MULTIQUARK INTERACTIONS

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1. Introduction

The atomic nucleus is a system of interacting nucleons. The nucleons are colourless three-quark clusters. Thus, in nuclei and nuclear processes there can appear nontrivial multiquark systems, first of all the colourless 6q-, 9q-, 12q-systems. It is natural to expect that in the ground and weakly excited states of nuclei ($E \approx M_A = A \cdot M$, M is the nucleon mass) they give a small admixture to the leading, nucleon channel in the total wave function of a nucleus:

$$\Psi = \Psi(AN) + C\,\Psi(3Aq) \tag{1}$$

so that $|C(E \approx M_A)|^2 \ll 1$. The probability of such an admixture can be estimated as the fluctuation probability of A nucleons of "a nucleon gas" of A particles to be in a small volume V_ξ [1]:

$$\beta_k^A = \binom{A}{k}\left(\frac{V_\xi}{AV_0}\right)^{k-1} = \binom{A}{k}\left(\frac{r_\xi}{r_a}\right)^{3(k-1)}\frac{1}{A^{k-1}}. \tag{2}$$

Here $r_a = 1.2\,fm$ is a mean radius of the nucleon-nucleon interaction in a nucleus, and $r_\xi = 0.75$ fm is a parameter of an order of the core radius of NN-forces. The latter is natural to connect with the confinment radius. The concept of fluctuations has been useful for phenomenological descriptions of high-energy nuclear reactions. Thus, it was first applied to the interpretation of the knocked-out reactions of deuterons from nuclei at large momentum transfers [2]; then, the idea of cumulative reactions, suggested in ref.[3], was realized by using the idea of "fluctuons" in nuclei [4]; on the same basis, but with adding the quark counting rules[5], the nuclear form factors at high transfer momenta, and the deep inelastic scattering on nuclei[6], etc.,were calculated.

The nature of fluctuons can be understood by introducing a concept of multiquark systems (MQS). The first calculations of multiquark bags[7] have shown that their mass give the comparably large excess as compared to the corresponding mass of nuclei, i.e. $E_\lambda = M_A + \Delta_\lambda$, where "the quark-nuclear splitting" $\Delta_\lambda \gtrsim 0.2$ GeV. These states E_λ are specific nuclear states to be revealed as resonances in the corresponding scattering amplitudes. In this case the total nuclear wave function must be of the following form

$$\Psi \cong C\,\psi(3Aq), \tag{3}$$

where $|C(E\approx E_\lambda)|^2 \approx 1$. At present indications do exist for possible resonances in the $^1D_2$ and $^3F_3$ phases of NN-scattering[8].

Thus, we conclude that the ground states of nuclei can have a small admixtures of MQS, and the pure MQS with significant probabilities can reveal themselves as dibaryons, three-baryons, and so on at large excitation energies of an order of 0,2 - 0,3 GeV above the mass of a nucleus.

2. Experimental Indications for MQS

2.1. Cumulative processes

Now cumulative nuclear reactions are well investigated (see, for instance, ref.[9]). Recently[10], on the basis of a large amount of experimental data on the cumulative production of mesons from p(8.9 GeV/c) $+ A \to \pi^\pm, K^\pm +$ anything, the main feature of the cumulative inclusive cross sections have been established. First, the limiting fragmentation of nuclei was found, beginning from the energy $E \gtrsim 4$ GeV. The corresponding cross section is presented in the factorized form

$$E\frac{d\sigma}{d\vec{p}} = f(A, p_\perp^2, x) = A^n\,\Phi(p_\perp^2)\,G(x), \tag{4}$$

where A is the atomic number of a target nucleus, and

$$\Phi(p_\perp^2) = 0.9\,\exp(-2.7p_\perp^2) + 0.1\,, \tag{4a}$$

$$G(x) = G_0\,\exp(-x/0.14)\,. \tag{4b}$$

Here X is determined in ref.[10] and differs from the Bjorken variable $X(p) = -\frac{Q^2}{2(PQ)} \leqslant 1$ by the account of mass correction. At very high energies they are the same, and provided that the momentum P is distributed in MQS composed of several k nucleons of a nucleus, we get $P = kP_0$ and $X \equiv X(P_0) \simeq kX(p)$, where P_0 is the corresponding momentum per one nucleon of MQS and X the usually longitudinal scale variable for a nucleon mass of a target. Second, the cumulative region is determined as the one for $X > 1$. In principle, $X \leq A$, and the physical meaning of X is connected with that mass of a target (in the nucleon mass units) which reacts with an incident particle as a whole.

