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M.A.Braun[1], M.V.Tokarev

SPIN-DEPENDENT AND SPIN-INDEPENDENT DEUTERON STRUCTURE FUNCTIONS AND NUCLEAR FERMI EFFECT[2]

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[1]St.Petersburg University, 198904 St.Petersburg, Russia
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1. Introduction

Experimental and theoretical investigations of the deuteron structure are traditionally attractive ones. Interest in the deuteron study is connected first of all with the fact that this is the simplest nuclear system. It has been most studied both experimentally and theoretically. In the second place the deuteron was used as an excellent neutron target. The neutron structure functions F_2^n, g_1^n were usually found from the experimentally known proton and deuteron structure functions.

Recently new data on the deuteron structure functions F_2^D and g_1^D have been obtained at CERN, SLAC and Fermilab [1]-[8]. The data together with the previous ones [9]-[12] give the basis for construction and verification of the relativistic deuteron theory.

Direct information on the proton and neutron structure functions is of great interest for verification of the theory of strong interaction - QCD. The information can be used to extract the spin-dependent and spin-independent parton distributions, to estimate nonperturbative effects, to verify nucleon models and sum rules such as Gottfried [13], Bjorken [14] and Ellis-Jaffe [15] ones.

The extraction procedure of neutron structure functions from deuteron and proton data is an ambiguous one and, therefore the estimate of nuclear effects in the deuteron is extremely important not only to obtain new information on F_2^n and g_1^n but also to verify deuteron models.

The nuclear effects in the deuteron have been studied in [16]-[29].

The shadowing effect is considered in [23]-[25]. It was found that it increases with decreasing x and Q^2 [25]. The $R_F^{D/N} = F_2^D/F_2^N$ ratio was estimated to be $\simeq 0.97$ at $x = 0.001$ and $Q^2 = 2-8\ (GeV/c)^2$. The difference $F_2^p - F_2^n$ was shown to have the crossover point at $x \simeq 0.015$. The nuclear shadowing decreases dramatically the value of Gottfried integral ($S_G \simeq 0.16$) with the parton sum rule $S_G = 1/3$. In [26] the nuclear shadowing has been analysed using the double interaction mechanism for inclusive diffraction processes. The shadowing contribution to the structure function F_2^D was very small and less than 2% at x up to 0.001 and $Q^2 = 4\ (GeV/c)^2$. The shadowing was found to be a 3% effect at $x = 10^{-3}$ and $Q^2 = 4\ (GeV/c)^2$ and fall down vanishing at $x = 0.1$ [27] . In [23] the corrections for the deuteron structure function F_2^D also estimated down to $x \simeq 10^{-5}$ were less than about 3% over the range of x covered by the E655 data [4]. Large (3-5)% shadowing in the deuteron SF at $x < 0.01$ was predicted in [28]. It should be noted that the NMC data [1] give no evidence of sizeable shadowing in the deuteron for $x > 0.004$, but the data cannot exclude a (2-3)% effect at $x < 0.004$ as predicted in [28].

The nuclear effect due to Fermi motion is considered in [16]-[24]. The order of the effect is (1-3)% for $x < 0.7$ [16]-[19].

Qualitatively other results were obtained in the framework of relativistic description of the deuteron [23, 24]. The behaviour of the $R_F^{D/N}$ ratio is similar to the EMC effect on heavy nuclei. A relativistic approach [20] for the analysis of the deuteron SF and the deuteron EMC effect was used in [21]. The function F_2^D was determined in terms of the truncated Dpn vertex function. The ratio F_2^D/F_2^N was found to have an oscillatory feature, but the median value of the ratio remains close to unity over a small x-range and drops to 0.9 around $x \simeq 0.55$.

In the framework of the operator product expansion method effects of Fermi motion and meson exchange currents (MEC) have been estimated in [29]. The nuclear effect reaches

$\sim 2\%$ at $x \simeq 0.6$ and the ratio F_2^D/F_2^N reproduces the EMC behaviour. The summary contribution of the impulse approximation and MEC leads to the ratio $F_2^D/F_2^N > 1$ at $x < 0.2$. As noted in [22] the MEC contribution turns out to be small in the region of x and Q^2 covered by the E655 data. It is about 6% (12%) at $x \simeq 10^{-3}(10^{-2})$ of the total shadowing correction to F_2^D. The shadowing correction due to vector meson dominance, pomeron and meson exchange was also found to be less than $\sim 3\%$ over the experimental range of x and Q^2 [4].

