high K^2 the region near the threshold of the deuteron electrodisintegration reaction corresponds to high momentum values in the deuteron wave function (DWF) argument.

This is the so-called high-momentum component (HMC) of DWF. This region recently attracted attention of both experimenters and theoreticians. The comparison of experimental data with predictions of various models indicates that the HMC of the nuclear system wave functions appear not large enough. For example, the investigation of deep inelastic electron-nucleus scattering requires modification of the momentum distribution function of the nucleons in a nucleus at momenta $p \geqslant 400$ MeV [11]. The modification has been achieved by taking into account the nucleon-nucleon correlations [12] . The investigation of the $\mu^{12}C \to \mu X$ reaction shows that at $x \geqslant 1$ (where x is the Bjorken variable) HMC of nuclear wave function is small [13]. The significance of the HMC investigation (both theoretical and experimental) has been considered in [14].

In this paper the inclusive deuteron electrodisintegration reaction , $d(e,e')x$, has been investigated in the relativistic impulse approximation (RIA) framework. The comparison of the predictions of the model with the measured energy spectra of the electrons in the $d(e,e')x$ reaction at large K^2 [15] has been carried out. In this experiment the spectrum region corresponding to the real pion production has been also investigated. In the considered model this contribution was approximated by the term corresponding to the Δ-isobar excitation, $d(e,e')\Delta N$. The good agreement between model predictions and experimental data have been obtained except for the region between the threshold and quasi-elastic peak (QEP) (this region corresponds to the HMC of DWF). In this region large sensitivity of the cross section to the choice of DWF model was observed. We investigated the question of HMC modification (as an example the D-wave of the Paris DWF was considered) in order to decrease the discrepancy between the theory and experiment. The polarization observables for the $\vec{d}(\vec{e},e')np$ reaction have been calculated for the kinematical conditions of the experiment [15] . It turns out that these observables are less sensitive to the choice of DWF model.

General analysis of $\vec{d}(\vec{e},e')np$ reaction.

The cross section of the inclusive $\vec{d}(\vec{e},e')np$ reaction has the following general form (for the case when the deuteron target has both vector and tensor polarizations and the electron beam is longitudinally polarized):

$$\frac{d^2\sigma}{dE'd\Omega_e}=N\{\sigma_T+\varepsilon\sigma_L+\sqrt{2\varepsilon(1+\varepsilon)}R_y\xi_y+\lambda_e\sqrt{2\varepsilon(1-\varepsilon)}R_x\xi_x+$$

$$+\lambda_e\sqrt{1-\varepsilon^2}R_z\xi_z+\lambda_e\sqrt{2\varepsilon(1-\varepsilon)}R_{yz}Q_{yz}+Q_{zz}(R_{zz}^T+\varepsilon R_{zz}^L)+ \qquad (1)$$

$$+\varepsilon(Q_{xx}-Q_{yy})R_{xx}+\sqrt{2\varepsilon(1+\varepsilon)}Q_{xz}R_{xz}\},$$

$$N=\frac{\alpha^2}{64\pi^3}\frac{E'}{E}p[-MWk^2(1-\varepsilon)]^{-1},\quad \varepsilon^{-1}=1-2\frac{\vec{K}_{1s}^2}{k^2}\tan^2\frac{\theta_e}{2},$$

where E(E') is the initial (final) electron energy in the laboratory system (l.s.), θ_e is the electron scattering angle in l.s., M is the deuteron mass, W is the invariant energy of the np-system, $\vec{p}$ is the nucleon momentum in the c.m.s. of the $\gamma^* d \to np$ reaction (γ^* is the virtual photon), ε is the linear polarization degree of γ^*, $\vec{K}_{1s}$ is the photon momentum in l.s., $\lambda_e = \pm 1$ depending on the mutual orientation of the initial electron spin and momentum, ξ_i and Q_{ij} (i,j = x,y,z) are the components of the vector polarization and tensor of the quadrupole polarization of the deuteron in its rest system (the coordinate system is defined by the following way - the z axis is directed along the virtual photon momentum $\vec{K}$ and the xz plane coincides with the electron scattering plane).