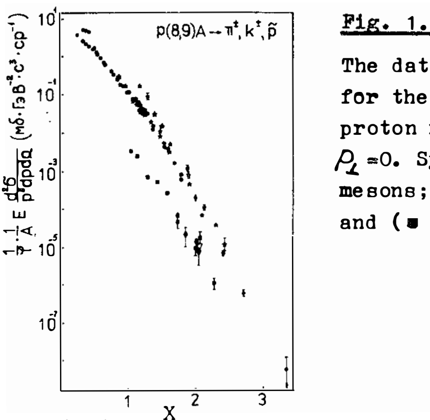

Fig. 1.

The data of ref.[10] are shown for the backward production for proton momenta 8.9 GeV/c and $p_\perp = 0$. Symbols (•) are for π^+-mesons; ($*$) for K^+-mesons; and (▪) for K^--mesons.

Fig. 1 shows [10] that the process is seen up to X of an order of 3 and larger. This means that the incident proton feels the MQS of mass $M_k = kM$ $(k \gtrsim 3)$. And because of a large momentum transfer in the reaction $(\approx 2\ (\text{GeV/c})^2)$ the space distribution of MQS is rather small $r_\xi \lesssim 1$ fm. The third is the universal slope of the nuclear structure function $G(x)$ determined by the constant mass value $\langle x \rangle \simeq$ $\simeq$ 0.14. Fourth, the observed volume "dependence" of the cross sectinns at $A \gg 1$ (Fig. 2a) $E\frac{d\sigma}{d\vec{p}} \approx A^{1}$ (i.e., n =1 in eq. (4)) says that MQS is not a "tube" in nuclear matter, (witn a consequence of $A^{2/3}$), rather, it is a cluster like object consisting of densely packed nuclear nucleons and existed in a nucleus irrespective of reactions where it takes part. And finally, individual properties of nuclei are seen from Fig. 2b[11], where the ratios of invariant cross sections divided by the corresponding atomic number A are shown for several nuclei.

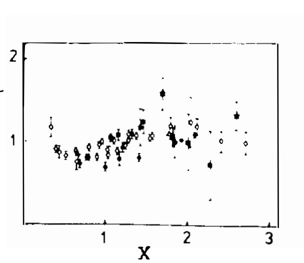

Fig. 2a.

The experimental data on $n = [\ln f(A_{Pb})/f(A_{Al})]/[\ln A_{Pb}/A_{Al}]$ as a function of X demonstrate the A^n-dependence of cumulative processes $pA \to \pi^+(\bullet)$, $K^+(*)$, $K^-(\square)$ and $dA \to \pi^+(\circ)$(see ref.[10]).

(It would be more conrageous to declare that here there are seen peculiarities of the structure function of a nucleon when the latter is surrounded by the other $A-1$ nucleons of a nucleus). In particular, it is clear that, for example, the deuteron structure function

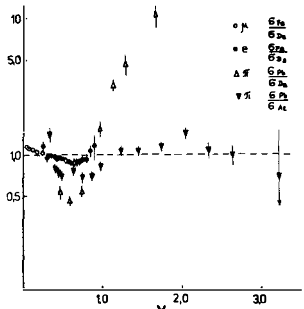

Fig. 2b.

The ratios of invariant crose section divided by A (ref.[11] and also ref.[15] on deep inelastic ed and eFe scattering).

goes to zero at $X=2$ (the deuteron mass is not larger than $M_{2}\approx 2M$), and therefore, the nuclear structure function divided by the deuteron one will go to infinity at this point (in a nucleus the more complicated $9q$ -system,etc., can be revealed, for which the kinematical limit is shifted to the right from $X>2$ and here the corresponding structure function does not turn to zero).