We would like to emphasize that the relativistic description of the deuteron is necessary to take into account correctly nuclear effects and in particular the nuclear effect due to Fermi motion of nucleons with a high momentum.

We have used the model of relativistic deuteron proposed in [30]. Our approach is based on the relativistic deuteron wave function (RDWF) with one nucleon on mass shell. The RDWF can be expressed via the vertex function $\Gamma_\alpha(x, k_\perp)$. This model has been successfully used for the descriptions of the deuteron electromagnetic form-factors and some processes involving the deuteron [31]-[34].

In the present paper the model of relativistic deuteron [30, 31] is used to calculate the spin-independent and spin-dependent structure functions F_2^D, g_1^D. The dependence of the ratios $R_F^{D/N} = F_2^D/F_2^N$ and $R_g^{D/N} = g_1^D/g_1^N$ of structure functions on x and Q^2 is investigated. These ratios characterize the nuclear effect in the deuteron. It is shown that in our consistent relativization scheme the nuclear effect in the deuteron due to Fermi motion for F_2^D is noticeable and reaches $\sim 6\%$ at $x \simeq 0.7$. We have found the neutron structure function F_2^n by comparing our calculated results for the deuteron SF and the ratio $R_F^{D/p}$ with the available experimental data on F_2^D and F_2^p [1, 2]. The Gottfried sum rule (GSR) was verified on the basis of the obtained F_2^n. A strong Q^2-dependence of the Gottfried integral $S_G(x, Q^2)$ was found. The BCDMS data on $F_2^C(x, Q^2)$ were used to predict the dependence of the ratio $R_F^{C/D}(x, Q^2)$ in the cumulative range.

2. Relativistic Impulse Approximation

The cross section of deep-inelastic lepton-deuteron scattering in one-photon approximation is expressed via the imaginary part of the forward scattering amplitude of the virtual photon on the deuteron - $W_{\mu\nu}^D$. The latter is related to the deuteron spin-dependent - $g_{1,2}^D(\nu, Q^2)$ and spin-independent - $F_{1,2}^D(\nu, Q^2)$ structure functions as follows

$$W_{\mu\nu}^D = -(g_{\mu\nu} - q_\mu q_\nu/q^2)\cdot F_1^D + (p_\mu - q_\mu(pq)/q^2)(p_\nu - q_\nu(pq)/q^2)\cdot F_2^D/\nu$$

$$+ i\epsilon_{\mu\nu\alpha\beta}q^\alpha\{s^\beta g_1^D/\nu + [s^\beta(qp) - p^\beta(sq)]M^{-1}g_2^D/\nu^2\}. \qquad (1)$$

Here q, p are the momenta of photon and deuteron, M is the deuteron mass, $Q^2 = -q^2 > 0, \nu = (pq)$. The 4-vector s_α describes the deuteron spin and satisfies the following conditions: $s^2 = -1, (ps) = 0$.

In the relativistic impulse approximation (RIA) the forward scattering amplitude of the virtual photon on the deuteron $A_{\mu\nu}^D$ is expressed via a similar scattering amplitude on the nucleon $A_{\mu\nu}^N$ as follows

$$A_{\mu\nu}^D(q,p) = \int \frac{d^4k_1}{(2\pi)^4 i} Sp\{A_{\mu\nu}^N(q,k_1)\cdot T(s_1,k_1)\}. \qquad (2)$$

