Neutrinos – Part I

Cheng-Ju S. Lin

Lawrence Berkeley National Laboratory

My Brief Intro Talk:

- Address neutrino-related recommendations from the last Advisory Meeting
- Discuss some general outlook

Ramon will discuss issues relating to the neutrino listings and reviews

Recommendation 1:

"We recommend that PDG add a review article to cover accelerator-based neutrino oscillation experiments"

We have a brand new Neutrino review by K. Nakamura and S.T. Petcov. They have expanded the coverage for accelerator-based experiments (Sec 13.5.2 RPP2010, pg. 177). Please review it and let us know if you are satisfied with the content.

where e_q is the charge of the quark. For neutrino scattering with the four-Fermi interaction

$$\frac{d\sigma}{d\Omega}(\nu d \to \ell^- u) = \frac{G_F^2 s}{4\pi^2} , \qquad (40.14)$$

where the Cabibbo angle suppression is ignored. Similarly

$$\frac{d\sigma}{d\Omega}(\nu \overline{u} \to \ell^+ \overline{d}) = \frac{G_F^2 s}{4\pi^2} \frac{(1+\cos\theta)^2}{4} . \qquad (40.15)$$

To obtain the formulae for deep inelastic scattering (presented in more detail in Section 16) we consider quarks of type i carrying a fraction $x = Q^2/(2M\nu)$ of the nucleon's energy, where $\nu = E - E'$ is the energy lost by the lepton in the nucleon rest frame. With $y = \nu/E$ we have the correspondences

$$1 + \cos\theta \to 2(1-y) ,$$

$$d\Omega_{cm} \to 4\pi f_i(x) dx\, dy , \qquad (40.16)$$

where the latter incorporates the quark distribution, $f_i(x)$. In this way we find

$$\frac{d\sigma}{dx\, dy}(eN \to eX) = \frac{4\pi\alpha^2 xs}{Q^4} \frac{1}{2} \left[1 + (1-y)^2\right] \times \left[\frac{4}{9}(u(x) + \overline{u}(x) + \ldots) + \frac{1}{9}(d(x) + \overline{d}(x) + \ldots)\right] \qquad (40.17)$$

where now $s = 2ME$ is the cm energy squared for the electron-nucleon collision and we have suppressed contributions from higher mass quarks.

Similarly,

$$\frac{d\sigma}{dx\, dy}(\nu N \to \ell^- X) = \frac{G_F^2 xs}{\pi} [(d(x) + \ldots) + (1-y)^2 (\overline{u}(x) + \ldots)] \qquad (40.18)$$

and

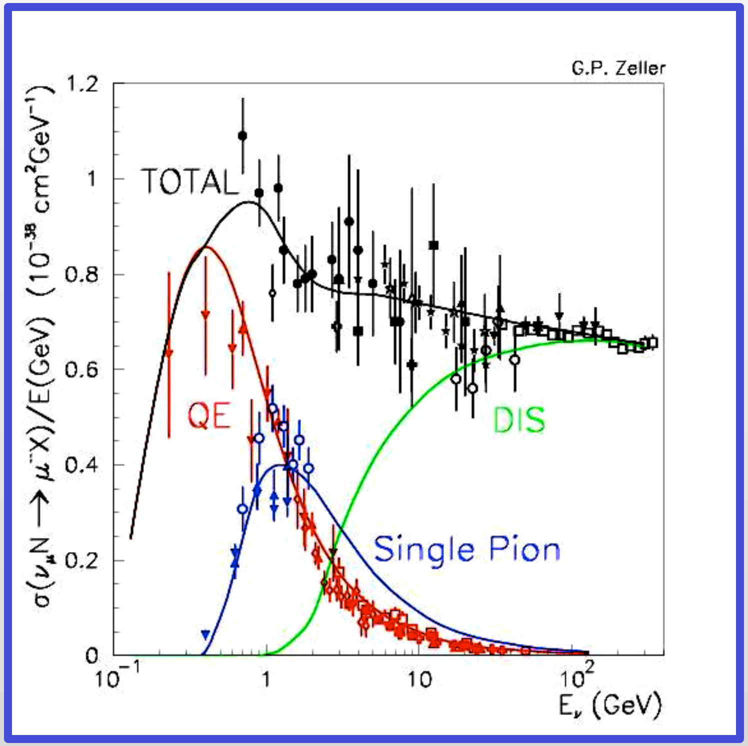
$$\frac{d\sigma}{dx\, dy}(\overline{\nu} N \to \ell^+ X) = \frac{G_F^2 xs}{\pi} [(\overline{d}(x) + \ldots) + (1-y)^2 (u(x) + \ldots)] . \qquad (40.19)$$

Quasi-elastic neutrino scattering ($\nu_\mu n \to \mu^- p$, $\overline{\nu}_\mu p \to \mu^+ n$) is directly related to the crossed reaction, neutron decay. The formula for the differential cross section is presented, for example, in N.J. Baker *et al.*, Phys. Rev. **D23**, 2499 (1981).

Recommendation 2:

"We also recommend that PDG expand its coverage to include neutrino cross section formulae"

We have added the formulas in the "*Cross-section formulae for specific processes*" review



Recommendation 3:

"We also recommend that PDG expand its coverage to include total neutrino cross section measurements at low energies (100-3000 MeV)"

We are working on including a plot (similar to the one on the left but with updated results) into the "*Plots of cross sections and related Quantities review*"

Neutrino Landscape

Neutrino Physics is a "hot" area of research. We are expecting new results to roll off the assembly line

Physics Now:

MINOS, Super-K, MiniBoone, SciBoone, MinerVa, KamLand, K2K, T2K-ND280, OPERA, Borexino, SNO, etc.

Near Term:

T2K, NoVa, Daya Bay, Double Chooz, Reno, MicroBoone

Long Term:

Hyper-K, DUSEL, INO, etc.

Note: 0νν$\beta\beta$ is another big area not covered in this talk

We Will Be Ready for the Results!!