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The spin dependent EMC effect

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The measurement of the ratio

$$R^A(x) = \frac{\frac{1}{A}F_2^A(x)}{\frac{1}{2}F_2^D(x)} \tag{1}$$

for A = 56 by the EMC group[1] and later for other elements[2] provoked many theoretical speculations[3], how to explain the deviation of $R^A(x)$ from unity (the EMC effect), the deviation which persists to the highest momentum transfers Q^2. Many proposed models describe correctly the x- and A-dependence, although they start from different physical assumptions. It is therefore hard to tell which is the underlying dynamics of the EMC effect. In the search for such distinctive test we propose the measurement of the 'polarized' EMC ratio $R_\uparrow^A(x)$ defined as the ratio of the spin dependent structure functions of a nucleon inside nucleus $g_1^A(x)$ and a free one $g_1^N(x)$

$$R_\uparrow^A(x) = \frac{g_1^A(x)}{g_1^N(x)} \tag{2}$$

These functions are measured directly in the deep inelastic scattering of polarized electrons on polarized targets. In the scaling limit they possess a simple parton interpretation

$$g_1(x) = \frac{1}{2}\sum_i e_i^2\left[q_+^i(x) - q_-^i(x)\right] = \frac{1}{2}\sum_i e_i^2 \Delta q^i(x)$$

where the sum runs over all hadron constituents of charge e_i and + (-) denotes helicity parallel (antiparallel) to the hadron helicity.

In this paper we present the calculation of the ratio $R_\uparrow^A(x)$ in the model with Δ isobars and pions which was checked to work in the standard EMC effect[4] (Fig. 1). The structure function $h^A(x)$ of a nucleon inside the nucleus ($h^A(x) = F_2^A(x)$ or $g_1^A(x)$) is given by

$$h^A(x) = \sum_{c=N,\Delta,\pi} \int_x^A dy\, f^c(y)\, h^c\left(\frac{x}{y}\right)$$

where $h^c(z)$ is the structure function of hadron c and $f^c(y)$ is the distribution of hadrons c inside the nucleus. The functions $f^c(y)$ are known for the nucleons and Δ isobars (the Fermi motion) or can be calculated phenomenologically for the pions[5]. The structure functions $F_2(x)$ are either accessible experimentally (for the nucleons and pions) or constructed phenomenologically[6]. The spin dependent structure functions $g_1^c(x)$ are obtained from $F_2^c(x)$ with the use of the Carlitz-Kaur model[7]. As compared to the standard EMC effect, no new parameters appear in the ratio $R_\uparrow^A(x)$. In Fig. 2 we present an example calculation[8] for ^{7}Li

$$R_\uparrow^7(x) = \frac{g_1^{Li}(x)}{g_1^P(x)}$$

Our result is given by the shaded area because of the uncertainties in the determination of $f^\pi(y)$. One sees that the 'polarized' EMC effect is nontrivial. It is even stronger than the standard one which is due to the fact that in ^{7}Li it is the 'valence' proton which gets altered. It is interesting to study $R_\uparrow^A(x)$ in other models. In most of them the spin structure has to be introduced ab initio.

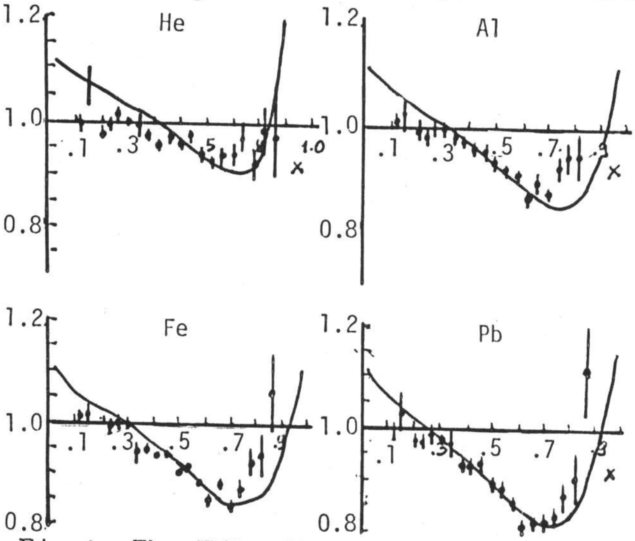

Fig.1. The EMC effect in the $N\Delta\pi$ model.

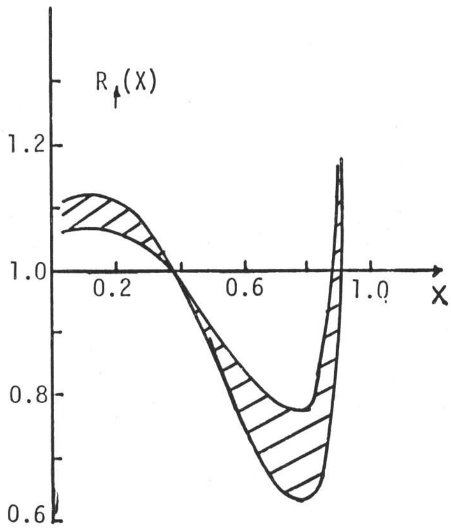

Fig.2. The spin dependent EMC effect in the $N\Delta\pi$ model for ^{7}Li.

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