Here $T(s_1, k_1)$ is the amplitude of the $\bar N + D \to \bar N + D$ process and the notation $s_1 = k^2 = (p - k_1)^2$ is used. Integration is carried out with respect to the active nucleon momentum k_1. Integral (2) is calculated in the light-cone variables ($k_\pm = k_0 \pm k_3, k_\perp$). The peculiar points of the integrand (2) on the plane of the complex variable k_- are due to the peculiarities of the nucleon virtualities k_1^2 and k^2. Some of the peculiarities are due to the propagators $\sim (m^2 - k_1^2)^{-1}$, $(m^2 - k^2)^{-1}$. The others are related with the vertex DNN and the amplitude $A_{\mu\nu}^N$. The integral is not zero if the region of integration on k_+ is restricted

$$0 < k_+ < p_+ - k_+. \qquad (3)$$

Taking into account only a nucleon pole in the unitary condition for the amplitude $T(s_1, k_1)$ and the relation between the RDWF and the vertex function $\Gamma_\alpha(k_1)$: $\psi(k_1) = \Gamma_\alpha\cdot(m + k_1)^{-1}$, the symmetrical part of the deuteron tensor $W_{\mu\nu}^D$ can be written as

$$W_{\mu\nu}^D = W_{\mu\nu}^{\alpha\beta}\cdot\rho_{\alpha\beta}^{(S)} \qquad (4)$$

$$W_{\mu\nu}^{\alpha\beta} = \int \frac{d^4k}{(2\pi)^4 i}\delta(m^2 - k^2)\theta(k_0)\theta(p_+ - k_+)\ Sp\{w_{\mu\nu}^N\cdot\bar\psi^\alpha(k_1)\cdot(m + \hat k_1)\cdot\psi^\beta(k_1)\}. \quad (5)$$

Here θ-function and light-cone variables are used. The tensor $\rho_{\alpha\beta}^{(S)}$ is the symmetrical part of the deuteron polarization density matrix. The antisymmetrical part of the deuteron tensor $W_{\mu\nu}^D$ is expressed in the form similar to (4,5). The vertex function $\Gamma_\alpha(k_1)$ is defined by 4 scalar functions $a_i(k_1^2)$ and takes the form [35]

$$\Gamma_\alpha(k_1) = k_{1\alpha}[a_1(k_1^2) + a_2(k_1^2)(m + \hat k_1)] + \gamma_\alpha[a_3(k_1^2) + a_4(k_1^2)(m + \hat k_1)]. \qquad (6)$$

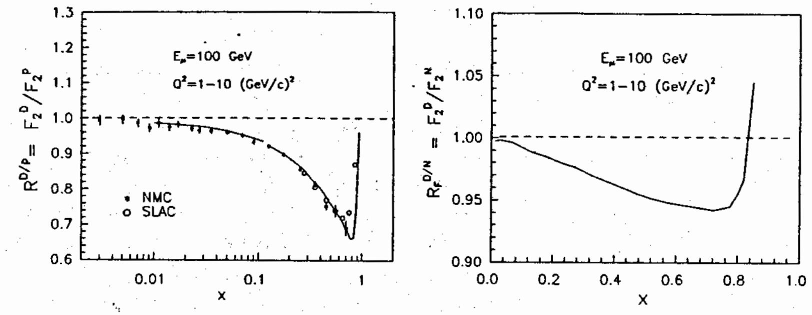
The relativization procedure of the deuteron wave function ψ_α has been proposed, and the scalar functions $a_i(k_1^2)$ have been constructed in [30].

3. Nuclear Fermi Effect in DIS with Unpolarized Deuteron

The deuteron structure function F_2^D in the light-cone variables is expressed as follows

$$F_2^D(\alpha, Q^2) = \int_\alpha^1 dx\ d^2k_\perp\ p(x, k_\perp)\cdot F_2^N(\alpha/x, Q^2). \qquad (7)$$

The nucleon SF $F_2^N = (F_2^p + F_2^n)/2$ is defined by the proton and neutron ones. The positive function $p(x, k_\perp)$ describes the probability that the active nucleon carries away the fraction of deuteron momentum $x = k_{1+}/p_+$ and the transverse momentum $k_\perp$ in the infinite momentum frame. It is expressed via the deuteron wave function $\psi_\alpha(k_1)$ as follows



a) b)

Figure 1. The $R_F^{D/p}$ and $R_F^{D/N}$ ratios of the structure functions for deep-inelastic lepton-deuteron scattering. Experimental data: $*$ - [1], o - [3].

