

MC implementation of MEC model

Overview

- MEC is suggested to be a solution of recent neutrino cross section mysteries.
- Because of the lack of hadronic system prediction from the models in the market, MEC implementation will take 3 steps.
 - i) Chose leptonic model. This provides differential cross section of lepton and energy-momentum transfer.
 - ii) Make hadronic model. This includes how to choose nucleons (=initial nucleon states) and how to share give energy-momentum transfer.
 - iii) Apply FSI.

Leptonic model

- Leptonic model should have following 3 requirements
 - i) It enhances $\sim 30\%$ of total cross section around 1 GeV
 - ii) It enhance high angle scattering, due to transverse nature
 - iii) It agrees with high statistics, precise e-scattering data
- GENIE uses Dytman model, which is totally empirical, can be tuned using (e,e') data
- NuWro uses Marteau model-based model (called np-nh model) and transverse enhancement model (TEM).
- GiBUU uses transverse projection as a hadronic tensor.

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Hadronic model

- Since hadronic system is not provided by any papers, we need to make it.
- GENIE and NuWro use nuclear cluster model. 2 nucleons are chosen from Fermi sea, then 2 nucleons and energy-momentum vector make CM system, and isotropic decay of this system provide 2 nucleon emission.
- GiBUU choose 2 nucleon from Fermi sea, but same location. But cross section is weighted based on phase space density (usually GiBUU manner).

Some remarks

- Leptonic models also predict hadronic system in some sense, because energy-momentum transfer is controlled by leptonic model
- Final state particles may shed the light. For example, it is hard to make 1 nucleon final state if interaction type is MEC (other ward, there is no CCQE xs enhancement if there is only one nucleon)

Discussions

- To predict correct phenomena, we need lots of input for hadronic system, including how to choose initial nucleon momentums, how to share energy-momentum transfer, what kind of pair is abundant, where 2 nucleons locate, etc.
- These inputs are crucial, because prediction (=final state particles and their kinematics) depends a lot on model.

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	GENIE	NuWro	GiBUU
What kind of Leptonic model?	Dytman model	np-nh model and TEM	Transverse projector for hadronic tensor
how to choose 2 nucleon momentum?	From Fermi sea, independently	From Fermi sea, independently	From Fermi sea, independently
how to choose 2 nucleon location?	both are random	both are random	both are random, but same location
Any correlations?	no	no	no, but xs is weighted by phase space density
what kind of pairs? n-p or n-n?	n-p : n-n = 1 : 4	n-p : n-n = 3 : 1	n-p : n-n = 3 : 1
How to share energy-momentum transfer by 2 nucleons?	nucleon cluster model	nucleon cluster model	not clear