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Neutrino-induced one-pion production revisited: the $\nu_\mu n \to \mu^- n\pi^+$ channel

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Understanding single pion production reactions on free nucleons is the first step towards a correct description of these processes in nuclei, which are important for signal and background contributions in current and near future accelerator neutrino oscillation experiments. We reanalyze our previous studies of neutrino-induced one-pion production on nucleons for outgoing πN invariant masses below 1.4 GeV, in order to get a better description of the $\nu_\mu n \to \mu^- n\pi^+$ cross section, for which current theoretical models give values significantly below data,. The $\nu_\mu n \to \mu^- n\pi^+$channel is very sensitive to the crossed $\Delta(1232)$ contribution and thus to spin 1/2 components in the Rarita-Schwinger Δ propagator. We show how these spin 1/2 components are nonpropagating and give rise to contact interactions. In this context, we point out that the discrepancy with experiment might be corrected by the addition of appropriate extra contact terms and argue that this procedure will provide a natural solution to the $\nu_\mu n \to \mu^- n\pi^+$ puzzle. To keep our model simple, in this work we propose to change the strength of the spin 1/2 components in the Δ propagator and use the $\nu_\mu n \to \mu^- n\pi^+$ data to constraint its value. With this modification, we now find a good reproduction of the $\nu_\mu n \to \mu^- n\pi^+$ cross section without affecting the good results previously obtained for the other channels. We also explore how this change in the Δ propagator affects our predictions for pion photoproduction and find also a better agreement with experiment than with the previous model.

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