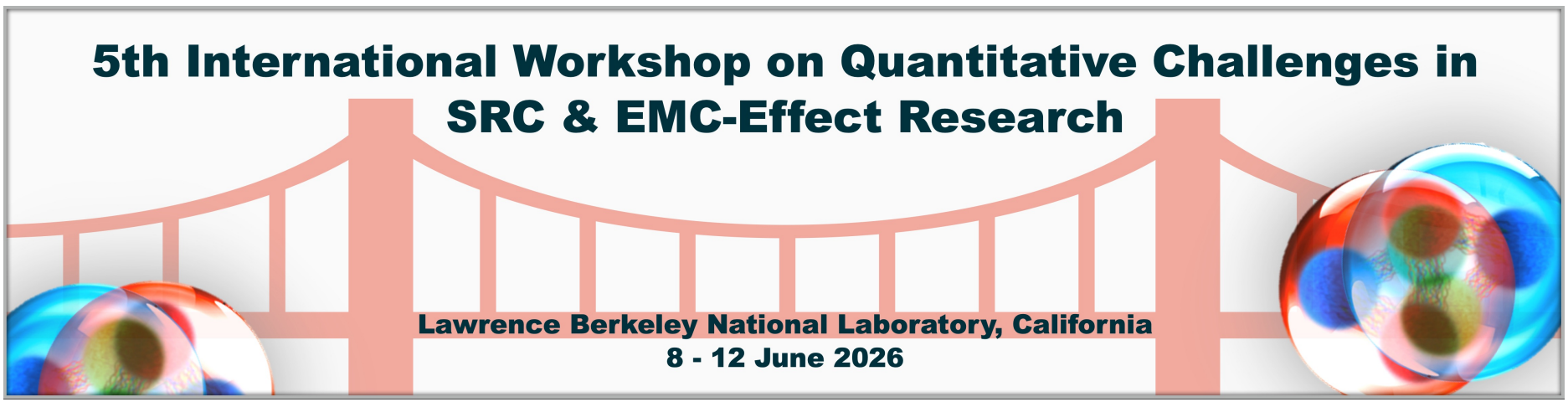
Few-Body Systems: Introduction

Axel Schmidt

June 10, 2026

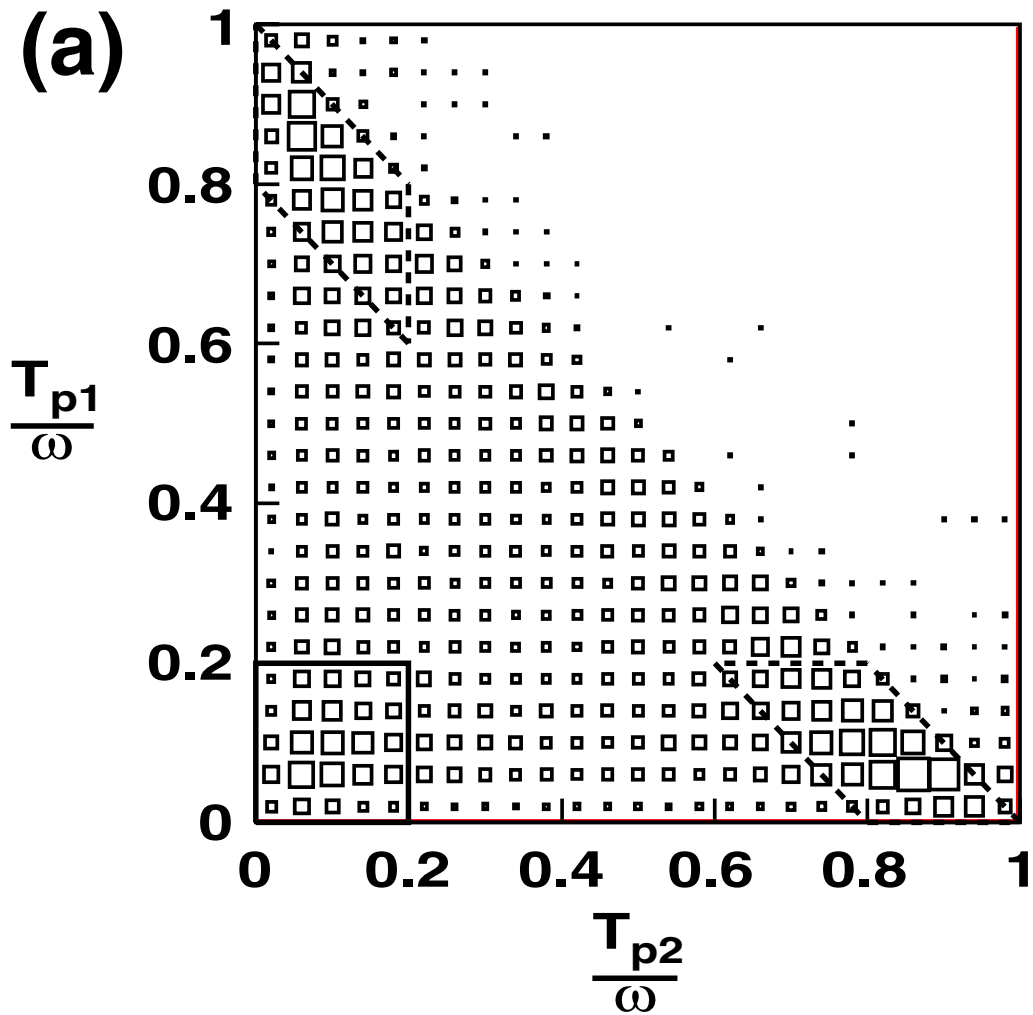


Why study SRCs in few-body systems?

