
Summary of Discussion Session on Cross Sections

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Abstract

A brief summary of the discussion session on cross sections is presented.

1. Objective and Questions

The issue that has been raised from atmospheric neutrino experiments is “How accurate can we predict the $\nu_\mu - \nu_e$ event ratio?” The issue is directly related to the currently central question of the neutrino physics: the determination of the mixing parameters of neutrino flavor oscillation.

It has been repeatedly stressed during this conference that there is an appreciable uncertainty in the theoretical or Monte Carlo evaluation of neutrino-nuclear cross sections. The uncertainty directly affects the $\nu_\mu - \nu_e$ event ratio. The objective of the session is to assess how feasible to limit the uncertainty at a desirable level, after identifying its sources.

2. Uncertainties in Nuclear Cross Sections

In this conference, Concha Gonzales-Garcia and Nakayama have presented systematic assessments of the cross section uncertainties. They were identified to come from:

- The parameter M_A in the axial nucleon form factor, affecting quasi-elastic and single-pion production cross sections
- Model dependence in quasi-elastic and pion-production cross sections.
- Contribution from coherent pion production.
- Ratio of neutral current and charge current cross sections.

- Nuclear effects (for ^{16}O) in cross sections.

The uncertainties associated with the first two items were estimated to be at 10% level each, while the other three items were of a few tens of % each. The estimates were obtained by comparing results by various methods of Monte Carlo simulation using different codes, and theoretical calculations based on different approaches.

The uncertainties shown are appreciable, but one notes obvious: the methods and the uncertainties are correlated. Monte Carlo codes presently used for simulation have been written based on more or less on the same formalism, and theoretical calculations are also based on a limited variety of approaches. Furthermore, comparison of a Monte Carlo simulation and a theoretical calculation may appear to provide a realistic assessment of uncertainty, but it requires a strong faith in them as realistic descriptions.

The listed uncertainties would serve, however, as working measures associated with each item, with this caveat.

3. Discussion Summary

During the session, the question was raised whether it is feasible to limit the overall uncertainty at about 10 %. Lengthy discussions followed, especially involving comments from A. V. Butkevich, J. Nieves, and J.-Y. Yu on various issues such as: 1) Testing cross section calculations against electron scattering data, 2) problems in the application of simple Fermi gas model, and 3) the importance of final-state interactions, in additions to those related to their theoretical works presented in this conference.

It became clear that it would be a difficult task to achieve the the 10 % limit, but at the end, especially J. Nieves noted that it would be feasible to do so, as nuclear cross sections would be well under control as a close agreement with (e, e') by his group's calculations shows. Chair concluded that much hard work is ahead of us.