Nuclear Physics A532 (1991) 359c–364c
North-Holland, Amsterdam

NUCLEAR
PHYSICS A

DIQUARKS AND $R=\sigma_L/\sigma_T$

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Abstract

The diquark contribution to the proton - proton scattering at high p_T was measured by SFM collaboration [1] . In the following the SFM result is used to predict the diquark contribution to $R=\sigma_L/\sigma_T$ measured in the deep inelastic lepton scattering. It is pointed out that spin=0 diquarks contribute to $R^D - R^p$ and to $R^e - R^\nu$. The SFM result is compatible with the deep inelastic data, however more precise R measurements are needed for quantative statements about the diquark contribution.

1. INTRODUCTION

The Split Field Magnet collaboration at Intersecting Storage Rings has shown [1] that the p_T dependence of the number of protons produced in pp scattering compared with p_T dependence of the number of produced K^+ and π^+ (p/K^+ . p/π^+) can only be explained by hard scattering of the (ud) diquark. The diquark scattering cross section was parametrized in the following form:

$$\sigma \sim F(Q^2)p(x,Q^2) = \lambda\ [0.5u_v(x,Q2) + d_v(x,Q^2)\ ](1+Q^2/M^2)^{-1} \qquad (1)$$

where :
λ is the probability that u and d quark form the diquark, $u_v(x,Q^2)$, $d_v(x,Q^2)$ are the structure functions of up and down valence quarks in isoscalar target [2] , M is the effective parameter describing the strength of the diquark binding.

SFM data were described correctly by three sets of parameters:

$$a)\ \lambda=0.3,\ M^2 = 20\ GeV^2 \quad b)\ \lambda=0.17\ ,\ M^2 = 10\ GeV^2$$
$$c)\ \lambda=x,\ M^2 = 9\ GeV^2 \qquad (2)$$

0375-9474/91/$03.50

2. DIQUARK CONTRIBUTION TO R

The diquark contribution to deep inelastic structure functions was studied by Close and Roberts [3] and Fredrikson and Jandel [4]. The conclusions of [3] and [4] do not agree, however in both papers it is assumed that there are mainly $(ud)_{I=S=0}$ diquarks in the nucleon. In the following this assumption together with the SFM result is used to predict the diquark contribution to R.

If diquark has spin equal to zero it can absorb only longitudinally polarized bosons (W^{+-}, γ) so it contributes to σ_L and thus to $R=\sigma_L/\sigma_T$. The contribution of diquarks to $F^2 \sim \sigma_L+\sigma_T$ is obscured by the assumptions about R which are usually made to obtain F_2.

The cross section for lepton (l) scattering on diquark (qq):

$$\frac{d^2\sigma^l}{dxdy}_{qq} \sim A^l\, F\, (Q^2)^K\, p(x,Q^2)\, f(y) \tag{3}$$

is the function of:
A^l the lepton diquark coupling constant, $F(Q^2)$ the diquark form factor, $p(x,Q^2)$ probability to find diquark in the nucleon and $f(y)$ angular term depending on the spin of the diquark

The power factor $1 \leq K \leq 2$ depends on the character of lepton-diquark scattering. For purely elastic scattering K=2.

The lepton-diquark coupling constant is equal to the square of charge of the diquark, for charged leptons. For neutral leptons the coupling constant should be proportional to the weak isospin (T) of the diquark. Because W^+ (W^-) acts as weak isospin rising (lowering) operator, the neutrino (antineutrino) diquark coupling constant should be equal to:

$$A^{\nu\ (\bar{\nu})} = (T \mp T_3)(T \pm T_3 + 1) \tag{4}$$

For $(ud)_{I=S=0}$ we have $I=T=T_3=0$ and thus neutrino (antineutrino) <u>does</u> <u>not</u> <u>interact</u> with such a diquark.

Assuming after [3,4] and in agreement with [1] that there are mainly $(ud)_{I=S=0}$ diquarks in the nucleon we may write the diquark contribution to R for charged lepton scattering on isoscalar target (D,Ca,Fe);

$$R^D_{qq} = \frac{1/9\, p(x,Q^2)\, F(Q^2)}{5/18(u + u + d + d)} \tag{5}$$

and for charged lepton scattering on proton target (H_2):

$$R^p_{qq} = \frac{1/9\, p(x,Q^2)\, F(Q^2)}{4/9(u + u) + 1/9\ (d+d)} \tag{6}$$

For neutrino scattering:

$$R_{qq}=0 \tag{7}$$

The contribution to R from gluon radiation (QCD) and target mass corrections (TMC) is the same for neutral and charged leptons and does not depend on isoscalarity of the target. It follows then from the equations (5,6,7) that:

$$R^e > R^\nu \quad \text{and} \quad R^{isoscalar} > R^{proton} \tag{8}$$

3. RESULTS

The diquark contribution to R^e on deuteron calculated from the formula (5) assuming the SFM result on $p(x,Q^2)F(Q^2)$ is shown on Fig. 1.