- Techically sophisticated calculations with fewer approximations
  - Fadeev equation-based approaches
  - Hyperspherical harmonics
  - Quantum Monte Carlo
  - ...
- Reduced complexity of final-state interactions
- Benchmarks for model ingredients
  - *NN* interactions, light-front ψ construction, etc.
- Reference systems for studies of heavier nuclei
  - a_2, EMC Effect, etc.
  - a_3 for 3N correlations
- Greater exclusivity in experiments

Highlights of past few-body experiments

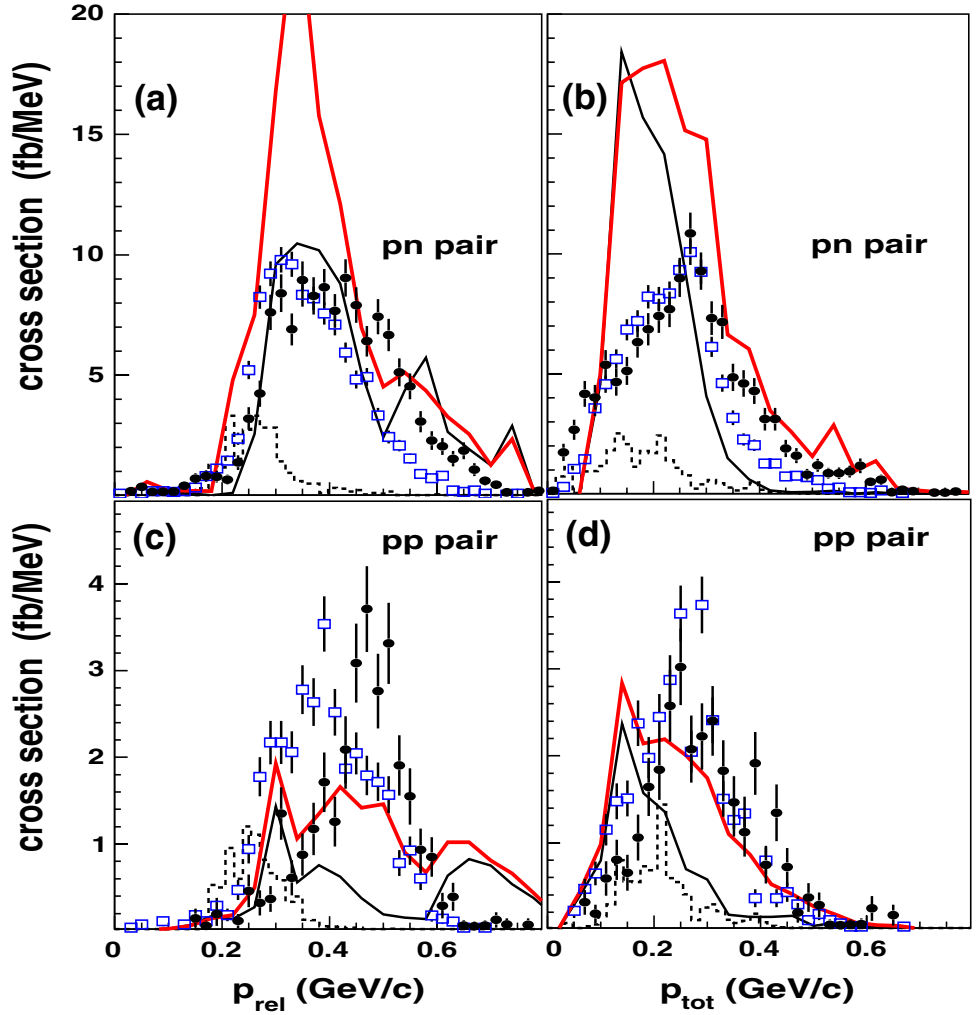
- Exclusive break-up $^3\mathrm{He}(e, e'pp)n$ (CLAS)



Niyazov et al., PRL 92, 052303 (2004)
Baghdasarian et al., PRL 105, 222501 (2010)

Highlights of past few-body experiments

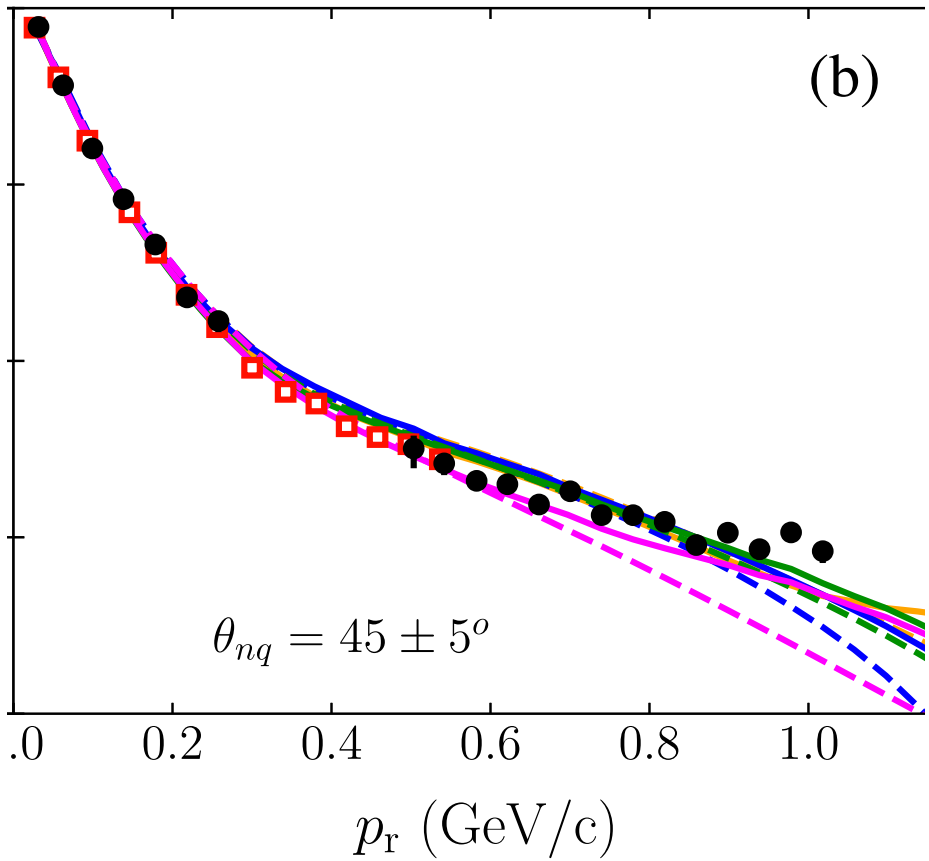
- Exclusive break-up $^3\mathrm{He}(e, e'pp)n$ (CLAS)



