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E2-88-140

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THE EMC RATIO AS A FUNCTION OF x, Q^2 IN THE RESCALING MODEL

Submitted to "Physics Letters"

1988

Recent discovery of the EMC-effect has shown an essential difference between the nucleus and nucleon structure functions (SF). To explain the EMC-effect, different schemes have been suggested /2-5/. In the note we will follow the rescaling model /4,5/; the SF of the nuclei A and A' are connected by the relation

$$\frac{1}{A'} F_K^{A'}(x,Q^2) = \frac{1}{A} F_K^{A}\left(x, \xi_{AA'}(Q^2)\cdot Q^2\right).$$

We will get the parametrization for the ratio

$$R^{A'}_{K,A} = \frac{A F_K^{A'}(x,Q^2)}{A' F_K^{A}(x,Q^2)}.$$

Hereafter the index K takes values 2 and 3.

We use the parametrization obtained by Lopeo and Yndurain /6,7/ for the nucleon SF by analysing its behaviour for $x \approx 0$ and $x \approx 1$.

The rescaling idea: the confinement radius λ_A depends on the nucleus type (that is, on A). Hence there appears the A-dependence of scale μ_A^2 of the Q^2-evolution of the SF moments /4,5/:

$$\bar{\alpha}\left(\xi_{AA'}(Q^2)\cdot Q^2\right) = \frac{\bar{\alpha}(\mu_A^2)}{\bar{\alpha}(\mu_{A'}^2)}\,\bar{\alpha}(Q^2),$$

where

$$\bar{\alpha} = \frac{g^2}{16\pi^2} \quad \text{and} \quad \frac{\mu_{A'}^2}{\mu_A^2} = \frac{\lambda_A^2}{\lambda_{A'}^2}.$$

The ratios of the confinement radii are given in paper /5/.

1. <u>The regions $x \to 1$</u>. The SF are in detail given in paper /6,7/. We consider their ratio $R^{A'}_{K,A}$. We get

$$R^{A'}_{K,A} \underset{x\to 1}{=\!=} \left[\frac{\bar{\alpha}(\mu_A^2)}{\bar{\alpha}(\mu_{A'}^2)}\right]^{-d_0} \frac{\Gamma\left(1+\nu(\bar{\alpha})\right)(1-x)^{-\frac{4C_F}{\beta_0}\ln\frac{\bar{\alpha}(\mu_A^2)}{\bar{\alpha}(\mu_{A'}^2)}}}{\Gamma\left(1+\nu(\bar{\alpha})-\frac{4C_F}{\beta_0}\ln\frac{\bar{\alpha}(\mu_A^2)}{\bar{\alpha}(\mu_{A'}^2)}\right)}, \quad (1)$$

where $\nu(\bar{\alpha}) = \nu_0 - \frac{4C_F}{\beta_0}\ln\bar{\alpha}(Q^2)$, $d_0 = \frac{4C_F}{\beta_0}\left(\frac{3}{4}-\gamma\right)$
and γ is the Euler constant.

Since $\left|1-\bar{\alpha}(\mu_{A'}^2)/\bar{\alpha}(\mu_A^2)\right| \ll 1$, expression (1) can be rewritten in the form

$$R^{A'}_{K,A} = \left[\frac{\bar{\alpha}(\mu_A^2)}{\bar{\alpha}(\mu_{A'}^2)}\right]^{d_x(\bar{\alpha})}, \quad (2)$$

where

$$d_x(\bar{\alpha}) = \frac{4C_F}{\beta_0}\left(\ln\frac{1}{1-x} + \psi\left(1+\nu(\bar{\alpha})\right) + \gamma - \frac{3}{4}\right).$$

2. <u>The region $x \to 0$</u>. The ratios of SF $R^{A'}_{K,A}$ have the form /6,7/:

$$R^{A'}_{3,A} \underset{x\to 0}{=\!=} \left[\frac{\bar{\alpha}(\mu_A^2)}{\bar{\alpha}(\mu_{A'}^2)}\right]^{-d_\lambda^{NS}}$$

$$R^{A'}_{2,A} \underset{x\to 0}{=\!=} \left[\frac{\bar{\alpha}(\mu_A^2)}{\bar{\alpha}(\mu_{A'}^2)}\right]^{-d^+_{\lambda_S}} \left\{1 + \frac{A_{NS}}{A_S}\left(d^+_{\lambda_S} - d^{NS}_\lambda\right)\ln\frac{\bar{\alpha}(\mu_{A'}^2)}{\bar{\alpha}(\mu_A^2)}\cdot \left[\alpha(Q^2)\right]^{\left(d^+_{\lambda_S}-d^{NS}_\lambda\right)} x^{(\lambda_S-\lambda)}\right\} \approx \left[\frac{\bar{\alpha}(\mu_A^2)}{\bar{\alpha}(\mu_{A'}^2)}\right]^{-d^+_{\lambda_S}}, \quad (3)$$

where $d_\lambda^{NS} = -\frac{\gamma_\lambda^{NS}}{2\beta_0}$, $d^+_{\lambda_S} = -\frac{\gamma^+_{\lambda_S}}{2\beta_0}$.

