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A NON CONVENTIONAL TEST OF SCALING VIOLATION IN DEEP INELASTIC SCATTERING

G. Iaselli
Dipartimento di Fisica dell'Università di Bari, and
INFN - Sezione di Bari

ABSTRACT

Scaling violation in deep inelastic scattering can be studied with the help of statistical procedure. The correlation between Q^2 and X as predicted in theoretical models can be, in this approach, easily compared to the experimental scenario.

The comparison between observed scaling violation and theoretical predictions in the deep inelastic scattering neutrino physics has been one of the major tasks of recent high energy experiments.

Such comparison has been carried on essentially by fitting the structure functions Q^2 and X dependence to theoretical analitical parametrizations[(1-4)].

In the framework of QCD theory other approaches have also been used such as the "moment" analysis or the Altarelli Parisi equation resolution[(1,5,6)].

All these approaches require many affords in determining accurately the experimental structure functions and need complex fitting procedures.

A different approach is proposed which directly analyses the X-Q^2 correlation of a data sample, explorating the detection of a definite pattern.

This can be performed using factor-analyting techniques. Classical factor analysis[7] is based fundamentaly on the faith that observed correlations are mainly the result of some underlying regularity in the data.

The strategy in factor analysis is to explore the data reduction possibilities by constructing a set of new variables on the basis of the interrelation exhibited in the data.

In doing so the new variables may be defined as exact mathematical transformation of the original data.

The basis model may be expressed as

$$Z_j = a_{j1}F_1 + a_{j2}F_2 + \cdots + a_{jn}F_n$$

where each of the m observed variables Z_j is described linearly in terms of n new uncorrelated components $F_1 \ldots F_n$ $(n < m)$, and a_{ji} is the standardized multiple regression coefficient of variable j on factor i.

Any correlation between the variables it is assumed to be loaded on the factors F_i, which therefore became an image of the correlation pattern.

The interrelation between X and Q^2 as determined in a given theoretical framework, can therefore be visualized by means of factor score distributions.

We generate via Monte Carlo charged current neutrino event configurations according to Buras-Gaemers QCD parametrizations[8] (sample A), Gluck et al. QCD parametrizations[9] (sample B) and to MQM ideas[4] (sample C).

All the quantities relevant for scaling violation analysis, namely the neutrino energy E, the four momentum Q^2 and the Bjorken variables X and Y, are considered.

The kinematics of the reaction requires that

$$Y = Q^2/2XEM \tag{1}$$

being M the proton mass.

Each sample of events is than analysed through the SPSS package[10]. A number of 3 factor is found to explain all the variance. A composite scale (factor score) is then built for each factor in the final solution.

For each data case a vector of a factor scores $\underline{f}$ is calculated

$$\underline{f} = \underline{F} \cdot \underline{Z}$$

where $\underline{F}$ is the factor score coefficient matrix and $\underline{Z}$ is the vector of standardized values of the variables which have been factor analysed.

At the end the SPSS procedure factor score distributions can therefore be obtained for each data sample. Figures (a-c) show these distributions when only kinematical correlation (1) is taken into account.

In Figs. 2, 3 and 4 distributions, respectively for samples A, B and C are given.

Factor analysis on the first two samples, which where generated according to QCD parametrizations, produce, as expected, factor score distributions very similar to each other.

The corrispondent distributions as extracted by processing sample C show a different pattern.

This approach therefore proves to be suitable to create a simple image of correlations existing in a given set of variables. When a definite theoretical model exists, such that the correlation is numerically fixed, factor analysis enables to make a straighforward comparison between the theoretical scenario and the experimental ones.

This can be achieved very easily by factor analysing the experimental data sample together with the Monte Carlo samples, generated, within a given model, according to the experimental observations.

A direct comparison of factor score distributions permits to answer the question if an observed correlation pattern is described mode or less accurately by the model.

Scaling violation in deep inelastic scattering could therefore be investigate with the help of such method.