2.2. Elastic and deep inelastic lepton scattering

The mechanism of lepton scattering is well known so that the investigation of the processes for $X>1$ is desirable. The data from SLAC for $^{2}D, ^{3,4}He$ at $X>1$ [12] and preliminary muonic data for ^{12}C [13] are available at present. Note that for the latter experiment, the structure function behaviour at $X \gtrsim 1$ has been predicted earlier [14], by using the result (4b) obtained from cumulative processes. For muonic deep inelastic scattering the A-dependence of structure functions has also been observed (EMC-effect[15]) and is now thoroughly investigated theoretically.

As to the elastic form factors of nuclei, one should say that the idea on 6q-admixtures in a deuteron is rather attractive in explaining its form factor behaviour at large momentum transfers $q^2 \gtrsim 2\ (GeV/c)^2$ [16]. The 9q-admixture seems also necessary to be induced for the interpretation of $^{3,4}He$ form factors. The 6q-components in the deuteron wave function are also needed for understanding the momentum spectra of nucleons, obtained in the deuteron-nucleus collision with a registration of protons at small forward angles[17].

Thus, we conclude that MQS do exist in nuclei irrespective of reactions in which they take part. They have the mass $M_k=kM$ (=3,4), small space dimensions of an order of the NN-core forces ones, so that the high momentum transfer reactions are most convenient for investigating them.

It is interesting to ascertain a specific feature of quarkparton distributions in multiquark systems, their Q^2-dependence, internal structure (e.g., the distributions of colour degrees of freedom), the role of these systems in understanding the nuclear forces (QCD for MQS at small and large distances).It is possible that peculiarities of these objects can give also a new information on fundamental properties of elementary particles.

3. Two-Channel Model

3.1. Coupled channel equations

In nuclei the nucleon channel is the main one. It is determined by the NN-interaction V_{NN}. The other, multiquark channel suggested to exist is formed by the V_{qq} interaction. Generally speaking, a mutual influence of these two channels is determined by the quark-nucleon interaction, and this latter can be constructed by using some models. Then it is possible to formulate a system of coupled channel equations which let us, in principle, to get estimations of multiquark admixtures, the space and momentum distribution of quarks, the width of MQS-states, etc. For simplicity we consider an example of two interacting nucleons which may compose at small distance a bag-type 6q-system /18/. The detailed form of eq. (1) for the wave function is as follows

$$\Psi = \hat{A}(\varphi(r)\phi_1\phi_2) + C_\lambda \psi_\lambda(6q). \tag{5}$$

Here ψ_λ is a superposition of the Gaussian-type wave functions for quarks in the 6q-bag with the slope parameter Ω =1 (GeV/c)^2 that corresponds to the radius of qq-interaction of an order of 0.5 fm, $\hat{A}$ is the antisymmetrization operator in quarks belonging to separate nucleons described by functions ϕ_1 and ϕ_2. The 6q-admixture amplitude C_λ and the relative-motion function of nucleons φ should be found as solutions of the coupled channel equations /18/

$$\left(-\frac{\hbar^2}{2m}\frac{d^2}{dr^2} + U - \epsilon\right)\varphi(r) = -C_\lambda \tilde{D}_\lambda(r), \tag{6}$$

$$-C_\lambda(E_\lambda - E) = \int dr\, \varphi(r)\tilde{D}^*_\lambda(r). \tag{7}$$

Here $\epsilon = E - 2M$ and m is the nucleon reduced mass. The coupling of channels is given by the function

$$\tilde{D}_\lambda = (E_\lambda - E)\langle\phi_1\phi_2/\psi_\lambda\rangle + \langle\phi_1\phi_2/V_{qN}/\psi_\lambda\rangle. \tag{8}$$