Niyazov et al., PRL 92, 052303 (2004)
Baghdasarian et al., PRL 105, 222501 (2010)

Highlights of past few-body experiments

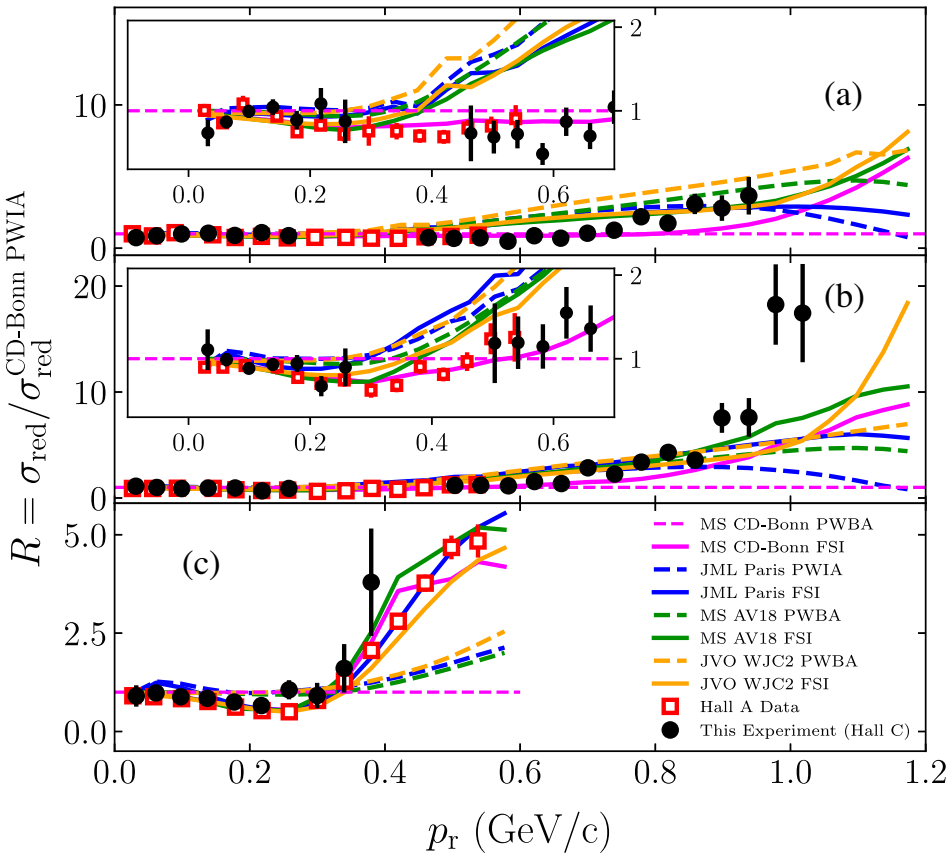
- Exclusive break-up ^{3}He$(e, e'pp)n$ (CLAS)
- $d(e, e'p)n$ at very large momentum (Halls A/C)



Boeglin et al., PRL 107, 262501 (2011)
Yero et al., 125, 262501 (2020)

Highlights of past few-body experiments

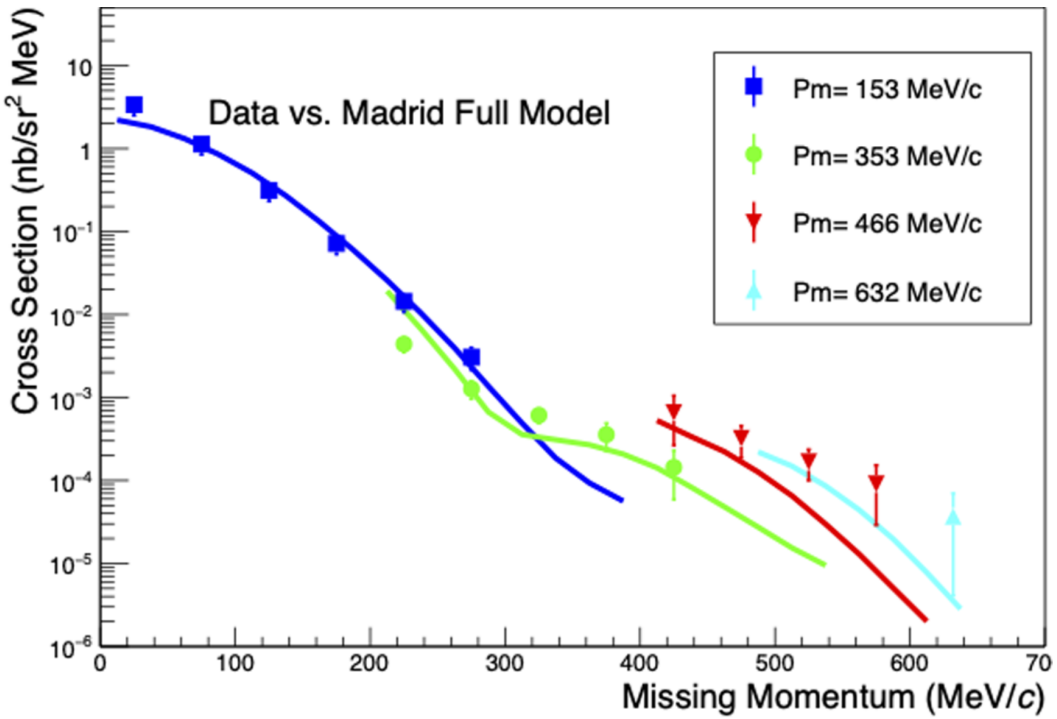
- Exclusive break-up $^3\mathrm{He}(e, e'pp)n$ (CLAS)
- $d(e, e'p)n$ at very large momentum (Halls A/C)



