Additional Polarization Studies in Neutrino-Nucleon Interactions

- In addition to the intriguing polarization studies presented by Beata Kowal (questions/discussion follows directly). The study of the production and polarization of hyperons produced in ν + N interactions and their subsequent decay :

$$\bar{\nu}_\mu + p \longrightarrow \mu^+ + \Lambda$$
$$\bar{\nu}_\mu + p \longrightarrow \mu^+ + \Sigma^0$$
$$\bar{\nu}_\mu + n \longrightarrow \mu^+ + \Sigma^-$$

can also yield considerable information on the value of M_A (independent of cross section) and axial vector nucleon-hyperon transition form factors. One can also look for the existence of pseudoscalar form factors and 2^{nd} class currents and even search for any violations of t-invariance.

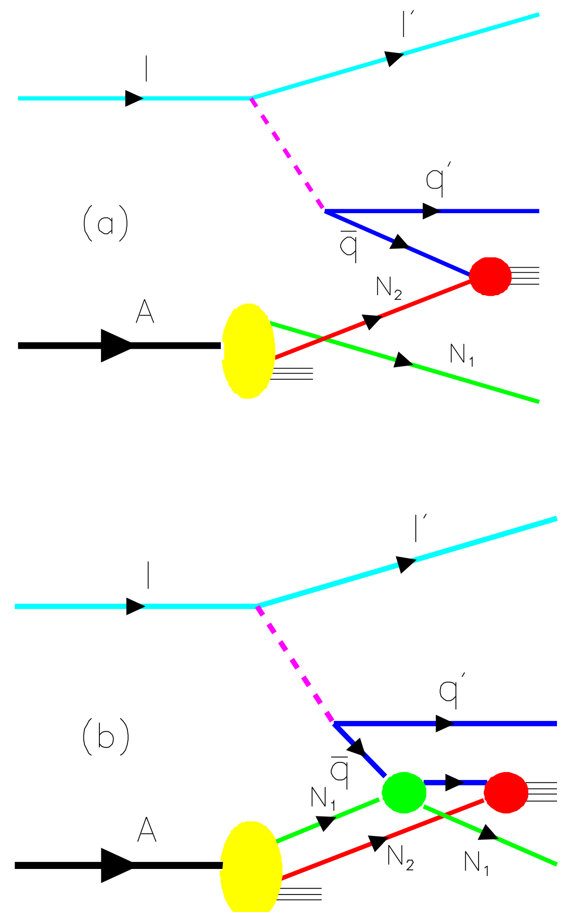
- Hyperon production has been studied since the earliest neutrino experiments such as Gargamelle in 1972: Observation of 'Elastic' Hyperon Production by Anti neutrinos: *Phys.Lett.B* 40 (1972) 593-596.
- DUNE should be able to make more accurate higher-statistics study of these hyperon production channels.
- The group from Aligarh Muslim University (F. Akbar, S. Athar, A. Fatima, S.K. Singh) have updated the theoretical expectations of hyperon production. **Atika Fatima** will give a flash talk on the Aligarh studies of hyperon production tomorrow.

Tension in low-x (<0.1) in combined ν A and $l^{\pm}$ A fit:

Shadowing in Neutrino Interactions: Difference expected compared to $l^{\pm}$ A

Nuclear Shadowing in Electro-Weak Interactions - Kopeliovich, JGM and Schmidt arXiv:1208.6541

- Several theoretical models successfully describe the shadowing effects observed in charged-lepton nucleus scattering.
- Most are based on hadronic fluctuations of the γ (or W/Z for neutrinos)
- These fluctuations then undergo multiple diffractive scattering off leading nucleons in the the nucleus.
- The multiple scatters interfere destructively.