Thus in general the $\vec{d}(\vec{e}, e')x$ reaction (where x denotes the undetected particles) is defined by 10 independent observables [16] : the $\sigma_T(\sigma_L)$ quantity determines the cross section of the transverse (longitudinal) photon absorption when all particles of the reaction are unpolarized; R_y ($R_{zz}^{T,L}$, R_{xx}, R_{xz}) is the analyzing power of the considered reaction with respect to the vector (quadrupole) part of the target polarization; R_x, R_z, R_{yz} are the spin correlation coefficients of the reaction. The R_{yz} and R_y quantities are proportional to the imaginary parts of the $\gamma^* d \to np$ reaction amplitudes and therefore they are equal to zero in any version of the impulse approximation. The $\gamma^* d \to np$ reaction is known [17] to be described by 18 amplitudes and all observables may be expressed in the form of bilinear combinations of these amplitudes (the formulae for these quantities in terms of the scalar amplitudes f_i of the $\gamma^* + d \to n + p$ reaction are listed in Appendix).

In the T-invariant theory of the electromagnetic interactions two observables R_y and R_{yz} must turn into zero. For a target

with the vector polarization it was for the first time determined in [18]. The T-odd effects, if they are in general possible, must be determined by the interference of the longitudinal and transverse electromagnetic current components of the $\gamma^* d \to np$ reaction. This is a general result concerning both the vector and tensor target polarization.

RIA model for $d(e,e')\Delta N$ reaction.

So far as we shall analyze the experimental data on the $d(e,e')x$ reaction obtained at large K^2 values, then it is neccessary to take into account the contribution corresponding to the pion production. We shall take into account the main part of this contribution which corresponds to the Δ-isobar excitation, $d(e,e')\Delta N$. Let us analyse this reaction in the RIA framework using the formalism earlier proposed by us for the virtual nucleon density matrix [21]. Let us consider for definiteness the $e^- d \to e^- \Delta^+ n$ reaction. Then the matrix element of this reaction may be written (in a one-photon exchange approximation) as: $\mathcal{M} = (e^2/k^2) j_\mu J_\mu$, $j_\mu = \bar{u}(k_2)\gamma_\mu u(k_1)$. The electromagnetic current J_μ of the $\gamma^* d \to \Delta^+ n$ process is defined in the RIA by the expression

$$J_\mu = \bar{u}_\alpha(p_2) j_{\mu\alpha} (\hat{q}+m)\left[F\hat{U} + \frac{G}{m} p\cdot U + \frac{m-\hat{q}}{2m}\left(f\hat{U} + \frac{g}{m} p\cdot U\right)\right] u_n^c(p)(q^2-m^2)^{-1}, \quad (2)$$

where p, q and p_2 are the 4-momenta of the neutron, virtual proton and Δ-isobar, respectively, m is the nucleon mass, u_α is the four-component spinor with the vector index of the Δ-isobar ($\gamma_\alpha u_\alpha = 0$, $p_{2\alpha} u_\alpha = 0$), $j_{\mu\alpha}$ is the vertex structure of the $\Delta^+ \to p\gamma^*$ transition, U_μ is the deuteron polarization 4-vector ($U\cdot p_d = 0$, $U_\mu \cdot U_\mu = -1$) and it is neccessary to regard U_μ as the axial vector due to the positive deuteron spatial parity; F, G, f, g are the invariant form factors of the dnp-vertex with one virtual nucleon [19].

The $j_{\mu\alpha}$ quantity is defined in general by three independent electromagnetic form factors (p and Δ are on the mass shell). We shall use the following form for the $j_{\mu\alpha}$ quantity

$$j_{\mu\alpha} = \frac{1}{2M_\Delta} F_M(k^2)\left[\left(\gamma_\mu - \frac{p_{2\mu}}{M_\Delta}\right) k_\alpha - g_{\mu\alpha}\left(\hat{k} - \frac{k\cdot p_2}{M_\Delta}\right)\right]\gamma_5, \quad (3)$$

where M_Δ is the Δ-isobar mass. The real function $F_M(k^2)$ is the electromagnetic form factor of the $\Delta \to p\gamma^*$ transition corresponding to the emission of M1 γ-quantum. The available experimental data on the $\gamma^* N \to \pi N$ and $\gamma N \to \pi N$ reactions in the region of the Δ-isobar excitation are an evidence of the fact that two other electromag-

netic form factors of the $\Delta \to N\gamma^*$ transition are essentially less in absolute values than the electromagnetic form factor of the M1-transition (up to $|k^2| \leq 3$ GeV^2) [20]. Therefore we shall neglect the contributions of electric quadrupole electromagnetic form factors corresponding to the emission of the longitudinal and transverse E2 γ-quanta in the $\Delta \to N\gamma^*$ transition.