In the case of orthogonal channels, $\tilde{D}_\lambda$ is determined only by the second term,the transition because of the V_{qN} interaction. The latter is introduced as a difference of the quark interactions in the whole system $V_{qq}=\sum_{i>j=1}^{6} V_{qq}(ij)$ and the phenomenological NN-interaction out of the core radius $U=\theta(r_a-r)[V_M(r)+\sum_{i>j=1}^{3} V_{qq}+\sum_{i>j=4}^{6} V_{qq}]$, namely

$$V_{qN}=V_{qq}-U. \tag{9}$$

The transition function $\widetilde{\mathcal{D}}_\lambda$ has a form of the δ-type interaction on the 6q-bag surface and can be approximated by $\widetilde{\mathcal{D}}_\lambda=\eta_\lambda\,\delta(r-r_a)$.

Finally, we note that the usual nuclear physics is based on the first equation (6) for nucleons with the right-hand side equaled to zero.

3.2. Estimations of 6q-admixtures and the widths of dibaryons

In estimating 6q-admixtures in the deuteron we use the fact that they are small in the ground state of nuclei $|C_\lambda|^2\ll 1$. Then the right-hand side of eq. (6) is small, and the system (6) and (7) is decoupled so that the admixture is

$$C_\lambda=-\frac{\int dr\,\varphi(r)\,\widetilde{\mathcal{D}}_\lambda(r)}{E_\lambda-E}. \tag{9'}$$

Now φ is the usual deuteron function which can be calculated using the known V_{NN} potentials. We have used the Reid hard core and Feshbach-Lomon potentials and the Hulton function for φ. The splitting $\Delta_\lambda=E_\lambda-E$ has been taken 0.3 GeV as is predicted by the MIT-bag for 6q-system. For the case of s^6-configuration of quarks one gets $C_\lambda(s^6)=$ -0.37 (Hülton); - 0.147 (Reid); -0.132 (Feshbach-Lomon), whereas . In the case of s^4p^2-configuration $C_\lambda=$ 0,26 (Hülten); 0.21 (Reid); 0.18 (Feshbach-Lomon). One can see, that the sign of admixture amplitudes depends on the selected configuration, and the total probability $C^2=C^2(s^6)+C^2(s^4p^2)$ is equal to $6.6\cdot 10^{-2}$ in agreement with the data on ed-scattering.

A specific property in solving eqs. (6), (7) for continuous states $\epsilon>0$ (e.g., for dibaryons as quasi-stable states of the 6q-system) is that near a resonance $E\approx E_\lambda$ we should compensate the small $(E-E_\lambda)$ in the left-hand side of eq. (7) by the large (and generally speaking, complex) value of C_λ. So that we may not neglect the right-hand side in eq. (6). However, the system of eqs. (6), (7) can be solved in a general case, if one uses the typical form of $\mathcal{D}=\eta_\lambda\,\delta(r-r_a)$. Then the ℓ-phase relative-motion nucleon wave function $\varphi(r)$ is obtained from eq. (6) in the form:

$$\varphi_\ell=\chi_\ell+2mC_\lambda\,\eta_\lambda\,G_\ell^{(+)}(r_a r_a). \tag{10}$$

Substituting (10) into (9), one can get

$$C_\lambda = - \frac{\eta_\lambda^* \chi_\ell(r_a)}{(E_\lambda - E) + 2m\,|\eta_\lambda|^2 G_\ell^+(r_a r_a)} \tag{11}$$

and then $\left(G_\ell^{(+)} = -\sqrt{\pi/2}\,(1/k)\chi_\ell^{(+)}(r_>)\chi_\ell(r_<);\ \chi_\ell \sim \sqrt{2/\pi}\,\mathrm{Sin}(kr - \frac{\ell\pi}{2} + \delta_\ell);\ \chi_\ell^{(+)} \sim e^{i(kr - \frac{\ell\pi}{2} + \delta_\ell)}\right)$

$$\varphi_\ell \underset{r\to\infty}{\approx} i/\sqrt{2\pi}\, e^{-i\delta_\ell}\left[e^{-ikr} - S_R e^{2i\delta_\ell} e^{ikr}\right]. \tag{12}$$

