Transport Estimations of Final State Interaction Effects on SRC Studies

Natalie Wright 08/04/2022



Motivation

- Exclusive SRC studies infer initial state → sensitive to distortions by FSI
- Calculations suggest specific kinematics (xB>1, high-Q2, ...) → Minimal / understood distortions
- Heavy nuclei calculations very complex

→ Useful to employ simulation as complimentary approach



Overview

- Effective transport theory to study FSI in ¹²C(e,e'p) and ¹²C(e,e'pp)
- GCF implemented in GENIE MC Generator
- Focus on data by Schmidt, Nature (2020); Cohen, PRL (2018):

CLAS Spectrometer

 $xB \ge 1.2$

 $Q^2 \ge 1.7 \; GeV^2$,

Large (e, e'p) missing-momentum









GENIE MC Generator

Generates Events for Neutrino Interaction Experiments

Modern framework for neutrino MC events

All neutrinos and targets

Accounts for FSI using data-driven INC

eGENIE - Electron scattering version of GENIE



UNIVERSAL NEUTRINO GENERATOR & GLOBAL FIT





GENIE/Base GCF Validation





FSI in previous studies: Transparency + SCX

- 1. Calculate PWIA
- 2. Allow (n,p), (p,n) SCX
- 3. Attenuation (transparency)

T ^N	T ^{NN}	P ^{pp}	P[p]p	P ^{p[p]}	P[pp]	P ^{p[n]}	P ^{[p]n}	P ^{np}	P ^{[n]p}	P ^{n[p]}	P ^[np]]
53%	44%	90.8%	4.1%	4.8%	0.3%	4.1%	3.5%	92.2%	3.5%	4.1%	0.2%	4
±	±	±	+ ±	±	±	±		±	±	±	±	
5%	4%	0.6%	0.3%	0.3%	0.02%	0.3%	0.2%	0.5%	0.2%	0.3%	0.01%	0

Schmidt, Nature (2020)

$$\sigma_{A(e,e'pp)}^{Exp} = \sigma_{A(e,e'pp)}^{GCF} \cdot P_A^{pp} \cdot T_{A,pp} + \sigma_{A(e,e'np)}^{GCF} \cdot p_A^{[n]p} \cdot T_A^* + \sigma_{A(e,e'pn)}^{GCF} \cdot P_A^{p[n]} \cdot T_A^*,$$



eGENIE FSI Generation

Data-driven INC Model

Transport each particle independently with at most one reinteraction

Place nucleon vertex randomly

 $P_{scattering}(\lambda) = 1 - e^{-\lambda/\lambda'}$

XSec Data





Analysis Overview

- Generate MC events
- Keep events based on CLAS acceptance
- Weight events by CLAS detection efficiency
- Smear momenta by CLAS resolutions
- Apply data event selection cuts



Selection Cuts

xB > 1.2

 $\theta_{pq} < 25^{\circ}$

$.62 < |p_{Lead}|/|q| < .96$.4 GeV/c < $|p_{miss}| < 1.0 GeV/c$

 $M_{miss} < 1.1$

 $|p_{Rec}| > 0.35 \ GeV/c$

FSI Can Impact GCF Events Detectable by CLAS





But... Selection Cuts Suppress FSI

CLAS Acceptance + Selection Cuts



Still, FSI Distorts Some Distributions

CLAS Acceptance



+ Selection Cuts

c.m.l

But not where physics was extracted!



But not where physics was extracted!





Solving old problems? Low E where Glauber struggles



Solving old problems! Low E where Glauber struggles



Schmidt, Nature (2020)



Updates:

Submitted to PLB (2021) Clarify normalization procedure (Unchanged) Double check effective transparencies Add higher stats while we're at it! Raise in A(e,e'pp)/A(e,e'p) Comparison to mean field





Conclusions

- Benchmarked GCF + FSI performance with data
- SRC selection cuts generally suppress FSI
- Complement to previous GEA-based studies
- Support previous interpretations of JLab data!

https://arxiv.org/abs/2104.05090 :)

BACKUP

Raise in A(e,e'pp)/A(e',e'p)





Mean Field



GENIE XSec Data

KE-dept. free nucleon cross sections



Atomic Data and Nucl.Data Tables 63(1996)p.93-116

