$\nu_\mu(\bar{\nu}_\mu)-^{56}$Fe deep inelastic scattering

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Neutrino experiments are run or planned which are aimed precisely to measure neutrino oscillation parameters and for better understanding of the neutrino properties. In most of these experiments nuclear targets are being used where nuclear medium modifications also play an important role. In the energy region of a few GeV a better understanding of medium effects is required. MINERνA [1] is taking data using neutrinos with several nuclear targets like ^{12}C, ^{56}Fe and ^{208}Pb and their aim is to understand the nuclear medium effects. INO [2] is planning to perform experiment with atmospheric neutrinos using iron calorimeters. NuTeV [3] has reported the results on weak charged and neutral current induced (anti)neutrino processes on an iron target in the deep inelastic region.

For the deep inelastic neutrino-nucleus scattering there are only a few calculations where the dynamical origin of the nuclear medium effects has been studied. In this work, we have studied nuclear medium effects on the weak structure functions F_2^A and F_3^A in a theoretical model using spectral function to describe the momentum distribution of nucleons in the nucleus, details are given in Ref.[4]. The effects of Fermi motion and binding energy corrections, pion and rho meson cloud contributions, and shadowing effects have been taken into account. Calculations have been done in a local density approximation using relativistic nuclear spectral functions which include nucleon correlations for nuclear matter. Using the structure functions, we have obtained the differential and total scattering cross sections in iron for $\nu(\bar{\nu})$ induced processes.

In a nuclear medium the expression for the cross section is written as:

$$\frac{d^2\sigma^{\nu(\bar{\nu})A}}{dx_A\, dy_A} = \frac{G_F^2 M_A E_\nu}{\pi}\left(\frac{m_W^2}{Q^2+m_W^2}\right)^2 \left(y_A^2 x_A F_1^{\nu(\bar{\nu})A} + \left\{1 - y_A - \frac{M_A x_A y_A}{2E_\nu}\right\} F_2^{\nu(\bar{\nu})A} \pm x_A y_A \left\{1-\frac{y_A}{2}\right\} F_3^{\nu(\bar{\nu})A}\right) \quad (1)$$

where G_F is the Fermi coupling constant, m_l is the mass of lepton, E_ν is the incident $\nu/\bar{\nu}$ energy, M_A is the mass of nucleus, in F_3^A, +ve(-ve)sign is for $\nu/\bar{\nu}$, $x_A = \frac{Q^2}{2M_A\nu}$ is the Bjorken variable, $y_A = \frac{\nu}{E_\nu}$, ν and q being the energy and momentum transfer of leptons and $Q^2 = -q^2$. We have used Callan-Gross relation $F_2(x) = 2xF_1(x)$.

In Fig.1 and Fig.2, we have presented the results for the differential scattering cross section at some values of x in iron and compared them with the experimental data of NuTeV[3] and CDHSW[5] collaborations. We find that our numerical results are in good agreement with the experimental results at LO and calculations at NLO make results more better. The details of the formalism and results would be presented in the symposium.

References

[1] Talk by David Schmitz at the 7th International Workshop on Neutrino-Nucleus Interactions in the Few-GeV Region

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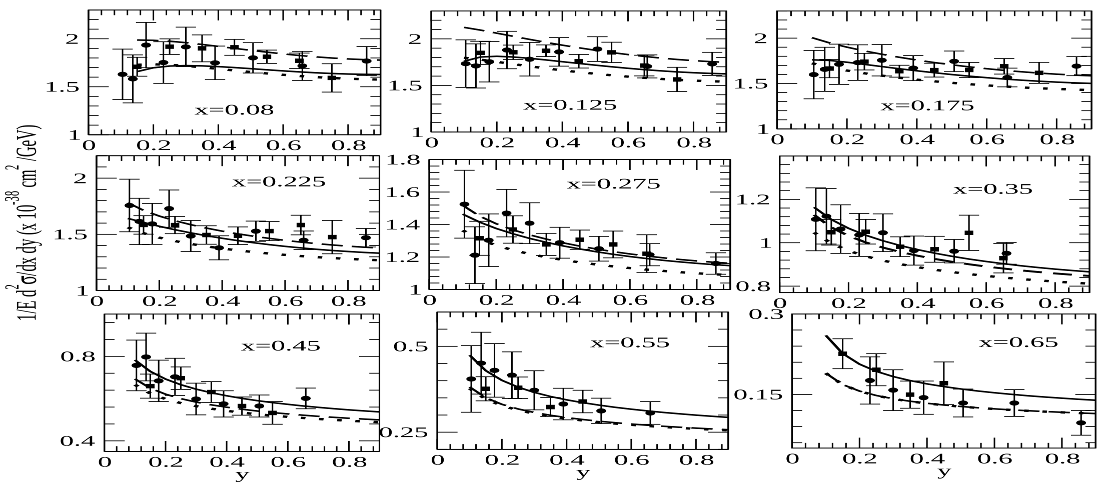

FIG. 1: $\frac{1}{E}\frac{d^2\sigma}{dxdy}$ vs y at different x for $\nu_\mu(E_\nu = 65$ GeV) induced reaction in ^{56}Fe using CTEQ6.6[6] parton distribution functions. Dotted and Dashed lines are the base(Fermi motion and binding energy)[4] and full(including pion and rho cloud contribution, shadowing and anti-shadowing effects)[4] calculations at LO respectively. Solid line is the full calculation at NLO. NuTeV [3] data have been shown by the squares and CDHSW [5] data by the solid circles.

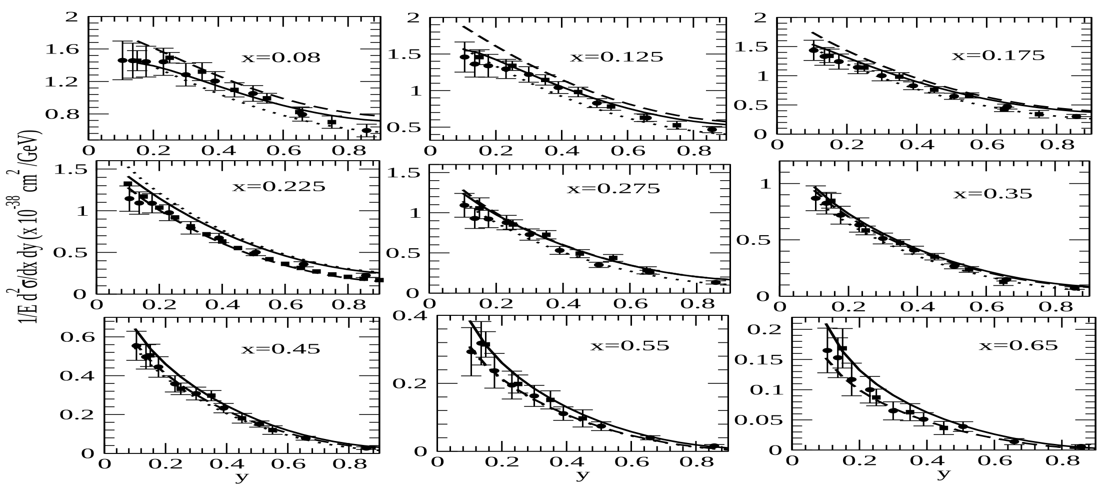

FIG. 2: $\frac{1}{E}\frac{d^2\sigma}{dxdy}$ vs y at different x for $\bar{\nu}_\mu$. Lines has the same meaning as in Fig.1

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