Title:	Nucleon binding energy and transverse momentum imbalance in neutrino-nucleus reactions
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Keywords:	Neutrino Nucleus Parallel
Issue Date:	2020
Publisher:	American Physical Society
Citation:	Physical Review D, 101(9).
Abstract:	We have measured new observables based on the final state kinematic imbalances in the mesonless production of ν μ + A → μ − + p + X in the MINERvA tracker. Components of the muon-proton momentum imbalances parallel (δ p Ty) and perpendicular (δ p Tx) to the momentum transfer in the transverse plane are found to be sensitive to the nuclear effects such as Fermi motion, binding energy, and non-quasielastic (QE) contributions. The QE peak location in δ p Ty is particularly sensitive to the binding energy. Differential cross sections are compared to predictions from different neutrino interaction models. The Fermi gas models presented in this study cannot simultaneously describe features such as QE peak location, width, and the non-QE events contributing to the signal process. Correcting the genie's binding energy implementation according to theory causes better agreement with data. Hints of proton left-right asymmetry are observed in δ p Tx . Better modeling of the binding energy can reduce the bias in neutrino energy reconstruction, and these observables can be applied in current and future experiments to better constrain nuclear effects.
Description:	Only IISERM authors are available in the record.
URI:	https://journals.aps.org/prd/abstract/10.1103/PhysRevD.101.092001 (https://journals.aps.org/prd/abstract/10.1103/PhysRevD.101.092001) http://hdl.handle.net/123456789/3297 (http://hdl.handle.net/123456789/3297)
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