The tensor $H_{\mu\nu} = \overline{J_\mu J_\nu^*}$ (the bar denotes the summation over r and c polarizations and averaging over deuteron polarizations) for the $e^- d \to e^- \Delta^+ n$ reaction we shall calculate in RIA using the formalism of the density matrix of a virtual nucleon. The $H_{\mu\nu}$ tensor has the following form in RIA (for the scattering of nonpolarized electrons by unpolarized deuterons)

$$H_{\mu\nu} = W_1(k^2,t)(-g_{\mu\nu} + k_\mu k_\nu/k^2) + \frac{1}{m^2}\bar{p}_{2\mu}\bar{p}_{2\nu} W_2(k^2,t), \quad t = q^2, \tag{4}$$

where $\bar{p}_{2\mu} = p_{2\mu} - k_\mu k \cdot p_2/k^2$. This is not the general expression for $H_{\mu\nu}$ defining differential cross section of the $\gamma^* + A \to A_1 + A_2$ with unpolarized hadrons A, A_1 and A_2. In a general case the $H_{\mu\nu}$ tensor is described by five structure functions which depend on three invariant variables: k^2, t and W. Only two structure functions W_1 and W_2 depending only on k^2 and t arise as a consequence of RIA and transverse $j_{\mu\alpha}$.

Since we take into account the emission only of M1-quanta in the $\Delta \to N\gamma^*$ transition then due to the fact that the corresponding electromagnetic current is transversal the relation follows between the structure functions

$$W_2(k^2,t) = (m^2/M_\Delta^2)\left[1 - (k^2 + M_\Delta^2 - t)^2/4M_\Delta^2 k^2\right]^{-1} W_1(k^2,t) \tag{5}$$

The inclusive cross section of the $e^- d \to e^- \Delta^+ n$ reaction is given by the following formulae

$$d^2\sigma/dE'd\Omega_e = \sigma_T^{(0)} + \varepsilon\sigma_L^{(0)},$$

$$\sigma_T^{(0)} = 2\pi\int d\cos\theta\, N W_1(k^2,t)\left[2 - k^2\vec{p}^{\,2}\sin^2\theta/M_\Delta^2\vec{k}^{*2}\right], \tag{6}$$

$$\sigma_L^{(0)} = -4\pi\int d\cos\theta\, N W_1(k^2,t)\left[1 - (k_0|\vec{p}|\cos\theta - E_\Delta|\vec{k}|)^2/M_\Delta^2\vec{k}^{*2}\right],$$

where E_Δ ($\vec{p}$) is the Δ - isobar energy (momentum) in c.m.s. of the $\gamma^* + d \to n + p$ reaction, $\vec{k}^*$ is the photon momentum in the Δ-isobar rest frame, θ is the angle between $\vec{k}$ and $\vec{p}$, k_0 is the photon energy in c.m.s. of Δ + N system.

The additional integration permits to take into account the Δ-isobar instability

$$d^2\sigma/dE'd\Omega_e = \sigma_T + \varepsilon\sigma_L, \quad \sigma_{T,L} = c\int_{w_1^2}^{w_2^2} dw^2 f(w^2, M_\Delta^2, \Gamma^2)\,\sigma_{T,L}^{(0)}(w^2), \quad (7)$$

where $w_1=(m+m_\pi)^2$, $w_2=(W-m)^2$, m_π is the pion mass, $f(w^2, M_\Delta^2, \Gamma^2) = c\,[(w^2-M_\Delta^2)^2 + M_\Delta^2\Gamma^2]^{-1}$, Γ is the Δ-isobar total width, and w is its current mass.

When integrating in (7) it is necessary to replace in (6) the fixed mass M_Δ by the current mass w. It is natural that $\int dw^2 f(w^2, M_\Delta^2, \Gamma^2) = 1$.

When conducting the numerical calculations it is neccessary to know $F_M(K^2)$. The dipole parametrization $F_M(K^2) = F_M(0)(1-K^2/M_D^2)^{-2}$ is usually used for this form factor. The $F_M(0)$ quantity detines the resonance amplitude $M_{1+}^{(3/2)}$ for the $\gamma N \to \pi N$ reaction corresponding to the production of the πN-system with isotopic spin $^3/2$ and total angular momentum $^3/2$

$$F_M^2(0) = 36 M_\Delta^2 \Gamma (|\vec{q}^*|/\alpha \vec{K}^{*2})(1+m/M_\Delta)^{-2} |M_{1+}^{(3/2)}|^2,$$

where $\vec{K}^*(\vec{q}^*)$ is the nucleon momentum in the $\Delta \to N\gamma(\Delta \to N\pi)$ decay in the Δ-isobar rest system. Using the results of the phenomenological analysis of the $\gamma N \to \pi N$ reaction [22] we obtain $F_M(0)=5.25$. In the literature there are several values cited for the parameter M_D:

0.71 GeV [23], 0.765 GeV [24], 0.8 GeV [25].

Electron energy spectra in d(e,e')x.

