QCD ANALYSIS OF NEUTRINO CHARGED CURRENT STRUCTURE FUNCTION F_2 IN DEEP INELASTIC SCATTERING

Mohammad Saleem
Centre for High Energy Physics
University of the Punjab
Lahore-20, Pakistan

and

The Institute for Basic Research
96 Prescott Street, Cambridge
Massachusetts 02138
U.S.A.

AND

Fazal-e-Aleem
Centre for High Energy Physics
University of the Punjab
Lahore-20, Pakistan.

ABSTRACT

An analytic expression for the neutrino charged current structure function $F_2(x,Q^2)$ in deep inelastic scattering, consistent with quantum chromodynamics, is proposed. The calculated results are in good agreement with experiment.

1. Introduction. Recently, the CCFRR group[1] has measured the neutrino charged current structure functions. The data were obtained using the Fermilab narrow band beam and the Laboratory E neutrino detector[2-4]. The structure function $F_2(x,Q^2)$ extracted from the neutrino and antineutrino event samples is plotted versus Q^2 in Fig.1.

A number of attempts have been made to fit the data for lepton-nucleon deep inelastic scattering by using QCD. The analyses are based on fitting of Altarelli-Parisi (A-P) equations. For a fixed $Q^2=Q_0^2$, the structure function F_2 is assumed to be of a particular form, so as to give x dependence consistent with experimental data at Q_0^2. The A-P equations are then solved numerically to yield results which are consistent with experiment. The arbitrariness of Q_0^2 is, however, restricted to sufficiently large values of Q_0^2 for which perturbative calculations can be trusted. In this paper, an analytic expression for $F_2(x,Q^2)$, consistent with QCD, is proposed.

2. Calculations and Discussion. According to QCD, the singlet structure function $F_2(x,Q^2)$ and its momenta are related to each other[5] by the equation

$$\int_0^1 x^{n-2}\, F_2^S(x,Q^2)\,dx = \delta_s^2 A_n^S[\ln(Q^2/\Lambda^2)]^{-d_s^n} \qquad (1)$$

The function $F_2(x,Q^2)$ can not be expressed as a product of two functions, one depending upon x only and the other depending upon Q^2 alone, because then the function of Q^2 alone as evaluated by using left hand side of equation(1) would be independent of n. This is not valid because right hand side of equation(1) depends upon n. To incorporate this n dependence, we assume that

$$F_2(x,Q^2) = A(1-x)e^{-ax}$$

where $$a = [\ln(Q^2/\Lambda^2)]^{0.747}$$

For large value of Q^2, this expression when substituted in equation(1) gives results which are consistent with QCD.

A very good agreement with experimental data for $Q^2>5$ $(GeV/c)^2$ is obtained by using $A=2$, $\Lambda=0.5GeV/c$.

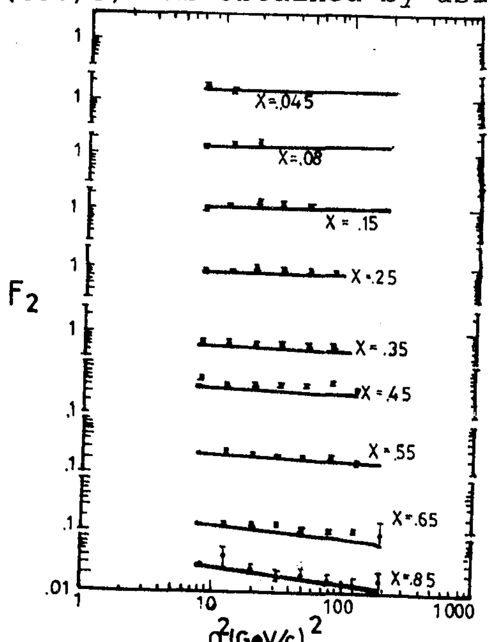

Fig.1 The structure function F_2 extracted from the CCFRR data versus Q^2 for fixed values of x. The solid curves represent the predictions of the model described in the text.

Fig.1 shows experimental data as well as theoretical predictions for $F_2(x,Q^2)$ plotted against Q^2 at fixed values of x. The agreement is quite satisfactory and confirms our assumption about the form of $F_2(x,Q^2)$.

3. Conclusion. Quantum chromodynamics is now believed to be the promising theory of strong interactions. The perturbative calculations of cross sections for deep inelastic scattering based on QCD are confirmed experimentally. However, numerical integration has to be performed to obtain various results. We have proposed a simple analytic expression for the structure function $F_2(x,Q^2)$. This expression yields results which are consistent with experiment.

4. Acknowledgement. The financial assistance from the Pakistan Science Foundation under contract No.P-PU/Phys(11/2) is gratefully acknowledged.

References

1. R.E.Blair et al., Preprint UR-831, COO-3065-339(1983).
2. P.Rapidis et al., Proceedings of the Summer Institute on Particle Physics, ed. A.Mosher, p.641, SLAC, Standford, California (1982).
3. R.Blair, Total Cross Section and -Distribution Measurements for Muon-Type Neutrinos and Antineutrinos in Iron, Ph.D. Thesis(1982), California Institute of Technology, Pasadena, California.
4. J.Lee, Measurements of $\nu_\mu N$ Charged Current Cross Sections from E_ν=25 GeV to E_ν=360 GeV, Ph.D. Thesis(1980), California Institute of Technology, Pasadena, California.
5. A.J.Buras, Rev.Mod.Phys.52, (1980)199.