Boeglin et al., PRL 107, 262501 (2011)
Yero et al., 125, 262501 (2020)

Highlights of past few-body experiments

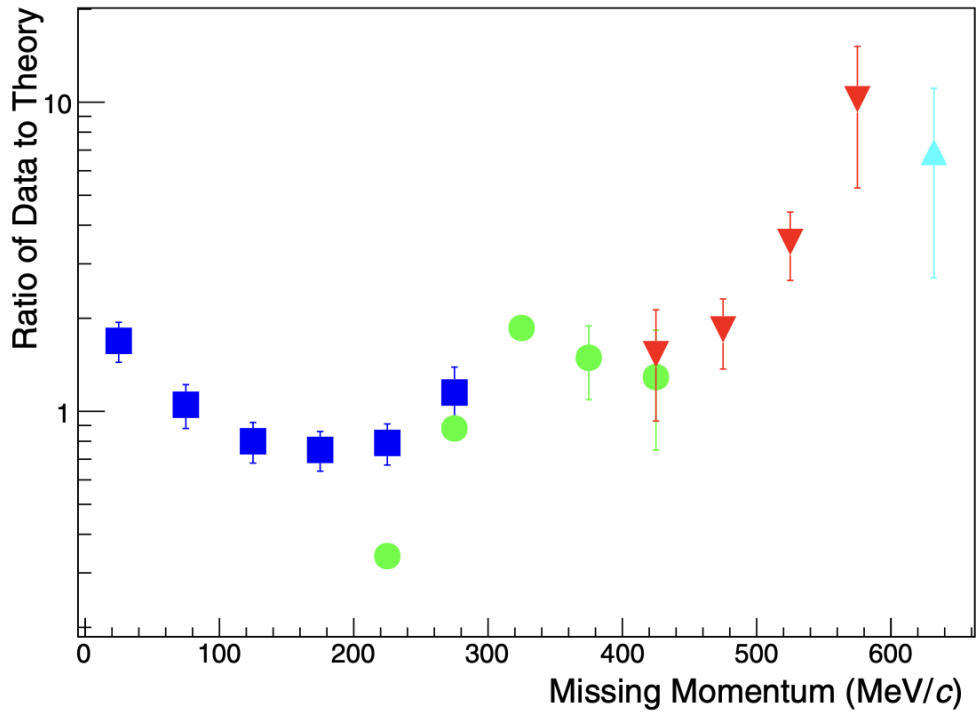
- Exclusive break-up $^3\mathrm{He}(e, e'pp)n$ (CLAS)
- $d(e, e'p)n$ at very large momentum (Halls A/C)
- $^4\mathrm{He}(e, e'p)^3\mathrm{H}$ (Hall A)



Iqbal et al., PRC 105, 064003 (2022)

Highlights of past few-body experiments

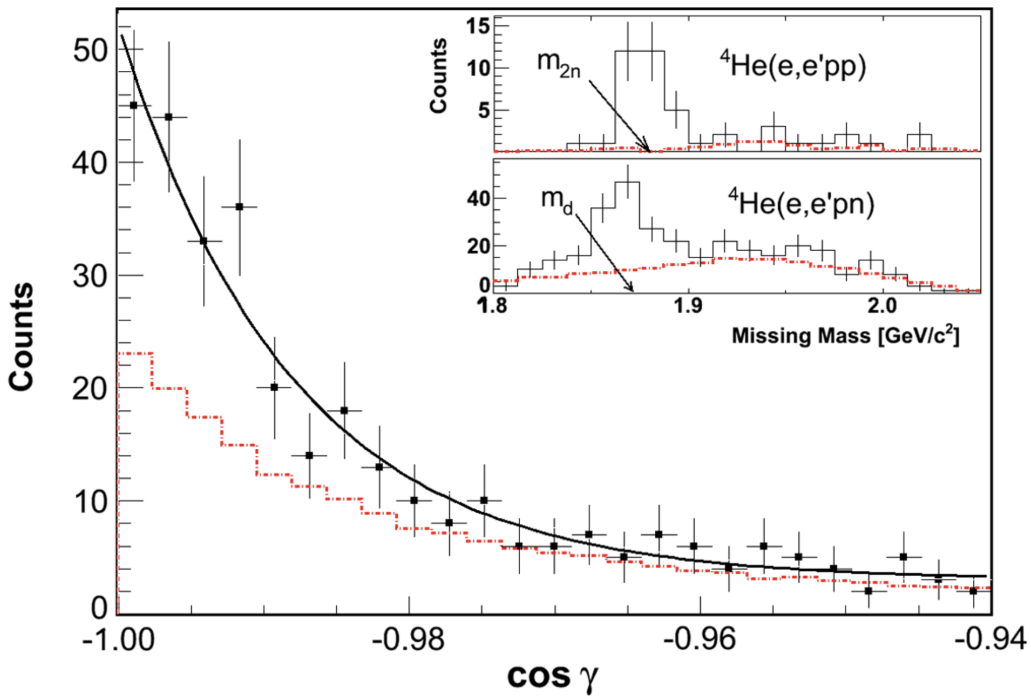
- Exclusive break-up $^3\mathrm{He}(e, e'pp)n$ (CLAS)
- $d(e, e'p)n$ at very large momentum (Halls A/C)
- $^4\mathrm{He}(e, e'p)^3\mathrm{H}$ (Hall A)