In [15] the final electron energy spectra were measured in the reaction of inclusive electron-deuteron scattering at $\theta_e = 180°$ and large K^2. The parameter $\varepsilon=0$ in the case of backward scattering and the expression for the $\vec{d}(\vec{e},e')np$ cross section is essentially simplified and takes the following form

$$\frac{d^2\sigma}{dE'd\Omega_e} = \frac{d^2\sigma_0}{dE'd\Omega_e}\cdot\left\{1 + \frac{3}{2}\lambda_e \xi_z A_z + \frac{1}{2} P_{zz} A_{zz}\right\}, \quad (8)$$

where Pzz is the degree of target tensor polarization which is connected in a standard way with the population of the magnetic sublevel with deuteron spin projection $m_z=0$; Pzz=1-3no, Azz= $(\sigma_+ + \sigma_- - 2\sigma_0)/(\sigma_0 + \sigma_- + \sigma_+)$, where $\sigma_m(m=\pm,0)$ is the cross section of the $\gamma^* d \to np$ reaction for the case when the target deuteron has the helicity m. Thus the Az asymmetry changes in the limits (-1, 1) and Azz asymmetry does in (-2,1).

The cross section and polarization observables in (2) we shall calculate in the RIA framework [26] which, in addition to the contributions of nucleon mechanisms, takes into account the contribu-

tion of the deuteron pole and contact, or "catastrophic", diagrams. The form factors of the dnp-vertex are obtained using the approach [27] and modern realistic DWF's. The deuteron electromagnetic form factors required for the calculations are taken from ref.[28]. For the nucleon electromagnetic form factors we use the dipole parametrization and also the scaling law[29]. The contribution of the $d(e,e')\Delta N$ process to the electron energy spectrum of the $d(e,e')x$ reaction is calculated in the framework of the model described above.

As can be seen in figures 1,2 there is a good agreement between the model predictions and experimental data in the QEP region. Besides there is practically no sensitivity of the spectrum to the choice of the DWF model. The sizeable sensitivity of the cross section to the choice of DWF model is in the region of large E', and theoretical values for the cross section turn out to essentially underestimate experimental ones. In this E' region the main contribution to the cross section is given by the D-wave HMC of DWF. The calculations of Laget [15] in the nonrelativistic impulse approximation (the nonrelativistic expansion of the interaction operator to terms of order m^{-3} is used in the model) also show the sensitivity of the cross section to the short-range part of the potentials of the NN-interaction in the large E' region. Note that the inclusion in calculations of the final state interactions and MEC leads to considerable improvement in the description of the experimental data. However the sizeable discrepancy between the theory and experiment still remains. The authors of [15] come to the conclusion that the experimental data indicate the lack of HMC in the models of DWF or the influence of effects not included in the model (such as six-quark clusters and relativistic corrections).

We have also investigated the impact of the dibaryon resonance (DR) excitation mechanism on the electron energy spectra in the $d(e,e')x$ reaction. DR's which spin does not exceed two and which may decay to n+p have been considered: $J^P=0^+$, I=1 , Mo = 2100 MeV, Γ_0 = 195 MeV; $J^P=1^-$, I=0 , M_1=2200 MeV, Γ_1 =100 MeV, $J^P=2^+$, I=1 , M_2=2150 MeV, Γ_2 =106 MeV [32] where J,P,I,M_J and Γ_J are the spin, spatial parity, isotopic spin, mass and total width of corresponding DR. The parameters describing the amplitude of DR electroexcitation were estimated by a χ^2 method using the experimental data on the $d(e,e'p)n$ reaction [33]. The DR parameters were chosen so as the DR effects in the differential cross section of $d(e,e'p)n$ reaction

do not exceed the uncertainties in the predicted cross section values caused by different choice of DWF's. It is important to underline that the discussed experimental data for d(e,e'p)n reaction [33] essentially improve the estimate of the possible DR contribution to the amplitude of the $\gamma^* d \to np$ reaction in comparison with that managed to extract from the analysis of inclusive electron spectra in the d(e,e')x reaction [34]: the values of the parameters decrease by an order of magnitude. In large E' region (to the right of QEP) the sizeable contribution gives only DR 0^+. The calculations show that the inclusion of the DR 0^+ excitation mechanism leads to the cross section increase (the value of this effect rapidly decreases as $|K^2|$ value increases since the electromagnetic form factor of the DR electroexcitation falls with increasing K^2 as $(K^2)^{-5}$ and it reflects the six-quark nature of DR) but its contribution turns out to be small (less than the discrepancy in the cross section caused by the use of different DWF's). Thus neither relativistic corrections nor the DR electroexcitation mechanism and nonrelativistic calculations (with inclusion of the final state interaction and MEC effects) are able to completely explain the discrepancy between theoretical and experimental values for the cross section in the region between QEP and threshold.