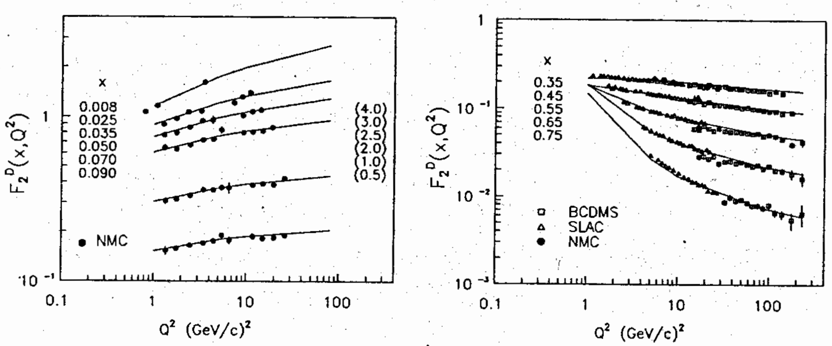


Figure 2. Deuteron structure function $F_2^D(x,Q^2)$ for deep-inelastic lepton-deuteron scattering. Experimental data: • - [2], △ - [3], □ - [10].

$$p(x,k_\perp) \propto Sp\{\bar{\psi}^\alpha(k_1)\cdot(m+\hat{k}_1)\cdot\psi^\beta(k_1)\cdot\hat{q}/\nu\cdot\rho^{(S)}_{\alpha\beta}\}. \tag{8}$$

Note that in the used approach the distribution function $p(x,k_\perp)$ includes not only usual S- and D-wave components of the deuteron wave function, but also a P-component. The latter describes the contribution of $N\bar{N}$-pair production.

We have used the NMC data [1, 2] on the ratio $R_F^{D/p} = F_2^D/F_2^p$ and F_2^p and also the relativistic deuteron model to extract the neutron SF F_2^n. For the latter the parametrization has been obtained

$$F_2^n(x,Q^2) = (1-0.75x)(1-0.15\sqrt{x}(1-x))\cdot F_2^p(x,Q^2). \tag{9}$$

Figure 1(a) shows the dependence of the $R_F^{D/p}$ ratio on x. A good agreement between theory and experiment is observed.

The nuclear effect in the deuteron is described by $R_F^{D/N}(x,Q^2)$. Figure 1(b) shows that with increasing x the effect of relativistic Fermi motion grows and the ratio $R_F^{D/N}$ reaches 6% at $x \simeq 0.7$. The dependence of the ratio $R_F^{D/N}$ on x resembles the nuclear EMC effect and over a range of $0.01 < x < 0.7$ it is practically independent of Q^2.

Our results differ from the estimation of the nuclear effect obtained in [16]-[19], where the latter one is no larger than (1-3)% and the ratio $R_F^{D/N}$ has not a typical EMC-behaviour. The results qualitatively similar to ours have been obtained in [23, 24].

Thus, the obtained results allow us to conclude that the dependence of the ratio $R_F^{D/N}$ on x is the universal one over a range of $0.01 < x < 0.7$ and it is defined by the structure of the RDWF.

In Figure 2 we compare $F_2^D(x,Q^2)$ with the experimental data [2, 3, 10]. These curves are in good agreement with the data both in a low and a high x-range. Scaling factors for different values of x and the corresponding curves are shown in Figure 2 too.

Thus, the extraction procedure proposed for $F_2^n(x,Q^2)$ is a self-consistent one because it includes a good description of higher statistics experimental data on the $R_F^{D/p}$ ratio and F_2^D over a wide kinematic range of x and Q^2. Therefore we consider that the use of our deuteron model and impulse approximation for describing the process is correct.

We would like to note that for a reliable estimate of other contributions to F_2^D due to nuclear effects such as nuclear shadowing, meson exchanges, etc., data at low x such as the E655 data [4] but with smaller experimental errors are required.