Iqbal et al., PRC 105, 064003 (2022)

Highlights of past few-body experiments

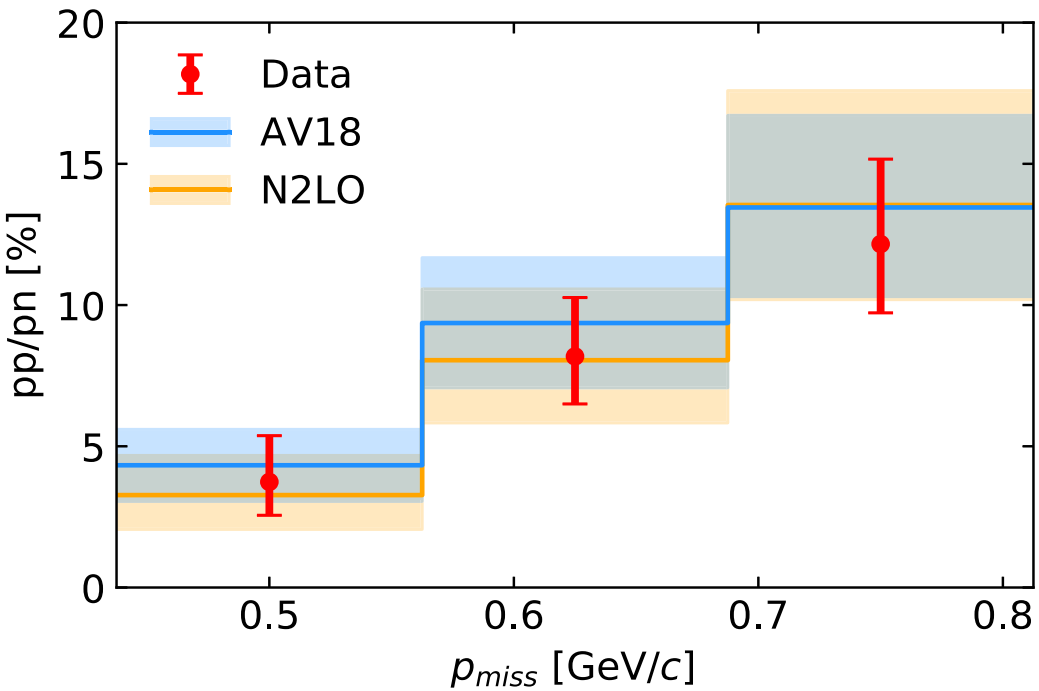
- Exclusive break-up $^3\mathrm{He}(e, e'pp)n$ (CLAS)
- $d(e, e'p)n$ at very large momentum (Halls A/C)
- $^4\mathrm{He}(e, e'p)^3\mathrm{H}$ (Hall A)
- $^4\mathrm{He}(e, e'pN)$ (Hall A)



Korover et al., PRL 113, 022501 (2014)
Pybus et al., PLB 805, 135429 (2020)

Highlights of past few-body experiments

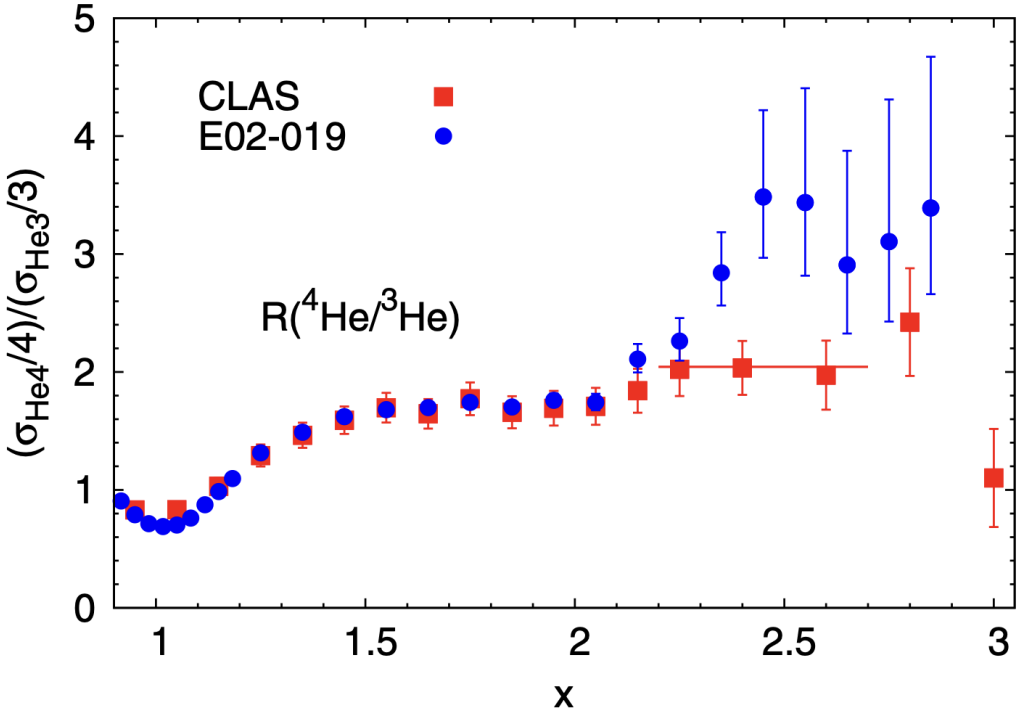
- Exclusive break-up $^3\mathrm{He}(e, e'pp)n$ (CLAS)
- $d(e, e'p)n$ at very large momentum (Halls A/C)
- $^4\mathrm{He}(e, e'p)^3\mathrm{H}$ (Hall A)
- $^4\mathrm{He}(e, e'pN)$ (Hall A)