In this connection we have decided to analyse to what extent one may modify the existing DWF's in order to describe the experimental data on the d(e,e')x reaction in large E' region. The D-wave underwent the modification, it was caused mainly by two reasons. First, the D-wave is worse known in comparison with the S-wave (there even exists an opinion [35], that the P_D parameter (the percentage of the D-wave admixture in DWF) has no model independent meaning and its value may not be unambiguiously determined from the experimental data) and, secondly, the D-wave contribution prevails in large E' region in the kinematical conditions of the experiment [15].

As can be seen in the figure 3, the modification carried out in the momentum region $100 \leq p \lesssim 500$ MeV and especially noticeably in the region $p \leq 300$ MeV (however in this region of DWF argument the S-wave prevails and therefore the D-wave distortion does not lead to sizeable effects in that part of energy spectrum of the d(e,e')x reaction which is determined by this momentum region). In the region $p \geq 300$ MeV the D-wave is increased by (20-30)% and this is sufficient for sizeable decrease of the discrepancy between the

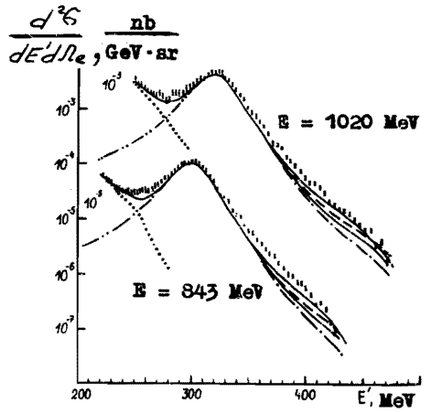

Fig.1. The electron energy spectra in the d(e,e')x reaction at E=843 and 1020 MeV and angle θ_e=180° [15]. The lower solid, dashed and dash-dotted curves correspond to following DWF's: for Paris potential [30], Reid soft-core potential [31] and relativistic DWF of Buck-Gross with λ = 0 [27]. The dotted curves describe the contribution of the d(e,e')Na reaction. The upper solid curves correspond to the calculations with the modified D-wave Paris DWF (see Fig.3)

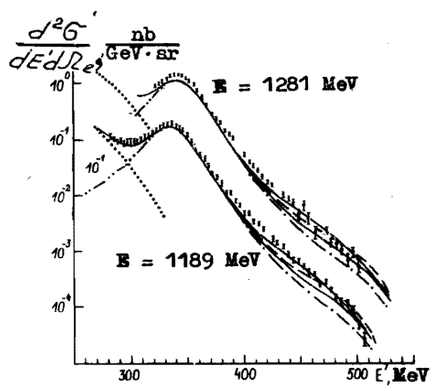

Fig.2. The same as in fig.1 but at E=1189 and 1281 MeV

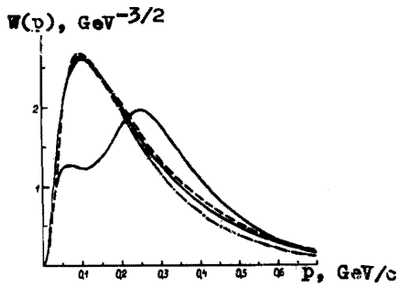

Fig.3. The momentum dependence of the D-wave for various DWF's. The solid, dashed and dash-dotted curves correspond to the Paris DWF, Reid soft-core potential DWF and relativistic DWF of Buck-Gross for $\lambda = 0$ case, resp. The solid curve with the dip correspond to the modified D-wave of Paris DWF (the D-wave admixture P_D in this case is 7.79%)