Shadowing - continued

- Why low x?
  - The lifetime of the hadronic fluctuation has to be sufficient to allow for these multiple diffractive scatters:

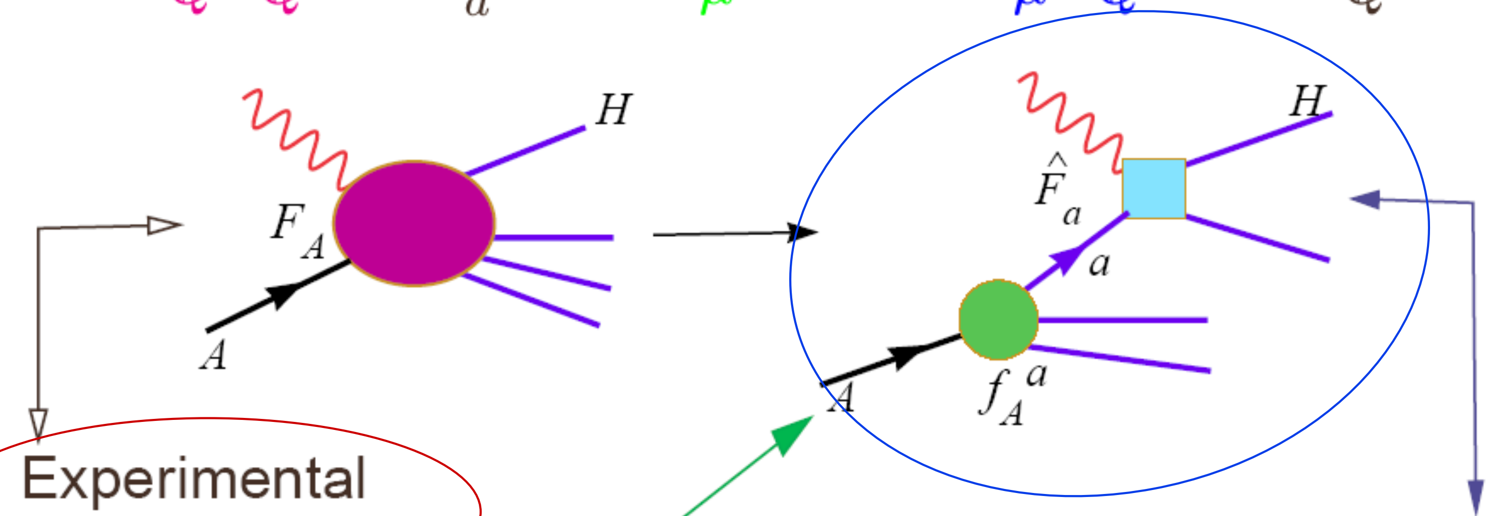
$$t_c = 2E_{had} \; / \; (Q^2 + m^2)$$

  - For a given Q^2 need large E_{had} to yield sufficient t_c which implies small x.
- m is larger for the vector current than the axial vector current → for a given Q^2 you need more E_{had} for the vector current than the axial vector current to have sufficient t_c.
- Speculation is that in addition to this difference, the frequency of hadronic fluctuations depends on the mass of the IVB.
- NEW DIRECTIONS: What do the concepts of "factorization" and "universal (nuclear) parton distributions" mean in the nuclear environment?

Global QCD Analysis in a Nutshell

Master Equation for QCD Parton Model – the Factorization Theorem

$$F_A^\lambda\left(x,\frac{m}{Q},\frac{M}{Q}\right)=\sum_a f_A^a\left(x,\frac{m}{\mu}\right)\otimes\widehat{F}_a^\lambda\left(x,\frac{Q}{\mu},\frac{M}{Q}\right)+\mathcal{O}\left(\left(\frac{\Lambda}{Q}\right)^2\right)$$



Experimental Input

Theoretical Calculations

Hard Cross-section perturbative calculable (may contain $\alpha_s^n \mathrm{Log}^n(M/Q)$)

universal Parton Dist. Fn.
Non-Perturbative Parametrization at Q_0
GLAP Evolution to Q

extracted by applying global analysis methods

What do the concepts of "factorization" and "universal (nuclear) parton distributions" mean in the nuclear environment?