Expression (3) contains the anomalous dimensions γ_λ^{NS} and $\gamma^+_{\lambda_S}$ obtained by analytical continuation from integer values of the argument n (as for the moments) to the region of noninteger values of λ and λ_S (see /7/). The values of λ, λ_S and ν_0 are fixed from the experimental data /8/ and Regge theory /6/. We use $\lambda = 0.5$; $\lambda_S = 1.6$; $\nu_0 = 0.47$. Respectively, we get $\gamma_\lambda^{NS} = -8.556$, $\gamma^+_{\lambda_S} = -9.718$.

3. To find the $R^{A'}_{K,A}$ parametrization in the whole region of x, we must connect the solutions (2) and (3). We do this as follows:

$$R^{A'}_{3,A} = \left[\frac{\bar{\alpha}(\mu_A^2)}{\bar{\alpha}(\mu_{A'}^2)}\right]^{-d^{NS}_{\lambda}} (1-x^a) + \left[\frac{\bar{\alpha}(\mu_A^2)}{\bar{\alpha}(\mu_{A'}^2)}\right]^{d_x(\bar{\alpha})} \cdot x^b$$

$$R^{A'}_{2,A} = \left[\frac{\bar{\alpha}(\mu_A^2)}{\bar{\alpha}(\mu_{A'}^2)}\right]^{-d^{+}_{\lambda_S}} (1-x^a) + \left[\frac{\bar{\alpha}(\mu_A^2)}{\bar{\alpha}(\mu_{A'}^2)}\right]^{d_x(\bar{\alpha})} \cdot x^b. \qquad (4)$$

The parameters a and b are determined by the conditions:
1. The parametrization of a straight line must be a straight line. Hence, a=b.
2. $R^{A'}_{K,A} = 1$ for $x \approx 0.18$. This conformity follows from the analysis of data /9-13/ and from the behaviour of the ratio calculated numerically /5/. Hence, a=0.5.

Using the relation for the coupling constants to the leading perturbation order:

$$\frac{\bar{\alpha}(\mu_A^2)}{\bar{\alpha}(\mu_{A'}^2)} = 1 + \beta_0 \bar{\alpha}(\mu_A^2) \ln \frac{\mu_{A'}^2}{\mu_A^2}$$

we arrive at the final expressions

$$R^{A'}_{3,A} = 1 - \bar{\alpha}(\mu_A^2) \ln \frac{\mu_A}{\mu_{A'}} \left[\gamma^{NS}_{\lambda}(1-\sqrt{x}) + \gamma_x(\bar{\alpha})\sqrt{x}\right] \qquad (5a)$$

$$R^{A'}_{2,A} = 1 - \bar{\alpha}(\mu_A^2) \ln \frac{\mu_A}{\mu_{A'}} \left[\gamma^{+}_{\lambda_S}(1-\sqrt{x}) + \gamma_x(\bar{\alpha})\sqrt{x}\right]. \qquad (5b)$$

Let us compare the expression (5b) with the experimental data /1,9-12/ for $A = Fe$ (Fig.1). The values λ_{Fe}/λ_1 =1.153 and μ_1^2=0.5 GeV^2 are presented in paper /5/. We conclude that the SF of the nucleon and deuteron are the same /4,5/. The value of the QCD parameter is chosen to be Λ = 210 MeV /14/. Note that the SLAC data /12/ are taken from the experiment on a copper target.

One can see that the parametrization (5b) agrees well with the data of different groups for $0.2 \leq x \leq 0.7$; the data are obtained in large range of Q^2; the Q^2 dependence of parametrization (3) is extremely weak. It is twice logarithmic and it is an argument of the Ψ-function. This behaviour of the ratio $R^A_{2,D}$ has been observed in the experiment (see Fig.2 in paper /9/).