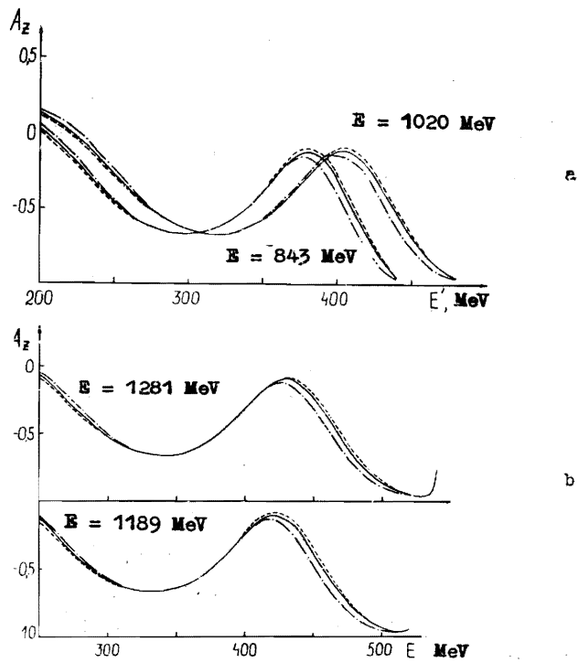

Fig.4. The A_z asymmetry for the kinematical conditions of the experiment [15]. The solid, dashed and dash-dotted curves correspond to the calculations with following DWF's: for Paris potential, relativistic Buck-Gross DWF for $\lambda = 0$ and the Reid soft-core potential DWF, resp

theory and experiment (see fig.1,2). The remaining discrepancy may be ascribed to nonconsidered here mechanisms (MEC, the final state interaction and so on). Note also that the analysis of the experimental data on deep inelastic muon-nucleus scattering $\mu^{12}C \to \mu X$ [11] led to the neccessity of increasing the HMC of the nuclear wave function in the momentum region $p \geqslant 400$ MeV. This led to the sizeable increase of the cross section in the $x \geqslant 1$ region and as a result the contradiction between the theory and experiment disappeared. The authors of [12-14] came to the analogious conclusion (they investigated the so-called EMC-effect). Thus from here one may see the important role of HMC of DWF which at present is still badly known. The difficulty of the HMC determination is connected to the fact that in the kinematical region where it becomes the most significant the additional (to the impulse approximation) mechanisms contribute.

Polarization observables in $\vec{d}(\vec{e},e')np$.

At present the first measurement of the spin dependent asymmetry in the scattering of the longitudinally polarized electrons by polarized nuclear target [36] is already carried out. This result demonstrates new powerful techniques in the investigation of the electromagnetic interaction in nuclear physics.

In this connection let us calculate in the RIA framework the polarization observables for the experimental conditions [15] ,i.e. backword scattering ($\theta_e = 180°$). In this case ($\varepsilon = 0$) from 8 independent polarization observables only two ones remain: Az and Azz (they are determined only by the transverse components of the electromagnetic current of the $\gamma^* d \to np$ reaction).

As can be seen in fig.4, the differences of Az asymmetry values for various DWF are small and therefore the asymmetry Az may hardly serve as a criterion for the choise of the DWF model.

It is shown in fig.5 how much the Az asymmetry changes if we use Paris DWF with modified D-wave. In this case the difference is not large as for the case of the energy spectrum since the asymmetry is the relative quantity.

As can be seen in fig.6, the Azz asymmetry is more sensitive to the choice of DWF model than the Az asymmetry (in the region where the D-wave contribution prevails). It is related to the fact that the Azz asymmetry is proportional to the D-wave which rather appreciably differs for various DWF's in high-momentum region.

Fig. 7 shows the change of the Azz asymmetry when using DWF

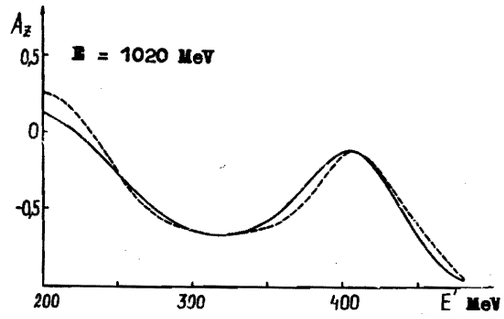

Fig.5. The A_z asymmetry calculated with Paris DWF-solid curve, with modified D-wave as in fig.3-dashed curve. Rinematical conditions correspond to the experiment [15]

