MEASUREMENT OF ν AND $\bar{\nu}$ STRUCTURE FUNCTIONS IN HYDROGEN AND IRON

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The CDHS neutrino detector has been used to measure events originating in a tank of liquid hydrogen and in the iron of the detector.

The experiment has been performed in the 400 GeV ν and $\bar{\nu}$ wide-band beams of the CERN SPS. The electronic techniques used give a better measurement of the hadron shower energy than bubble chamber experiments. The $\nu(\bar{\nu})$Fe events in the tank wall are used to determine the total $\nu(\bar{\nu})H_2$ cross-sections with a minimum of systematic uncertainty. Comparison of the tank-wall rates with the iron-module ones permits checks on the systematics of the acceptance.

After kinematical and geometrical selection 4457 νH_2 and 4178 $\bar{\nu}H_2$ charged-current interactions are retained, as well as 2105 νFe and 1075 $\bar{\nu}$Fe interactions produced in the tank wall surrounding the hydrogen target. The iron-module results are based on the analysis of 150,000 antineutrino events.

Results on total cross-sections and quark distributions in the energy range 20 to 320 GeV for νH_2, and 20 to 160 GeV for $\bar{\nu}H_2$ [1] are in agreement with the expectations of the quark-parton model (QPM) as well as quarks (antiquarks) distributions previously observed in $\nu(\bar{\nu})$ scattering in bubble chamber or charged-lepton scattering experiments.

After reconstruction of tank events in the vertex detector (15 MWPCs), muon and hadronic energy in the iron detector, the $\nu(\bar{\nu})H_2$ data in x, y bins are corrected for acceptance and smearing by a Monte Carlo program.

Comparison of iron and hydrogen structure functions

For this comparison H_2 and Fe differential cross-sections have been used in the neutrino energy range 40-160 GeV. The expressions of cross-sections in the QPM are simple at y = 0

$$\frac{d^2\sigma^{\nu Fe}}{dxdy} = \frac{d^2\sigma^{\bar{\nu}Fe}}{dxdy} \propto F_2^{\nu Fe} = q_{Fe} + \bar{q}_{Fe} + q_L^{Fe}$$

$$\frac{d^2}{dxdy}\,(\sigma^{\nu p} + \sigma^{\bar{\nu}p}) \propto \text{"}F_2{}^H 2\text{"} = q_H + \bar{q}_H + q_L^H$$

and at y = 1

$$\frac{d^2\sigma^{\bar{\nu}N}}{dxdy} \propto x(\bar{u} + \bar{d} + 2\bar{s})_{Fe} \qquad \frac{d^2\sigma^{\bar{\nu}p}}{dxdy} \propto 2x\,(\bar{d} + \bar{s})_H$$

The extrapolations take into account the Q^2 evolution and the presence of longitudinal (q_L) structure functions.

1) The ratio of F_2^{Fe}/"$F_2^H 2$" (Fig. 1) might be 1 in the absence of the EMC effect.

We do not observe a significant deviation from unity, but given the large experimental uncertainties, the results are not in disagreement with the electron-scattering results. They seem to disagree with the EMC observations at small x; this may be because the neutrino results refer to a smaller Q^2. Systematic uncertainties could not explain the large difference with EMC at x = 0.05.

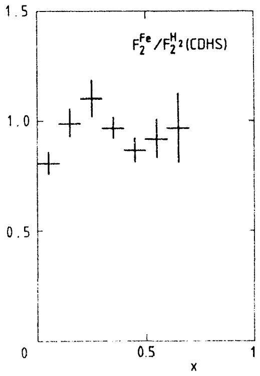

Fig. 1

2) The ratio $\frac{(\bar{u} + \bar{d} + 2\bar{s})_{Fe}}{2\,(\bar{d} + \bar{s})_H}$ (Fig. 2) might be 1 in the absence of the EMC effect and if $\bar{u} = \bar{d}$.

No significant deviation from unity is observed. For the ratio of the integrated seas, we find

$$\int_0^{0.3} xdx[(\overline{u+d})/2 + \bar{s}]_{Fe} \,/\, \int_0^{0.3} xdx(\overline{d+s})_p = 1.10 \pm 0.11 \pm 0.07$$

The EMC result has been discussed by Jaffe [2] who noted that, because of the positive deviation in the region of x in which the contribution to the quark counting sum rule is large, and because the shape of the deviation is similar to the anti-quark sea distributions, one should conclude that the binding effects do not perturb the valence, but rather the sea structure functions. The relative effect on the sea is then much larger, because of the smallness of the sea; an effect of the order of 1.5 - 2 in the ratio sea(Fe)/sea(D_2) is required to understand the EMC data. An effect as large as that expected by Jaffe seems to be excluded.

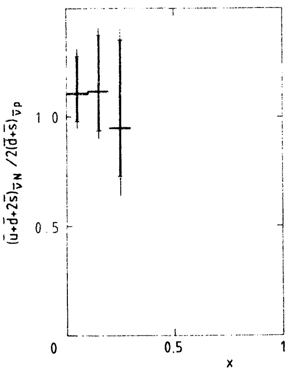

Fig. 2

[1] H. Abramowicz et al., paper 683, preprint CERN-EP/84-57 (Submitted to Z. Phys. C).

[2] R.L. Jaffe, Phys. Rev. Lett. 50 (1983) 228.