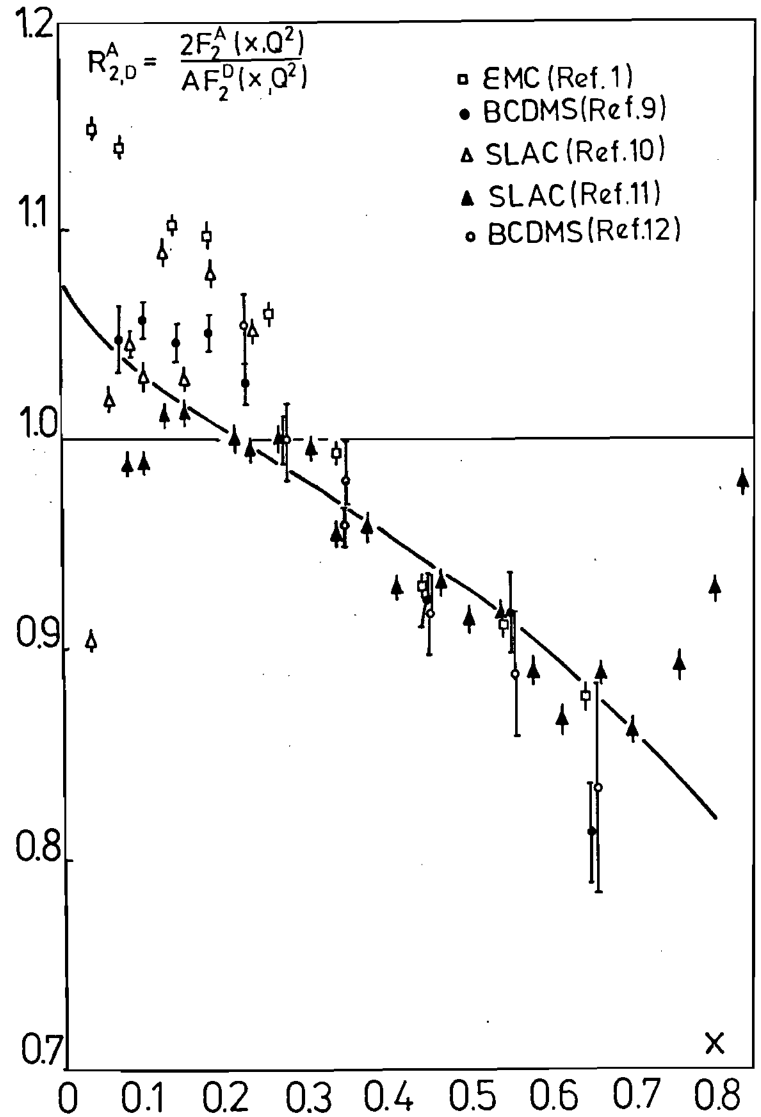

Fig.1. Comparison of the parametrization $R^{Fe}_{2,D}$ with the experimental data of groups /1,9-12/. The data of groups /9,12/ (of groups /1,10,11/) are given only with statistical errors (without errors). The SLAC data /12/ are obtained on the copper target.

The author is grateful to A.V.Efremov and D.I.Kazakov for permanent interest of the work and numerous discussions and A.V.Radjushkin and V.T.Kim for useful remarks as well.

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Received by Publishing Department
on February 26, 1988.

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Поведение ЕМС отношения как функции x, Q^2 в модели рескейлинга

Мы рассмотрели поведение отношения $R^{A'}_{K,A} = \frac{AF^{A'}_K(x,Q^2)}{A'F^A_K(x,Q^2)}$ ($K=2,3$) при $x \to 0,1$ в модели рескейлинга. Мы построили простую параметризацию для $R^{A'}_{K,A}$, совместную с поведением в точках $x \simeq 0,1$. Параметризация крайне слабо зависит от Q^2 и хорошо согласуется с экспериментальными данными в области $0,2 \leq x \leq 0,7$.

Работа выполнена в Лаборатории теоретической физики ОИЯИ.

Препринт Объединенного института ядерных исследований. Дубна 1988

Kotikov A.V. E2-88-140

The EMC Ratio as a Function of x, Q^2 in the Rescaling Model

We consider the ratio $R^{A'}_{K,A} = \frac{AF^{A'}_K(x,Q^2)}{A'F^A_K(x,Q^2)}$ ($K = 2,3$) as $x \to 0,1$ in the rescaling model. We propose a simple parametrization for $R^{A'}_{K,A}$ compatible with its behaviour at $x \simeq 0,1$; the parametrization slightly depends on Q^2 and well agrees with experimental data in the region $0.2 \leq x \leq 0.7$.

The investigation has been performed at the Laboratory of Theoretical Physics, JINR.

Preprint of the Joint Institute for Nuclear Research. Dubna 1988