The obtained neutron SF can be used to verify the Gottfried sum rule (GSR) [13]:

$$\int_0^1 [F_2^p(x) - F_2^n(x)]\frac{dx}{x} = \frac{1}{3}. \tag{10}$$

The neutron and proton structure functions in the parton model can be expressed via the valence (u_V, d_V) and sea $(\bar{u}, \bar{d}, s, \bar{s})$ quark distributions, and the sum rule (10) can be written as follows

$$S_G = \frac{1}{3} + \frac{2}{3}\cdot\int_0^1[\bar{u}(y) - \bar{d}(y)]dy. \tag{11}$$

As has been reported in [1], the value of S_G obtained from the measurements of F_2^D and F_2^p is considerably below the value of the naive quark-parton model equal to 1/3: $S_G = 0.240 \pm 0.016$. This result is usually interpreted as the violation of the isospin

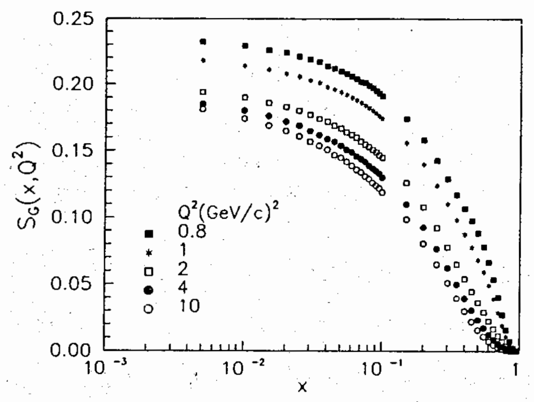
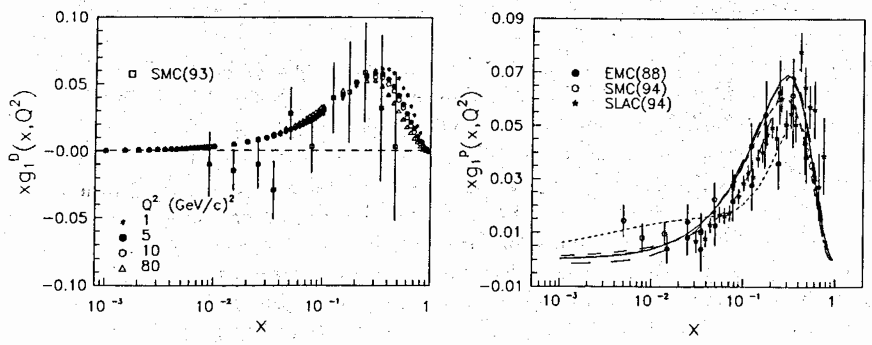


Figure 3. The Gottfried integral $S_G(x, Q^2)$.



a) b)

Figure 4. Deep-inelastic spin-dependent deuteron (a) and proton (b) structure functions. Experimental data: a) ◻ - [5]; b) ∘ - [7], ⋆ - [8], • - [12]. Theoretical results have been obtained with the parton distributions taken from: - - - [37], —— [38], - - - [39]. — — [40].

symmetrical sea. This value of S_G was obtained for averaged $Q^2 = 4\ (GeV/c)^2$, and the extrapolation procedure for an unmeasured low (0-0.004) and high (0.8-1.0) x-range was used.

The calculated results of the Gottfried integral as a function of x and Q^2 are shown in Figure 3

$$S_G(x, Q^2) = \int_x^1 [F_2^p(y, Q^2) - F_2^n(y, Q^2)] \frac{dy}{y}. \tag{12}$$

One can observe a noticeable Q^2-dependence of $S_G(x, Q^2)$. We should like to note that the range of low Q^2 and large x makes a dominant contribution to $S_G(x, Q^2)$. With increasing Q^2 the value of S_G decreases and the discrepancy with predictions in the quark-parton model grows. It could mean that the clouds of $q\bar{q}$- pairs of valence u and d quarks are essentially different and with increasing Q^2 the violation of the flavour symmetry of the sea becomes large.

