

KINEMATICAL ANALYSIS OF THE NEUTRINO-INDUCED TWO-PROTON KNOCK-OUT REACTIONS*

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The discoveries of the ArgoNeuT Collaboration are confronted with the NuWro neutrino event generator simulations. The initial nucleon pair configuration reconstruction procedure is tested. It is shown that the procedure favours the antiparallel configuration. A kinematical argument, why this result is expected, is provided.

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1. Introduction

The contribution of $2p2h$ final states to the neutrino–nucleus cross section in the energy region of ~ 1 GeV has been studied in many theoretical and phenomenological analyses. Recently, the ArgoNeuT Collaboration emphasized the role of short-range correlated (SRC) nucleon pairs in the two-proton knock-out reactions [1]. The ArgoNeuT experiment detected 30 charged current neutrino events with exactly 2 protons and no pions in the final state. On a specific subsample of events, the reconstruction of the initial nucleon pair configuration has been performed. It was concluded that 4 out of 15 selected events happened on the SRC nucleon pair.

The ArgoNeuT discoveries were confronted with the NuWro Monte Carlo event generator [2]. The details of the simulations and the results of the analysis are presented in Ref. [3].

2. Initial nucleon configuration reconstruction

As given in Ref. [1], the procedure begins with the incident neutrino energy reconstruction

$$E_\nu = E_\mu + T_{p1} + T_{p2} + T_{A-2} + E_{\text{miss}} , \quad (1)$$

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where p_1 , p_2 denote the more and the less energetic protons respectively. The simulations show the tendency of this procedure to underestimate the neutrino energy and, therefore, the three-momentum transfer [4]. However, the direction of the transfer is reconstructed quite accurately ($\vec{q}_{\text{rec}} \simeq \vec{q}$).

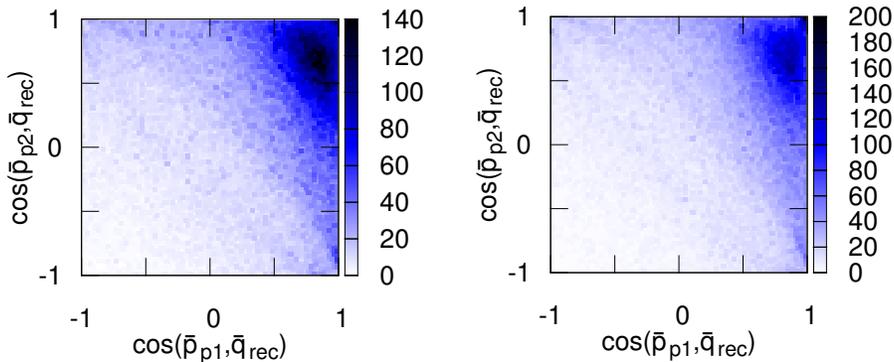


Fig. 1. Cosine of the more energetic proton \vec{p}_{p1} and the reconstructed three-momentum transfer \vec{q}_{rec} versus the cosine for the less energetic proton \vec{p}_{p2} . (Left) the LFG model, (right) the SF approach [3]. Shades of grey (colours) represent number of events in each bin.

Then, the Ansatz is made that the momentum is transferred to the more energetic proton only, hence $\vec{p}_{p1}^i \equiv \vec{p}_{p1} + \vec{q}_{\text{rec}}$ and $\vec{p}_{p2}^i \equiv \vec{p}_{p2}$. As seen in Fig. 1, the three-momentum transfer and both protons are strongly correlated and, in general, $\vec{q}_{\text{rec}} \approx \vec{p}_{p1} + \vec{p}_{p2}$. Therefore, the reconstructed configuration tends to be antiparallel ($\vec{p}_{p1}^i \approx -\vec{p}_{p2}^i$) and it does not depend on the reaction mechanism nor the initial SRC nucleon configuration.

3. Summary

The two-proton knock-out event data from the ArgoNeuT experiment has been analysed. It has been shown that the given reconstruction procedure is not sensitive to the existence of the SRC nucleon pairs.

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