Korover et al., PRL 113, 022501 (2014)
Pybus et al., PLB 805, 135429 (2020)

Highlights of past few-body experiments

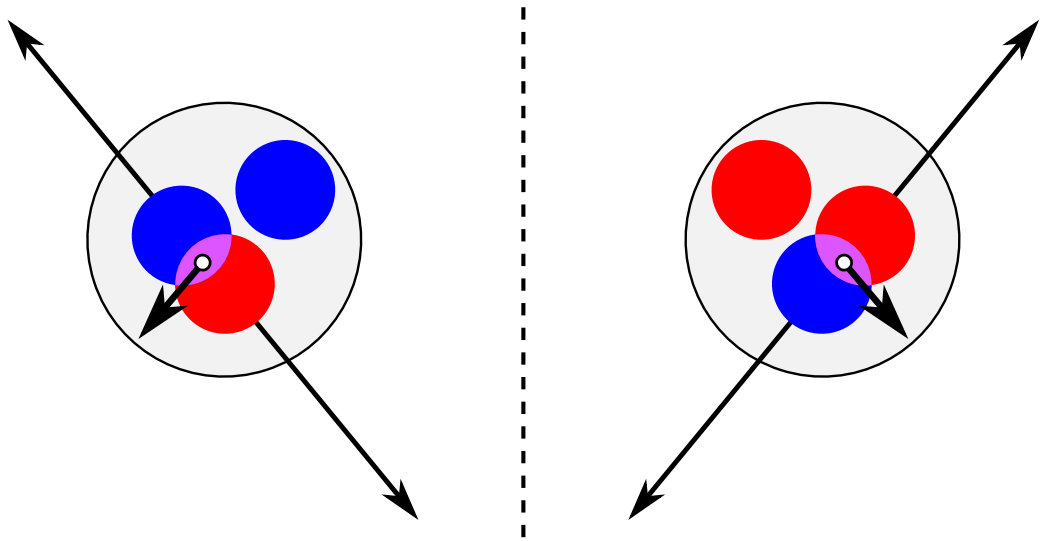
- Exclusive break-up $^3\mathrm{He}(e, e'pp)n$ (CLAS)
- $d(e, e'p)n$ at very large momentum (Halls A/C)
- $^4\mathrm{He}(e, e'p)^3\mathrm{H}$ (Hall A)
- $^4\mathrm{He}(e, e'pN)$ (Hall A)
- Inclusive scattering on light nuclei (XEM1)



Fomin et al., PRL 105, 212502 (2010)
Fomin et al., PRL 108, 092502 (2012)