4. Nuclear Fermi Effect in DIS with Vector Polarized Deuteron

The deuteron spin-dependent SF in the light-cone variables can be written as follows

$$g_1^D(\alpha, Q^2) = \int_\alpha^1 dx\ d^2k_\perp\ \Delta p(x, k_\perp) \cdot g_1^N(\alpha/x, Q^2). \tag{13}$$

The nucleon spin-dependent SF is defined as $g_1^N = (g_1^p + g_1^n)$. The function $\Delta p(x, k_\perp)$ describes the helicity distribution for an active nucleon that carries away the fraction of deuteron momentum $x = k_{1+}/p_+$ and the transverse momentum $k_\perp$ in the infinite momentum frame. It is expressed via the deuteron wave function $\psi_\alpha(k_1)$ as follows

$$\Delta p(x, k_\perp) \propto Sp\{\bar{\psi}^\alpha(k_1) \cdot (m + \hat{k}) \cdot \psi^\beta(k_1) \cdot \hat{q} \cdot \sigma^{\mu\nu} \cdot \rho_{\alpha\beta}^{(A)} \cdot \epsilon_{\mu\nu\gamma\delta} p^\gamma s^\delta\}, \tag{14}$$

where $\rho_{\alpha\beta}^{(A)}$ is the vector part of the deuteron polarization density matrix.

The dependence of the deuteron SF $xg_1^D(x, Q^2)$ on x for $Q^2 = 1, 5, 10, 80\ (GeV/c)^2$ is shown in Figure 4(a). The Carlitz – Kaur model [36] for the nucleon SF and parton distributions [37] have been used. The weak Q^2-dependence of xg_1^D is observed. We compare our results with the SMC data [5]. Taking into account large errors, the agreement between the calculated results and the experimental data should be considered as a good one.

Note that in the Carlitz – Kaur model the nucleon structure functions $g_1^{p,n}$ are proportional to momentum distributions of valence quarks (u_v, d_v) over a high x-range. Their behaviour in a low x-range is regulated by the "spin dilution factor" $cos(\theta)$. It is a measure of transferring of spin from valence quarks to gluons and $q\bar{q}$ pairs and it is significant at low x.

Figure 4(b) shows the results for the xg_1^p obtained with different parton distributions [37]-[40] and the experimental data [7, 8, 12]. Note that the proton and neutron SF in the model [40] have a negative singular asymptotic as follows $g_1^{p,n} \sim (-1)/(xln^2(x))$ at $x \to 0$.

The predictions of the model [40] for g_1^p are in disagreement with the new SMC data [7]. Large experimental errors for the data of g_1^D do not allow one to choose between numerous proton models. It is necessary to measure g_1^p with a higher accuracy in a lower x-range to discriminate some proton models or parton distributions. The other asymptotic for g_1^p at low x has been considered in [41] and it takes the form $\sim (+1)/(x ln^2(x))$. The behaviour of g_1^p due to negative signature cuts is in good agreement with the SMC data [7].

The nuclear effect in the deuteron for the spin-dependent SF is described by the ratio $R_g^{D/N}(x,Q^2) = g_1^D(x,Q^2)/g_1^N(x,Q^2)$. Figure 5 (curve 1) shows the dependence of the $R_g^{D/N}$ ratio on x and $Q^2 = 1-80\ (GeV/c)^2$. The parametrizations of parton distributions are taken from [37, 38, 39]. The ratio $R_g^{D/N}$ is found to be practically constant and independent of parton distributions over a wide kinematic range of x and Q^2. It should be noted that $R_g^{D/N}$ is also independent of nucleon models [36, 40]. The nuclear effect due to relativistic Fermi motion is found to be $\sim 10\%$ in the range $x = 10^{-3} - 0.7$. Similar results have been found in [42, 43] too.

Thus, the obtained results allow us to conclude that the dependence of the ratio $R_g^{D/N}$ on x is the universal one in the range $x < 0.7$ and it is defined by the structure of the RDWF.

We should like to emphasize here that the extraction of the neutron SF g_1^n from the deuteron and proton data is not direct, and so it is necessary to take into account the nuclear effect in the deuteron.

Figure 5 (curves 2,3,4) shows the dependence of the ratio $R_g^{D/p} = g_1^D/g_1^p$ on x at $Q^2 = 10\ (GeV/c)^2$. This ratio, in contrast to $R_g^{D/N}$, is strongly dependent both on the parton distributions [37, 38, 39] and the nucleon models [36, 40].