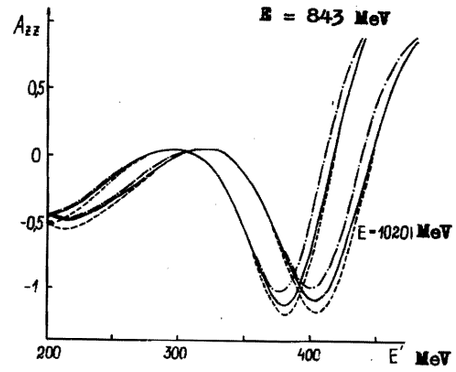

Fig.6,a

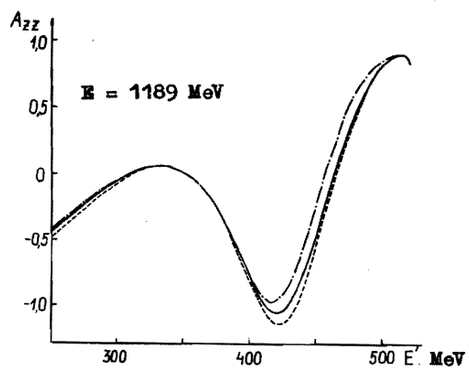

Fig.6,b

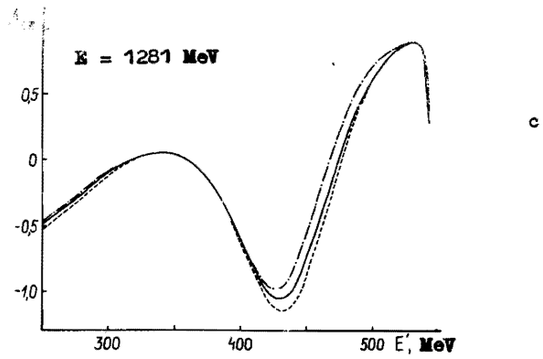

Fig.6. The A_{zz} asymmetry for the kinematical conditions [15]. The notations are as in fig.4.

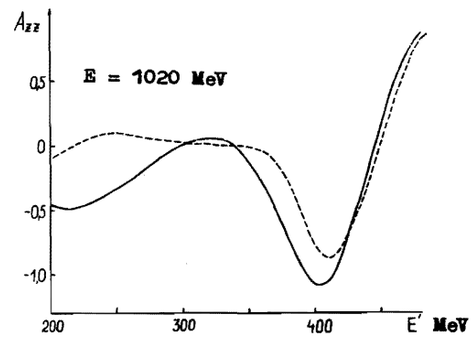

Fig.7. The same as in fig.5 for the A_{zz} asymmetry

with modified D-wave. By the reason of the mentioned above influence of this effect on Azz asymmetry is larger than on Az asymmetry (especially in a small E' region). The most strong differences take place in that region of the E' variable where the contribution from the real pion production prevails (see fig.1) and experimentally these two reaction channels ($ed \to enp$ and $ed \to eNN\pi$) are not separated since the energy spectrum d(e,e')x is measured. Note that just in this region (the region of the minimum between QEP and the peak corresponding to the Δ- isobar excitation) the calculations of Laget [15] (taking into account the real pion production) are approximately by up to a factor of 1.5 lower than the experimental values. The reasons which lead to this difference may be following: the smallness of HMC of DWF and the failure of the nonrelativistic approach at such kinematical conditions.

The reaction of the inclusive deuteron electrodisintegration with a polarized beam and target $\vec{d}(\vec{e},e')$np has been investigated in detail in the framework of the nonrelativistic approach [37]. The sensitivity of polarization observables to the choice of DWF model, MEC, the isobar configurations and to the parametrization of the nucleon electromagnetic form factors has been studied.

Conclusion

In the paper the reaction of inclusive deuteron electrodisintegration in the large K^2 region has been analyzed in the framework of a general approach (having the relativistic invariance). The comparison of the model predictions with the experimental data obtained in [15] has been carried out. The measured electron energy spectra in the d(e,e')x reaction also contains an intermediate region (between QEP and the peak corresponding to the Δ-isobar excitation). The comparison shows that QEP and intermediate regions are well described in the relativistic approach. However the predicted cross section in the region between QEP and the threshold of d(e,e')np turns out to be essentially less than the measured one. In this region the HMC of DWF ($p \geq 400$ MeV) gives the main contribution to the cross section. It is found that existing realistic DWF's essentially differ in the region of large momenta and this leads to large sensitivity of the cross section in this region on the choice of DWF parametrization. We did not take into account the MEC and final state interaction contributions. However we showed that the DR contribution is small in this region (and decrease as $|K^2|$

increase). In this connection the influence on the cross section of the HMC modification (for the case of DWF D-wave) has been investigated. It was shown that small modification leads to essential improvement of the situation. Thus the region between QEP and the threshold of $d(e,e')np$ (at large K^2) may serve as a good information source about HMC of DWF. However it is necessary for this to take into account in a common approach such effects as relativistic corrections, DR, the final state interaction and MEC.