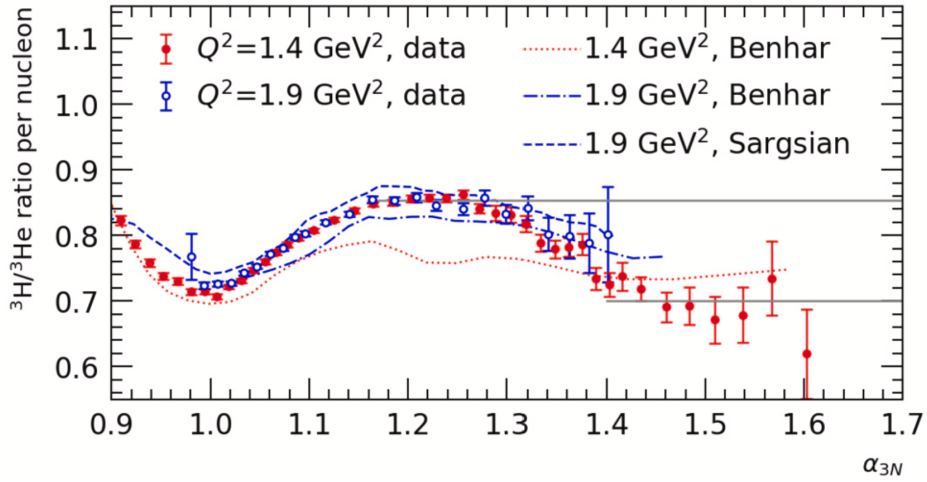
Highlights of past few-body experiments

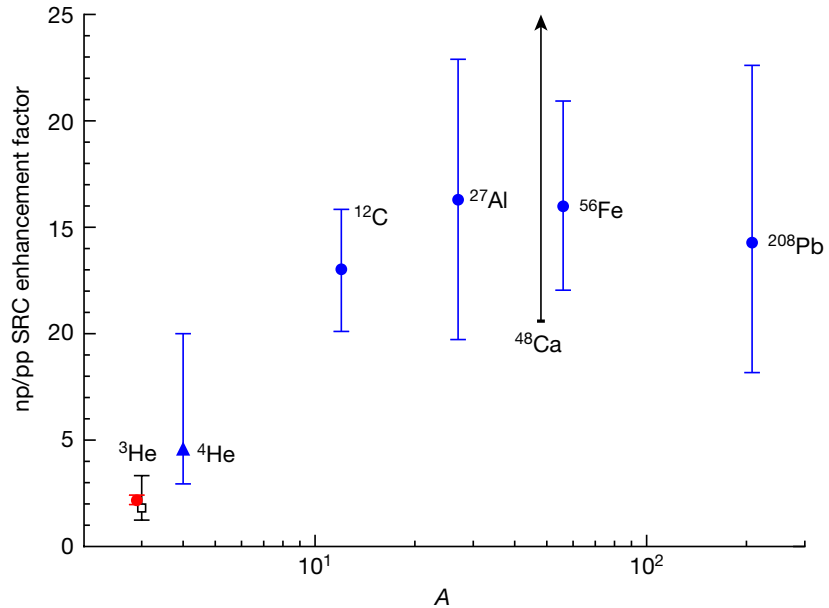
- Exclusive break-up $^3\mathrm{He}(e, e'pp)n$ (CLAS)
- $d(e, e'p)n$ at very large momentum (Halls A/C)
- $^4\mathrm{He}(e, e'p)^3\mathrm{H}$ (Hall A)
- $^4\mathrm{He}(e, e'pN)$ (Hall A)
- Inclusive scattering on light nuclei (XEM1)
- Hall A Tritium program



Highlights of past few-body experiments

- Exclusive break-up $^3\mathrm{He}(e, e'pp)n$ (CLAS)
- $d(e, e'p)n$ at very large momentum (Halls A/C)
- $^4\mathrm{He}(e, e'p)^3\mathrm{H}$ (Hall A)
- $^4\mathrm{He}(e, e'pN)$ (Hall A)
- Inclusive scattering on light nuclei (XEM1)
- Hall A Tritium program
  - $A(e, e')$

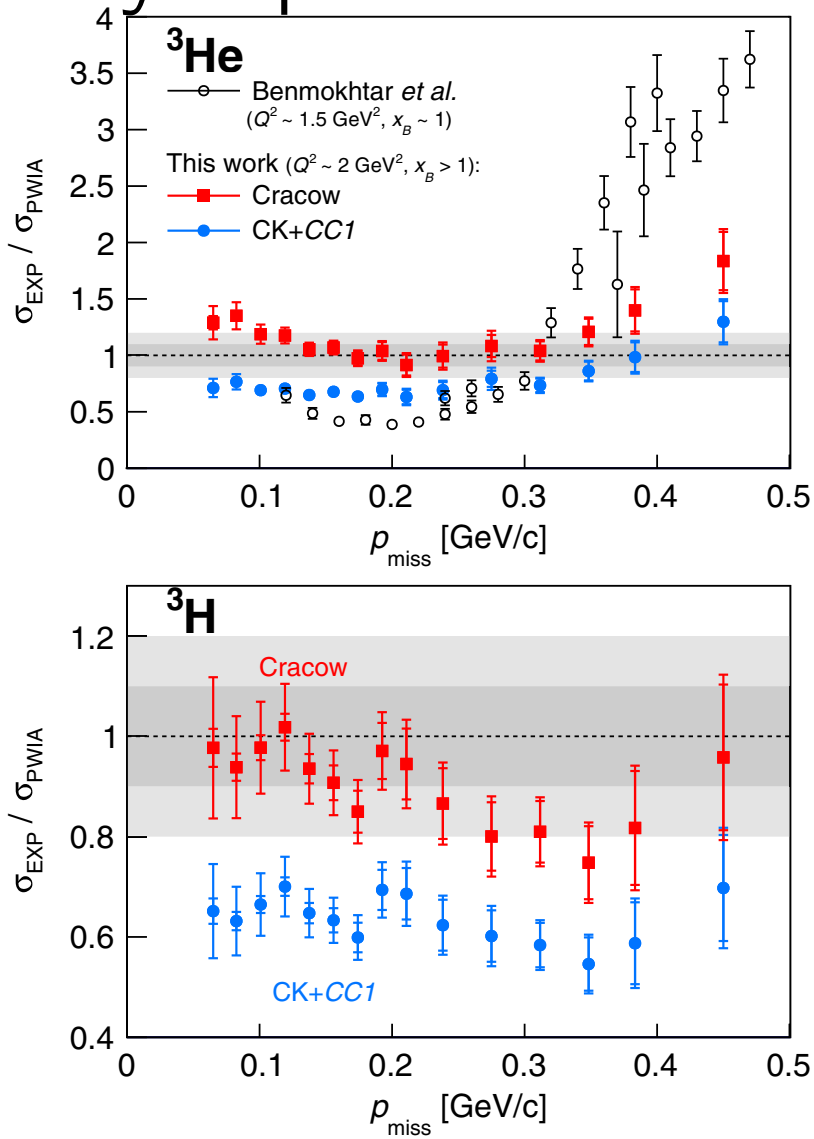




Li et al., Nature 609, p. 41 (2022)
Li et al., PLB 869, 139734 (2025)