5. Nuclear Fermi Effect in DIS at $x > 1$

Considerable progress has been achieved in the recent analysis of the experimental data on the deep-inelastic structure function ratio $R^{A/D} = F_2^A/F_2^D$, and new nuclear effects have been found [44].

It has been shown that

- the ratio $R^{A/D}(x,Q^2)$ is independent of Q^2 over a range of $0.001 < x < 0.7$, $0.01 < Q^2 < 200\ (GeV/c)^2$,
- saturation effect in A-dependence is clearly observed,
- the crossover point x_0 $(R^{A/D}(x_0,Q^2) = 1)$ does not depend on A,
- the quark distributions of all flavours are equally distorted by nuclear medium.

Note that the experimental data on the ratio $R^{A/D}(x,Q^2)$ cover in the main the region $x < 1$ [45]. The results of an analysis of the data on the ratio show that the quark configurations in free and bounded nucleon differ from one another. Nuclear quark configurations can be explored only in the cumulative range $x > 1$ [46].

The new data for the carbon nuclear structure function $F_2^C(x,Q^2)$ at x up to 1.3 are presented by the BCDMS collaboration in [47].

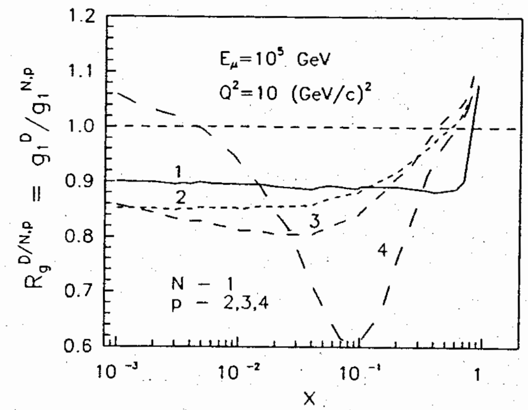


Figure 5. The $R_g^{D/p} = g_1^D/g_1^p$ and $R_g^{D/N} = g_1^D/g_1^N$ ratios of the spin-dependent structure functions for deep-inelastic lepton-deuteron scattering. Curves 1 and 2-4 present $R_g^{D/N}$ and $R_g^{D/p}$, respectively. The parton distributions are taken from: 2 - [37], 3 - [38], 4 - [39].

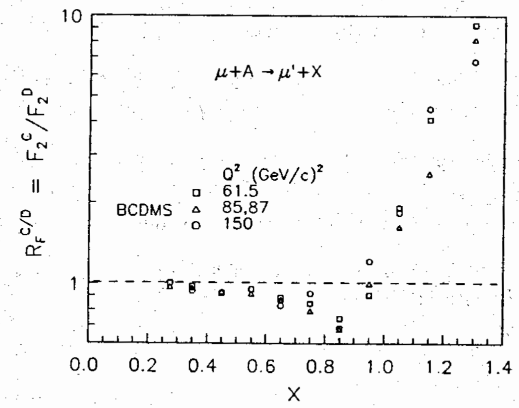


Figure 6. Dependence of the $R_F^{C/D}$ structure functions ratio on x. The experimental data for $F_2^C(x,Q^2)$ are taken from [47, 48].

We use the data on F_2^C and the calculated results of the F_2^D structure function based on the deuteron model [30, 31] to study the ratio

$$R^{C/D}(x,Q^2) = \frac{F_2^C(x,Q^2)}{F_2^D(x,Q^2)}. \quad (15)$$

Our results are shown in Figure 6. The nuclear effect ratio $R_F^{C/D}$ at $x > 1$ demonstrates an exponent increase $\sim exp(\alpha \cdot x)$ and differs significantly from unit at $x < 1$. Note that the behaviour of the ratio in the range $x < 1$ is in good agreement with the experimental data [48]. We would like to emphasize that the effect is not due to the kinematic boundary condition. One can see that the ratio $R_F^{C/D}$ does not manifest regularity around the integer number x predicted in [49] and connected with two nucleon correlations. Note that in [50] the exponent dependence of the cross section ratio $R^{A/D} \sim \rho_A^\pi/\rho_D^\pi$ for inclusive backward pion production in the $p + A \to \pi + X$ process in the cumulative range $(x > 1)$ has also been observed. It has been concluded that nuclear mechanisms of particle production in the process differ significantly in the cumulative and non-cumulative ranges.