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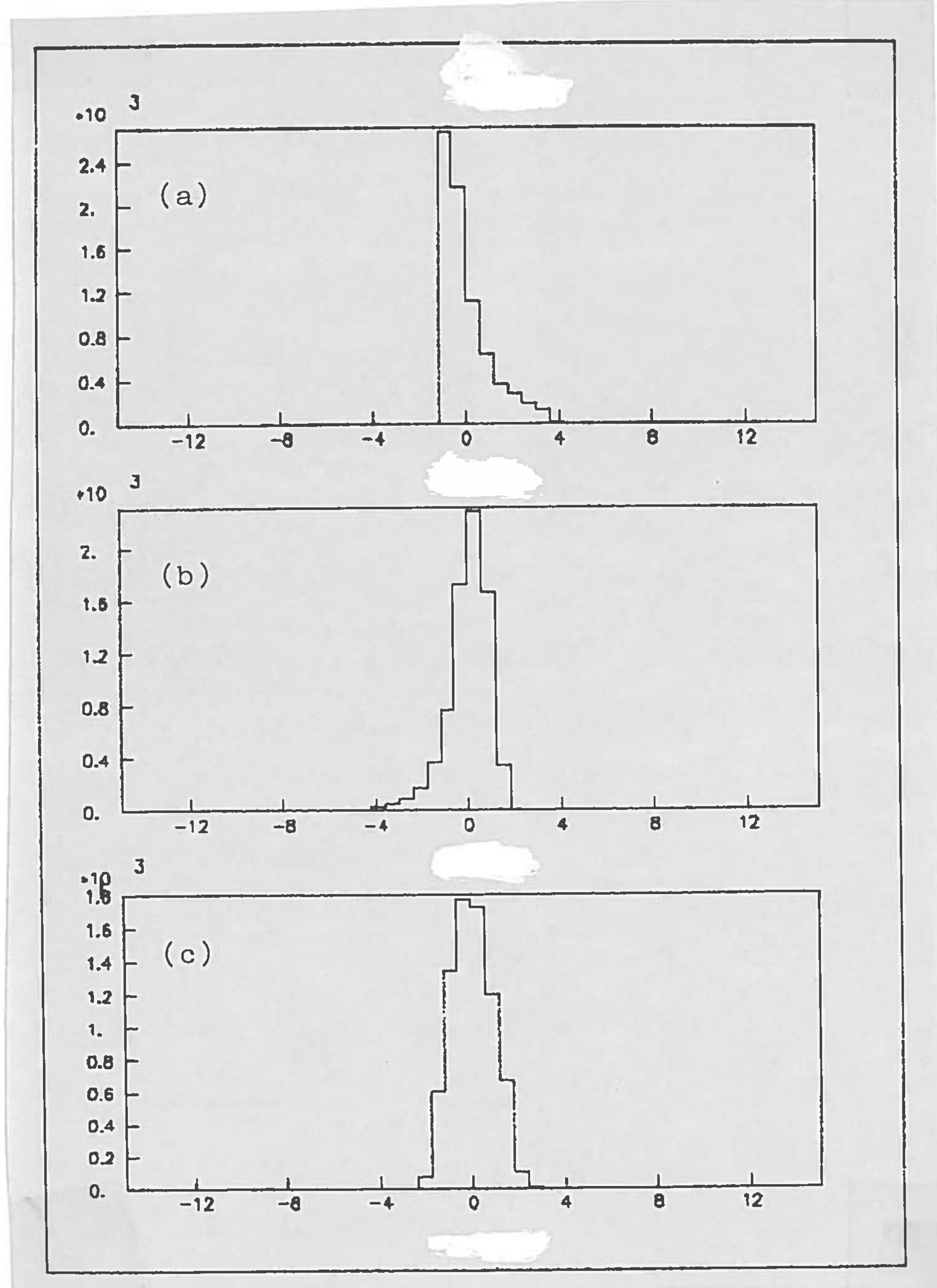

FIG. 1 - Factor score distributions as determined when only the kinematical relation among the variables is considered.