Highlights of past few-body experiments

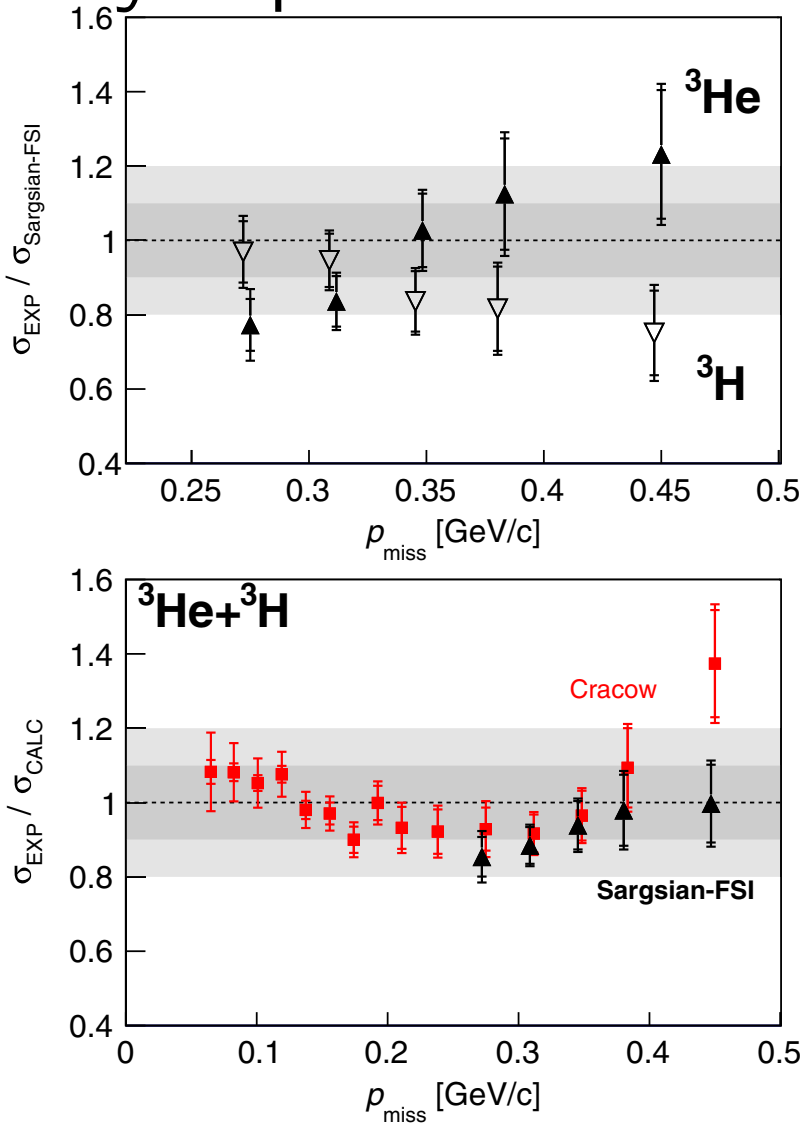
- Exclusive break-up $^3\mathrm{He}(e, e'pp)n$ (CLAS)
- $d(e, e'p)n$ at very large momentum (Halls A/C)
- $^4\mathrm{He}(e, e'p)^3\mathrm{H}$ (Hall A)
- $^4\mathrm{He}(e, e'pN)$ (Hall A)
- Inclusive scattering on light nuclei (XEM1)
- Hall A Tritium program
  - $A(e, e')$
  - $A(e, e'p)$



Cruz-Torres PLB 797, 134890 (2019)
Cruz-Torres, Nguyen et al., PRL 124, 212501 (2020)

Highlights of past few-body experiments

- Exclusive break-up $^3\mathrm{He}(e, e'pp)n$ (CLAS)
- $d(e, e'p)n$ at very large momentum (Halls A/C)
- $^4\mathrm{He}(e, e'p)^3\mathrm{H}$ (Hall A)
- $^4\mathrm{He}(e, e'pN)$ (Hall A)
- Inclusive scattering on light nuclei (XEM1)
- Hall A Tritium program
  - $A(e, e')$
  - $A(e, e'p)$



Cruz-Torres PLB 797, 134890 (2019)
Cruz-Torres, Nguyen et al., PRL 124, 212501 (2020)

Unpublished data under analysis

- XEM2
  - Preliminary data soon to be published (Nadia, Mon.)

Unpublished data under analysis

- XEM2
  - Preliminary data soon to be published (Nadia, Mon.)
- CLAS12 Run Group M
  - Many nuclear targets, including d, ^{4}He
  - Analysis notes under collaboration review
  - See Igor Korover's talk

Unpublished data under analysis

- XEM2
  - Preliminary data soon to be published (Nadia, Mon.)
- CLAS12 Run Group M
  - Many nuclear targets, including d, ^{4}He
  - Analysis notes under collaboration review
  - See Igor Korover's talk
- Hall D SRC/CT Experiment
  - GlueX spectrometer, d, ^{4}He, ^{12}C targets
  - Analysis notes under collaboration review
  - See Oscar Lin's talk (Tues.)

Unpublished data under analysis

- XEM2
  - Preliminary data soon to be published (Nadia, Mon.)
- CLAS12 Run Group M
  - Many nuclear targets, including d, ^{4}He
  - Analysis notes under collaboration review
  - See Igor Korover's talk
- Hall D SRC/CT Experiment
  - GlueX spectrometer, d, ^{4}He, ^{12}C targets
  - Analysis notes under collaboration review
  - See Oscar Lin's talk (Tues.)
- ALERT-SRC Experiment
  - CLAS12 + ALERT recoil tracker
  - $^4\mathrm{He}(e, e'pd)n$ + many others
  - See Florian Hauenstein's talk

Open questions

- How do pairs form in simple systems, purely $1S_{1/2}$ nucleons?
  - How to connect this to heavier nuclei?
- Can we benchmark fully relativistic descriptions at extreme kinematics?
- Can we improve/benchmark sophisticated FSI calculations?
- Can we find evidence of non-nucleonic components?
- What state is left behind after SRC removal?
- How can we learn about 3N SRCs from simple systems?
  - How will these systems best serve as a reference for studies of heavier nuclei?