where the resonance part of S-matrix is

$$S_R = 1 - 2i\,\frac{m\pi}{k} C_\lambda \eta_\lambda \chi_\ell(r_a) = \frac{(E_\lambda - E) - \delta E + i\Gamma/2}{(E_\lambda - E) - \delta E - i\Gamma/2} \tag{13}$$

and the resonance width is

$$\Gamma = 2\,\frac{m\pi}{k}\,|\eta_\lambda|^2 \chi_\ell^2(r_a). \tag{14}$$

Estimations of the widths done in [18] are as follows

$$\Gamma(s^6) = 29\ \mathrm{MeV}, \qquad \Gamma(s^4p^2) = 9{,}3\ \mathrm{MeV}, \tag{15}$$

and are smaller than $\Gamma_{exp} \approx$ 50-100 MeV obtained from experiment where the $\ell = 2$ and 3 nucleon-nucleon scattering in the region of dibaryon energies $\epsilon \gtrsim 0.2$ GeV has been investigated. However, one should note that the theory predicts [19] a large density of the dibaryon states which can overlap rather strongly.

Thus, we conclude that in the ground state of the deuteron the 6q-admixture amplitude has the negative sign and small value of an order of several per cent. In the case of scattering, when $E \approx E_\lambda$ a system becomes the true 6q-system (dibaryon).

4. Deuteron Form Factor

Six-quark degrees of freedom are coordinated in a central part of the deuteron, thus, they will influence the form factor at large momentum transfers. The total wave function (5) consists of two terms and therefore the form factor is composed of three parts:

$$F = F_N + 2C_\lambda F_{int} + C_\lambda^2 F_{6q}. \tag{16}$$

The first term F_N includes, in principle, effects of the exchange of quarks belonging to separate nucleons. However, the calculations [16] show that for realistic NN-potentials their contribution in the whole region of momentum transfer up to $q^2 \approx 8\ (\mathrm{GeV}/c)^2$ does not exceed 10% (Fig. 3). Also, a special investigation of interference effects (Fig. 4) was carried out. For the Reid soft core potential their value

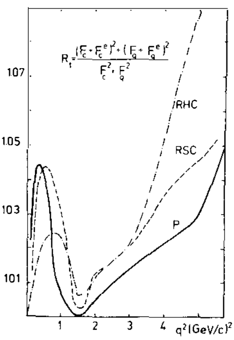

Fig. 3.

The contribution of the exchange form factors to ed-scattering without six-quark admixtures, calculated with the Reid Hard Core (RHC), soft Core (RSC) and Paris (P) wave functions of the deuteron (see ref.[16]).

turns out to be about 20% and can be neglected in comparison with the six-quark contribution. As to the form factor F_{6q} , it has been calculated on the basis of the relativistic harmonical oscillator model [20], that gives:

$$F_{6q} = \frac{e^{-5q^2/4\Omega(1+q^2/2m_6^2)^{-1}}}{(1+q^2/2m_6^2)^5} . \qquad (17)$$

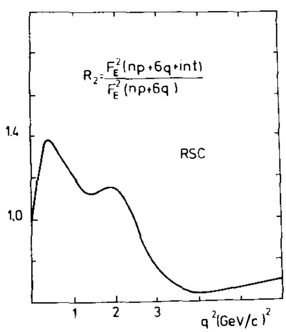

Fig. 4.

The contribution of the interference term to ed-scattering (from ref.[16]).

Here the parameters are $\Omega = 1$ $(GeV/c)^2$ and $m_6 = 1,2$ GeV. Fig. 5 shows calculations of the form factor (16) and the comparison with experimental data. The result is that the 6q-admixture is $C_\lambda^2 = 0.07$.

Thus, one can conclude that the smallness of interference effects in the case of deuteron does not allow us to make a definite conclusion on the sign of the 6q-amplitude. Then, the exchange effects are negligible. And finally, the main contribution to the large momentum transfer region appears because of 6q-admixtures. At present it is clear that MQS cannot be ignored in interpretating the form factor behaviour at high momentum transfers.