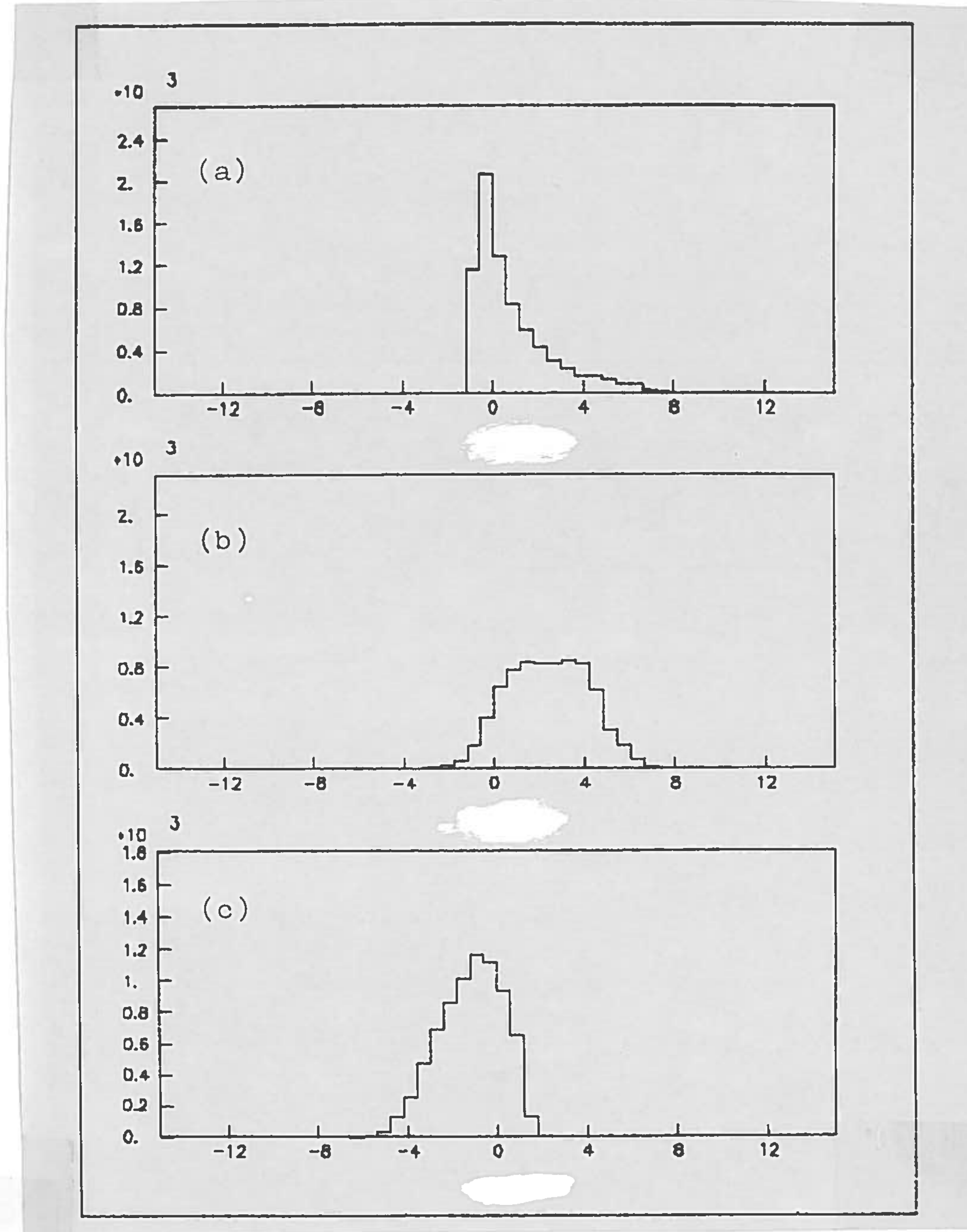

FIG. 2 - Factor score distributions for sample A, generated according to Buras-Gaemers QCD parametrizations.