We consider that the systematic experimental study of the nuclear effect at $x > 1$ is very important to obtain new information on quarks in nuclei and also to verify deuteron relativistic models.

6. Conclusions

- The effect of relativistic Fermi motion was estimated for the spin-independent and spin-dependent deuteron structure functions.
- The dependence of the ratio $R_F^{D/N}$ on x resembles the nuclear EMC effect on heavy nuclei. The value of the nuclear effect reaches $\sim 6\%$ at $x \simeq 0.7$.
- The dependence of the ratio $R_g^{D/N}$ on x due to relativistic Fermi motion in the kinematic range $x = 10^{-3} - 0.7$, $Q^2 = 1 - 80\ (GeV/c)^2$ is approximately constant. The value of the nuclear effect due to Fermi motion is found to be $\simeq 10\%$.
- The calculated results for the structure functions F_2^D, g_1^D are in good agreement with the experimental data (BCDMS, SLAC, NMC, SMC).
- A strong Q^2-dependence of the Gottfried integral $S_G(x,Q^2)$ is obtained in the range $Q^2 < 10\ (GeV/c)^2$.
- The nuclear effect ratio $R_F^{C/D}$ in the cumulative range was estimated and the ratio was shown to differ significantly from unit at $x < 1$.

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Браун М.А., Токарев М.В. E2-95-26

Спин-зависимая и спин-независимая структурные функции дейтрона и ядерный эффект ферми-движения

Рассматривается процесс глубоконеупругого лептон-дейтронного рассеяния в релятивистском импульсном приближении. В рамках ковариантного подхода в переменных светового конуса на основе релятивистской волновой функции дейтрона вычислены спин-зависимая $g_1^D(x, Q^2)$ и спин-независимая $F_2^D(x, Q^2)$ структурные функции (СФ). Результаты расчетов сравниваются с экспериментальными данными. Оценена величина ядерного эффекта, обусловленного фермиевским движением нуклонов в дейтроне и установлено, что отношение $R_F^{D/N} = F_2^D/F_2^N$ достигает 6% при $x \cong 0{,}7$. Извлеченная из экспериментальных данных СФ нейтрона использовалась для проверки правила сумм Готтфрида. Показано, на основе полученной F_2^n, что нарушение флейворной симметрии морских кварков может быть большим с ростом Q^2. Установлено, что эффект релятивистского фермиевского движения для спин-зависимой структурной функции дейтрона составляет ~10% в широком кинематическом диапазоне x и Q^2. Экспериментальные данные BCDMS для F_2^C использовались для оценки отношения $R_F^{C/D}$ в кумулятивной области ($X > 1$).

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Braun M.A., Tokarev M.V. E2-95-26

Spin-Dependent and Spin-Independent Deuteron Structure Functions and Nuclear Fermi Effect

Deep-inelastic lepton-deuteron scattering in the relativistic impulse approximation is considered. The spin-dependent $g_1^D(x, Q^2)$ and spin-independent $F_2^D(x, Q^2)$ structure functions (SF) are calculated using the covariant approach in light-cone variables. The results are compared with experimental data. The effect of relativistic Fermi motion described by the ratio $R_F^{D/N} = F_2^D/F_2^N$ is estimated to be 6% at $x \cong 0.7$. The extracted neutron SF is used to verify the Gottfried sum rule. It is shown that the violation of the flavour symmetry of sea quarks can be large with increasing Q^2. It is found that the nuclear effect due to relativistic Fermi motion for the spin-dependent structure function reaches ~10% over a wide kinematic range of x and Q^2. The BCDMS experimental data on F_2^C are used to estimate the $R_F^{C/D}$ ratio in the cumulative range.

The investigation has been performed at the Laboratory of High Energies, JINR.

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