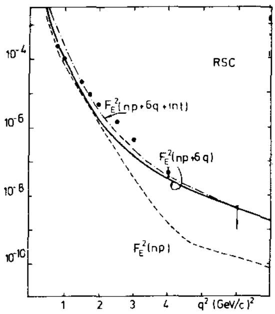

Fig. 5.

The electric-form-factor calculations /16/ for the deuteron. The dashed line - the relativistic calculation without 6q admixture, the solid line - with 6q but without interference term, the dash-dotted line - with the interfe rence term.

5. Deep Inelastic Scattering on Nuclei

Residual nuclear interactions form the couples of nucleons (something like deuterons) inside nuclei.The probability for these pairs to exist in the nucleus is proportional to its atomic number A (at large A. (It can be estimated using the fluctuation formula (2), where the short-range correlation volume V_ξ should be replaced by the long-range one V_0 with the mean nucleon-nucleon distances in a nucleus r_0 , i.e.,$V_0 = \frac{4}{3}\pi r_0^3$). Then, at small distances between nucleons in a nucleus couples will reveal themselves as 6q-systems with the probability $P_A(6q) \approx \frac{V_\xi}{V_0}$ (For 9q-systems it is $(V_\xi/V_0)^2$ and so on). As a result, the total probability to find a 6q-system in a nucleus is $\approx A \cdot P_A$.

So, the deep inelastic cross section on a nucleus that is suggested to have both the usual nucleon and additional 6q-phases will consist of two terms. In the case of small scattering angles of leptons the first nucleon term is as follows

$$\frac{d^2\sigma}{dQ^2 dx} = A \, \frac{4\pi\alpha^2}{Q^4} \cdot \frac{F_2^N(x)}{x},$$

where the nucleon Bjorken scale variable $x = \frac{Q^2}{2M\nu}$, M is the nucleon mass, Q^2 and $\nu = E - E'$ are the four-momentum and energy transfers. $F_2^N(x)$ is the corresponding structure function that characterizes the momentum distribution of quark-partons in a nucleon. The second term is the deep inelastic cross section on a 6q-system having the mass approximately twice that of a nucleon $M_D \approx 2M$:

$$\frac{d^2\sigma}{dQ^2 dx_D} = A \, P_A \, \frac{4\pi\alpha^2}{Q^4} \cdot \frac{F_2^f(x)}{x} .$$

Here the corresponding Bjorken variable is $x_D = \frac{Q^2}{2M_D\nu} = \frac{1}{2}x$, and $x = 2x_D$, so that now x is changed in the interval $1 \leq x \leq 2$ (since $x_D \leq 1$). The total cross section on a nucleus with allowing for a renormalization is in the form:

$$\frac{1}{A}\frac{d^2\sigma}{dQ^2dx} = \frac{4\pi\alpha^2}{Q^4} F_2^A(x) ,$$

where the nuclear structure function is [21]

$$F_2^A = (1-P_A)F_2^N(x) + P_A F_2^f(x) + F_A^\pi(x) . \tag{18}$$

Here there is also the mesonic structure function F_A^π , since a nucleus contains the virtual mesonic fields which may contribute to deep inelastic scattering. The kinematical region, where mesons influence the total cross section, is the one of comparably small x because of the small mass of pions: $x_\pi = \frac{Q^2}{2M_\pi\nu} \leq 1$ and we get for $x = \frac{Q^2}{2M\nu} = \frac{M_\pi}{M}x_\pi \lesssim$ 0.15. Really the limit 0.15 is smoothed because of the momentum dependence of mesons in nuclei. The number of virtual mesons n_A^π is known, in principle, from the modern nuclear models (see, e.g.,ref.[22]) and depends on the so-called critical nuclear density parameter ρ_c characterizing the point of the phase transition from nuclear matter to the mesonic condense phase. The critical ρ_c is expected to be several times as large as the normal nuclear density ρ_0 . Also, the theory says that the heavy nuclei have an excess of the pion field as compared with the light nuclei, and this brings hopes to understand the enhancement at small x of the iron structure function in comparison with the deuteron one[21,23].