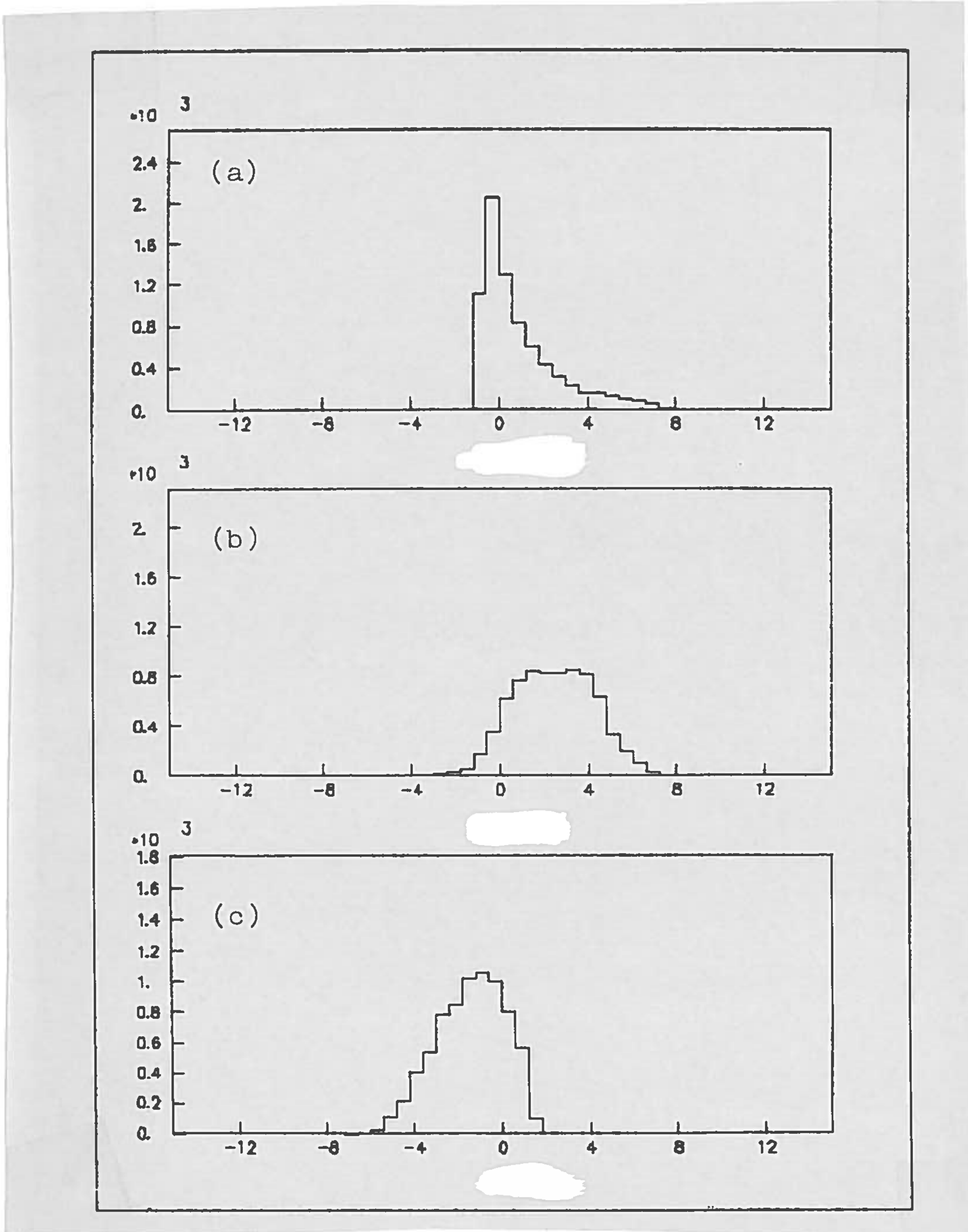

FIG. 3 - Factor score distributions for sample B, generated according to Gluck et al. QCD parametrizations.