The polarization observables in the $\vec{d}(\vec{e},e')np$ reaction have been investigated for the Kinematical conditions of the experiment [15]. Unfortunately, for the asymmetries (for given Kinematical conditions there are two asymmetries; Az and Azz) the sensitivity to the choise of DWF model and its HMC decreases.

Appendix

The connection of the observables in the formula (1) with the scalar amplitudes f_i of the $\gamma^* d \to np$ reaction is determined by the following formulae

$$\sigma_T = \frac{4\pi}{3}\int dx\Big[|f_3|^2+|f_4|^2+|f_5|^2+|f_6|^2+|f_9|^2+|f_{10}|^2+ +|f_{11}|^2+|f_{12}|^2+\frac{\omega^2}{M^2}\left(|f_1|^2+|f_2|^2+|f_7|^2+|f_8|^2\right)\Big],$$

$$\sigma_L = -\frac{8\pi}{3}\frac{K^2}{K_0^2}\int dx\Big[|f_{15}|^2+|f_{16}|^2+|f_{17}|^2+|f_{18}|^2+\frac{\omega^2}{M^2}\left(|f_{13}|^2+|f_{14}|^2\right)\Big],$$

$$R_y = -2\pi\frac{\omega}{M}\frac{\sqrt{-K^2}}{K_0}\int dx\, Im\,(f_4 f_{14}^* - f_2 f_{16}^* + f_3 f_{13}^* - f_1 f_{15}^* - - f_7 f_{17}^* - f_8 f_{18}^* + f_{12} f_{14}^* + f_{11} f_{13}^*),$$

$$R_x = 2\pi\frac{\omega}{M}\frac{\sqrt{-K^2}}{K_0}\int dx\, Re\,(f_4 f_{14}^* - f_2 f_{16}^* + f_3 f_{13}^* - f_1 f_{15}^* - - f_7 f_{17}^* - f_8 f_{18}^* + f_{12} f_{14}^* + f_{11} f_{13}^*),$$

$$R_z = 4\pi\int dx\, Re\,(f_{12} f_4^* + f_{11} f_3^* - f_9 f_5^* - f_{10} f_6^*),$$

$$R_{yz} = -4\pi\frac{\omega}{M}\frac{\sqrt{-K^2}}{K_0}\int dx\, Im\,(f_{15} f_1^* + f_{13} f_3^* + f_{16} f_2^* + f_{14} f_4^* + + f_{17} f_7^* + f_{18} f_8^* + f_{14} f_{12}^* + f_{13} f_{11}^*).$$

$$R_{zz}^{T} = 2\pi \int dx \left[2\frac{\omega^2}{M^2}\left(|f_1|^2 + |f_2|^2 + |f_7|^2 + |f_8|^2\right) - |f_5|^2 - \right.$$

$$\left. - |f_6|^2 - |f_{11}|^2 - |f_{12}|^2 - |f_3|^2 - |f_4|^2 - |f_9|^2 - |f_{10}|^2 \right],$$

$$R_{zz}^{L} = -4\pi \frac{K^2}{K_0^2} \int dx \left[2\frac{\omega^2}{M^2}\left(|f_{13}|^2 + |f_{14}|^2\right) - |f_{15}|^2 - |f_{16}|^2 - |f_{17}|^2 - |f_{18}|^2 \right],$$

$$R_{xx} = \pi \int dx \left[2Re\left(f_5 f_9^* + f_6 f_{10}^* + f_4 f_{12}^* + f_3 f_{11}^*\right) + \right.$$

$$\left. + |f_3|^2 + |f_4|^2 + |f_{11}|^2 + |f_{12}|^2 - |f_5|^2 - |f_6|^2 - |f_9|^2 - |f_{10}|^2 \right],$$

$$R_{xz} = -4\pi \frac{\omega}{M} \frac{\sqrt{-K^2}}{K_0} \int dx\, Re\left(f_1 f_{15}^* + f_3 f_{13}^* + f_{16} f_2^* + f_4 f_{14}^* + \right.$$

$$\left. + f_{17} f_7^* + f_{18} f_8^* + f_{12} f_{14}^* + f_{11} f_{13}^* \right),$$

where $\omega(K_0)$ is the deuteron (virtual photon) energy in the c.m.s. of the $\gamma^* + d \to n + p$ reaction, $x = \cos\theta$, θ is the nucleon emission angle (between $\vec{k}$ and $\vec{p}$) in the c.m.s. of the $\gamma^* + d \to n + p$ reaction, and the integration over x variable is carried out in the limits from -1 to +1.

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