Below we present the results of calculations of the nuclear structure functions following ref.[21] where both the small and large x regions have been considered within a unified model dealing with nucleons, mesons, and multiquarks in nuclei.

In the standard valence quark model one can write the nucleon structure function

$$F_2^N(x) = \frac{1}{2}(F_2^p + F_2^n) = \frac{5}{18}(x\,u_\nu(x) + x\,d_\nu(x)) + \frac{12}{9}x\,u_s$$

and the 6q-state function:

$$F_2^f(x) = \frac{5}{18}\left[\frac{x}{2}u_\nu^f\left(\frac{x}{2}\right)\right] + \frac{6}{9}\left[\frac{x}{2}u_s^f\left(\frac{x}{2}\right)\right].$$

The parameters of the quark distribution function in F_q^{N} are chosen to describe the deep inelastic μD-scattering. (For a deuteron the pion field has been neglected so that the corresponding nucleon structure functions have a meaning of the effective ones). The parameters for the 6q-system were obtained from the conditions: $\langle u_v^f \rangle = 3$ - the conservation of the baryon number, and also $\langle x q^D(x) \rangle = \langle x q^A(x) \rangle$, where the distribution function for quarks in a nucleus q^A is represented as a composition of the corresponding functions for nucleons, mesons, and 6q-systems. This latter condition assumes the momentum conservation of quarks and it means that the presence of virtual pions makes the mean quark momentum in the nuclear nucleons somewhat smaller than that for the free nucleon. It is to be noted that just this condition makes it possible to get a miminum at $x \sim 0.3$ with a value smaller than unity for the ratio of the iron and deuteron structure function observed by the EMS-collaboration /15/ (see fig. 6).

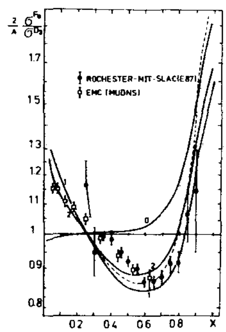

Fig. 6.

The calculations are from ref. /21/. Curves 1,2 - $P_A/P_D = 2.0$ and dashed line - $P_A/P_D = 2.3$. The other notation see in the text.

All parameters are tabulated for the deuteron as follows/21/

for the valence quark distribution

	u_v	d_v	u_v^f	d_v^f
γ_v	3	4	7	11
C_v	2.25	1.55	4.6	0.23

for the *sea* quark distribution

	u_s	u_s^f
γ_s	7	11
C_s	0.15	0.23

Curve 0 in Fig. 6 shows the EMS-effect calculated without meson contributions in (18); curve 1 is for $\rho_c = 3.9\rho_0$ (excess of pions per one nucleon in the A -nucleus is $\delta n_A^{\pi} = 0.83$); curve 2 is for $\rho_c = 4.2\rho_0$ ($\delta n_A^{\pi} = 0.63$). The 6q-contribution for the deuteron was taken as $P_D = 0.07$ and for an A -nucleus $P_A = 2.3\, P_D$ .The corresponding absolute values of cross sections are shown in Fig. 7 (case $\rho_c = 3.9\rho_o$).

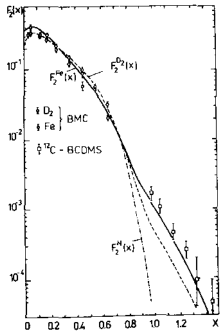

Fig. 7.
Calculations[21] and the comparison with experiment of the structure function of a heavy nucleus (solid line) and the deuteron (dashed line). Experiment •, o from[15], □ - from [13].

Thus, the increase of the ratio R in the cumulative region $X \gtrsim 1$ is due to the 6q-admixtures in nuclei. The increase at small $X \lesssim 0.2$ is due to the pion fields which are enhanced in heavy nuclei (this is a pure nuclear effect). The prediction of the deuteron and nuclear-structure-function behaviour at large X is very important to be checked out by the corresponding measurements of deep inelastic scattering.