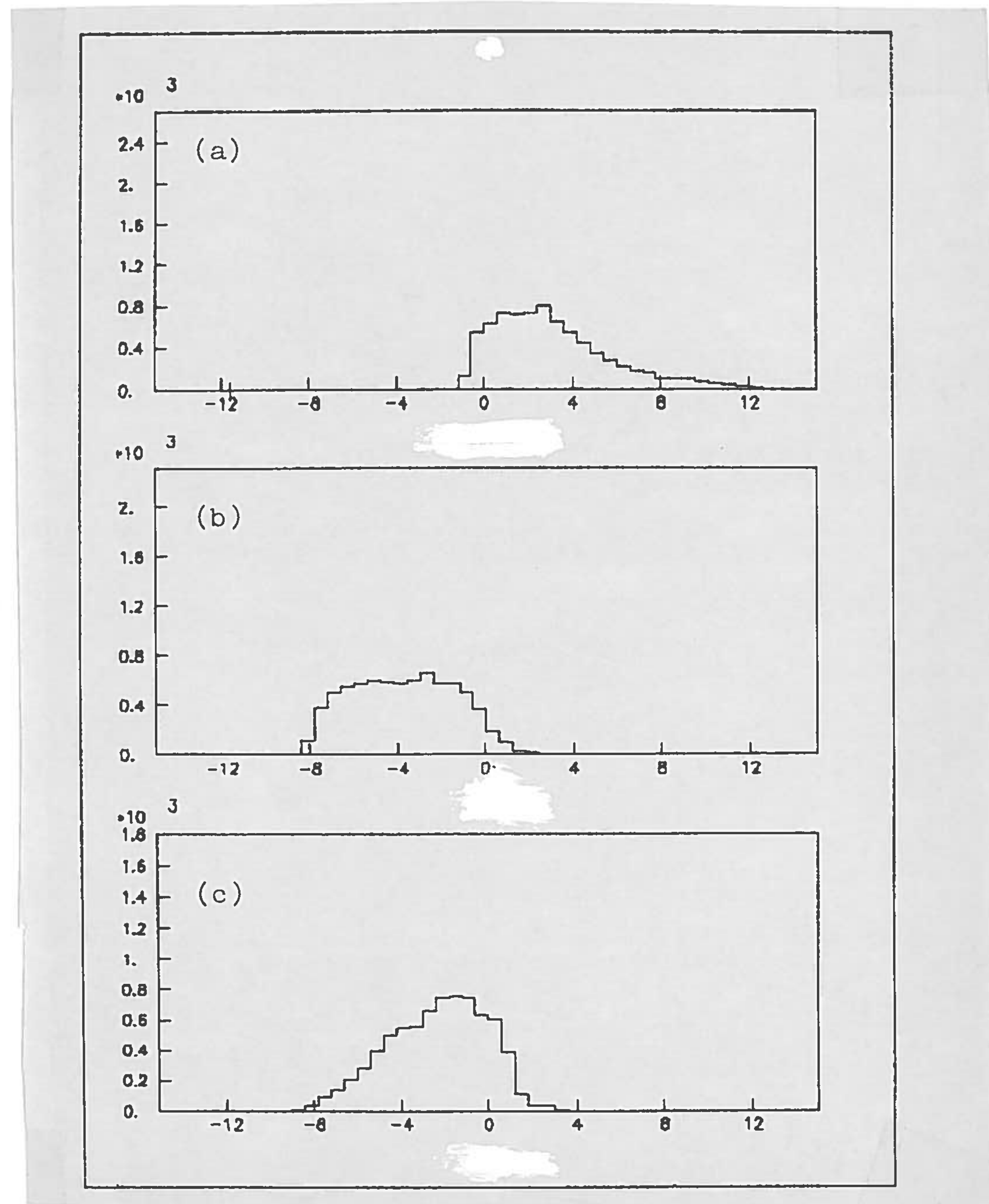

FIG. 4 - Factor score distributions for sample C, generated according to MQM parametrizations.