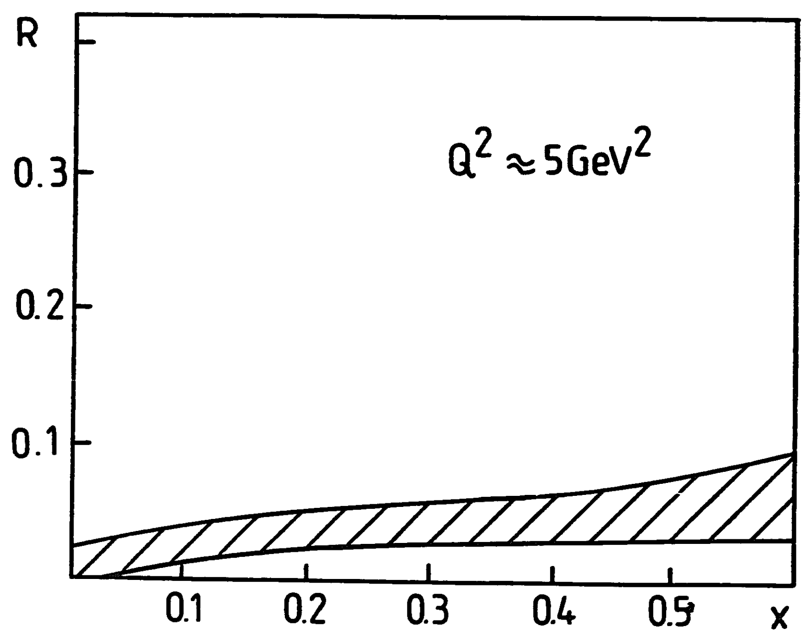

Figure 1. Predicted diquark contribution to R^D in charged lepton scattering. The sketched area is allowed by three sets of parameters (2) describing SFM data.

The diquark contribution to R placed on top of the QCD and TMC contributions is compared with SLAC [5] and CDHSW [6] measurements on Fig. 2.

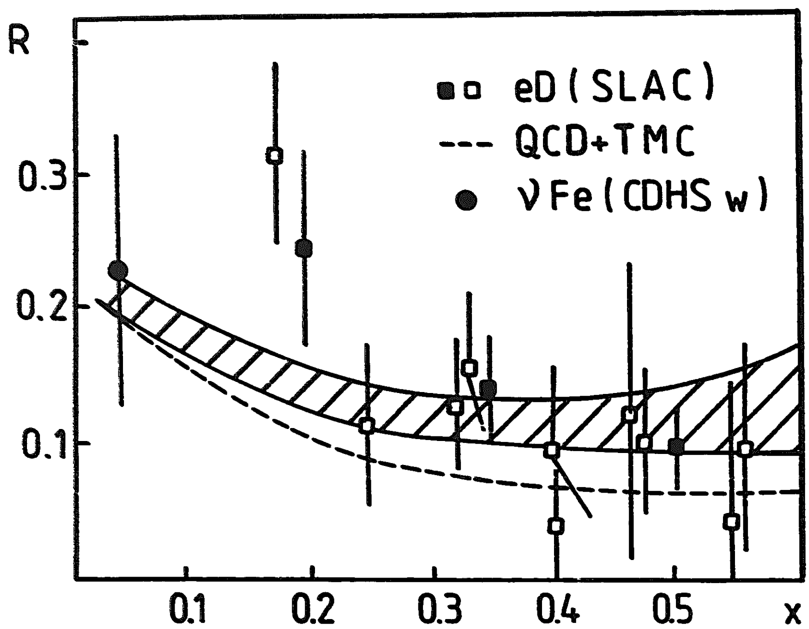

Figure 2. R containing QCD, TMC and diquark contribution compared with the SLAC (eD) and CDHSW (νFe) measurements for Q^2=5 GeV^2. The sketched area corresponds to three sets of parameters (2) describing diquark contribution measured by SFM.

Fig. 3 shows R^D-R^P measured at SLAC compared with the expected diquark contribution. The diquark contribution is compatible with the deep inelastic data, however large errors do not allow for any quantative statement about the diquark structure function. Due to the poor measurement of R^ν no statement about R^e-R^ν is possible.

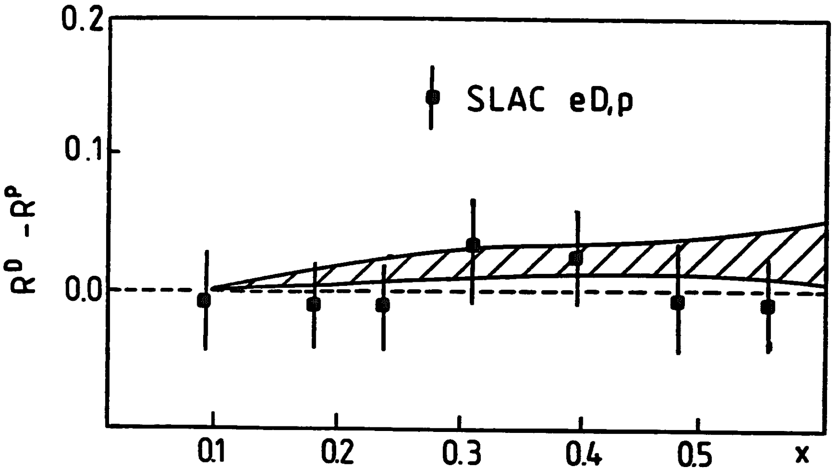

Figure 3. Diquark contribution to R^D-R^p compared with SLAC measurement. The sketched area corresponds to three sets of parameters describing SFM data.

4. CONCLUSIONS

The $(ud)_{I=S=0}$ diquarks contribute to R and particularly to the differences R^D-R^p and R^e-R^ν. The SFM result [1] on the diquark contribution is compatible with the deep inelastic data on R^D and R^D-R^p. More precise data are needed to determine the diquark structure function.

5. REFERENCES

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