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New developments in the Ghent Model for Single Pion Production

Single-pion production constitutes an important contribution to neutrino-nucleus cross sections in the region regime covered by current and future accelerator-based neutrino-oscillation experiments. To analyse and interpret the data of these experiments, it is absolutely necessary to have good models for these cross sections available.

The Ghent model [1] for single-pion production consists of a low-energy part described by the three-level vertices of resonances on top of a background described by a Lagrangian from chiral perturbation theory (ChPT). This model can be extended to higher energies using Regge theory.

In order to improve the performance of the model, we reformulated our description in terms of helicity amplitudes and a multipole expansion. The advantage of this procedure, is that cross section contributions are separated in parts with fixed quantum numbers, providing more flexibility for further refinement of the model. Using this scheme makes it possible to effectively unitarize the whole background, taking into account the pion-nucleon scattering phases provided by pion-nucleon scattering data. Further, we modified the delta decay width and formfactors to incorporate Watson's theorem [2] and included meson exchange diagrams in the background, to obtain a better agreement with other models and data.

In this contribution we will present the results of these efforts in the vector sector. Work on implementing these developments in the axial part of neutrino-induced single pion production is in progress. In a next step, we will incorporate the updated description of the pion production off the nucleon in our nuclear model [3] to study the impact of these modifications on the total neutrino cross section and the comparison with data.

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[2] L. Alvarez-Ruso, E. Hernández, J. Nieves, and M.J. Vicente Vacas Physical Review D93, 014016 (2016)

[3] A. Nikolakopoulos, R. Gonz\'alez-Jim\'enez, N. Jachowicz, and J.M. Udías Phys. Rev. D 107, 053007 (2023)

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