NuInt12 : Eighth International Workshop on Neutrino-Nucleus Interactions in the Few-GeV Region

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Determination of $sin^2\theta_W$ using $\nu(\bar{\nu})$-Nucleus scattering

Friday, 12 September 2014 18:00 (1h 30m)

We shall present the results of our study of non-isoscalarity corrections and nuclear medium effects in the extraction of $sin^2\theta_W$ using Paschos-Wolfenstein(PW) relation.
PW relation for an isoscalar nuclear target is defined as
\begin{eqnarray} \label{ratio_cross}
R_{PW}=\frac{\sigma(\nu_\mu~A \rightarrow \nu_\mu~X)~-~\sigma(\bar\nu_\mu~A \rightarrow \bar\nu_\mu~X)}{\sigma(\nu_\mu~A \rightarrow \mu^-~X)~-~\sigma(\bar\nu_\mu~A \rightarrow \mu^+~X)}=\frac{1}{2}~-~\sin^2 \theta_W
\end{eqnarray}
where $\sigma(\nu_\mu(\bar\nu_\mu)~A \rightarrow \nu_\mu(\bar\nu_\mu)~X)$ is the neutral current induced neutrino(antineutrino) cross section, $\sigma(\nu_\mu(\bar\nu_\mu)~A \rightarrow \mu^-(\mu^+)~X)$ is the charged current induced neutrino(antineutrino) cross section for a Z=N nuclear target A, and θ_W is the Weinberg angle. The above relation is valid for the total as well as differential cross sections.

The differential cross section is expressed in terms of nuclear structure functions. We have studied nuclear medium effects in the structure functions $F_2^A(x,Q^2)$ and $F_3^A(x,Q^2)$
by taking into account Fermi motion, nuclear binding, shadowing and antishadowing corrections and pion and rho meson cloud contribution.
Calculations have been performed in a local density approximations using relativistic nuclear spectral functions which include nucleon correlation.
These structure functions are calculated with target mass correction (TMC) and
CTEQ6.6 parton distribution functions (PDFs) at the Leading-Order (LO).

Summary

NuTeV Collabn. has obtained $sin^2\theta_W$ using iron nuclear target and found $\sin^2\theta_W$ to be 0.2277 ± 0.0004, which is
3 standard deviations above the global fit of $sin^2\theta_W = 0.2227 \pm 0.0004$ and this is known as NuTeV anomaly.
PW relation is valid for an isoscalar target while iron is a nonisoscalar target(N=30,Z=26), therefore, non-isoscalar corrections are required. Furthermore, nuclear dynamics may also play an important role in the case of neutrino nucleus scattering. Various corrections made by the NuTeV Collaboration has been discussed in literature, but still the reported deviation could not be accounted for.

We shall present the result for $sin^2\theta_W$ vs y, at some values of x for (anti)neutrino energy of 80 GeV, for an isoscalar target like carbon as well as nonisoscalar nuclear target like iron.
To see the effect of nonisoscalarity in iron target we use a modified PW relation:
\begin{eqnarray}
R_{PW}=\frac{1}{2}-\sin^{2}\theta_W + \delta R^{NI}
\end{eqnarray}
where δR^{NI} is the correction factor due to nonisoscalarity. We find that there is a nonisoscalarity dependence on the determination of $sin^2\theta_W$ in the different regions of x and y.
We shall also present the results for $sin^2\theta_W$ vs y due to nuclear medium corrections. We shall discuss these results in detail in the workshop.

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