6. Conclusion

It seems, we should introduce the "true" (bag-type) multiquark systems and consider a nucleus as a system of nucleons and small admixtures of MQS appearing at the moment when nucleons overlap at small distances. They are necessary to explain the main features of hadron- and lepton-nuclear processes at high energies and momentum transfers (cumulative reactions, form factors, deep inelastic scattering). The magnitude of MQS-admixtures is of an order of several per cent for nuclei in the ground states and increases with the excitation energy. Probably there exist the pure 6q-states (dibaryons) at the total energy about and higher than 2.2-2.3 GeV. Many questions around MQS are of interest and are now investigated very extensively: their radial shape, energy and other-quantum-number states, the quark distributions (structure functions of nuclei, their A -dependence), and so on. We hope that the study of these questions will be very useful for understanding backgrounds of both the nuclear and elementary particle physics.

References

1. Blokhintsev D.I.. Zh.Eksp. Teor.Fiz.,1957, 33, p. 1295 (Sov. Phys. JETP, 1958, 6, p. 995).
2. Azhgirei L.S. et al. Zh. Eksp. Teor.Fiz., 1958, 33, p. 1185 (Sov. Phys. JETP,1958, 5, p. 911).
3. Baldin A.M. Brief Communication on Physics, Acad. of Sci. of the USSR, 1971, p. 1.
4. Burov V.V., Lukyanov V.K., and Titov A.I. In: Proc. Int. Conf. on Selected Topics in Nucl.Structure, v. 2, Dubna, 1976; JINR, D-9920, p. 432, Dubna, 1976.
   Efremov A.V. Yad.Fiz. (Journ. of Nucl.Phys.), 1976, 24, p. 1208.
5. Matveev V.A., Muradyan R.M., Tavkhelidze A.N. Nuovo Cim.Lett., 1973, 7, p. 719;
   Brodsky S.J. and Farrar G.R. Phys.Rev.Lett.,1973, 31, p. 1153.
6. Burov V.V. et al. Yad.Fiz.,1978, 28, p. 321. (Sov. J. Nucl.Phys. 1978, 28, p. 162).
7. Matveev V.A., Sorba P. Nuovo Cim.Lett.,1977, 20, p. 145.
8. Kamae T. In:Proc. ICOHEPANS, Versailles, France, 1981, p. 25.
9. Baldin A.M. In: Proc. CERN-JINR School of Physics, Hondo (Finland) 1981.
10. Baldin A.M. et al. JINR, E1-82-472, Dubna, 1982.
11. Baldin A.M. JINR, E2-83-415, Dubna, 1983.
12. Schutz W.P. et al. Phys.Rev.Lett.,1977, 38, p. 259;
    Day D. et al. Phys.Rev.Lett.,1979, 43, p. 1143.
13. Savin I.A.. In: Proc. Int. Seminar on the High Energy Phys. Problem. Dubna, 1981,JINR, D2-81-728, p.233, Dubna, 1981.
14. Baldin A.M.. JINR, E1-80-545, Dubna, 1980.
15. Aubert J.J. et al. Phys.Lett.,1983, 123B, p. 275.
    (See also the SLAC data in: Bodek A. et al. SLAC-PUB-3041, 1983).
16. Burov V.V. et al. Z. fur Phys.,1982, A30, p. 149.
17. Ableev V.G. et al. Nucl.Phys.,1983, A393, p. 491.
18. Dorkin S.M., Lukyanov V.K., Titov A.I. JINR, P2-82-913, Dubna, 1982.
19. Dorkin S.M., Reznik B.L., Titov A.I. Yad.Fiz.,1982, 36, p. 1244.
20. Fujimura K. et al. Progr. Theor.Phys.,1970, 44, p. 193;
    Kizukuri Y. et al. Progr. Theor.Phys.,1980, 64, p. 1478.
21. Titov A.I. JINR, E2-83-460, Dubna, 1983.
22. Bunatyan G.G., Yad.Fiz.,1980, 31, p. 1186;
    Bunatyan G.G., Mishustin I.N. Yad.Fiz.,1982, 36, p. 1121.
23. Ericson M., Thomas A.W. CERN/TH-3553, Geneva, 1983.