Update on the 12 GeV EMC Effect Experiment in Hall C

Cameron Cotton

Hall C Users Meeting
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Outline

Physics Motivation

E12-10-008 Physics Goals

E12-10-008 Targets & Kinematics

Phase I Preliminary Results
Motivation: Discovery of the EMC Effect

**Prediction (Pre-1983)**

\[
F_2^A(x) = ZF_2^p(x) + NF_2^n(x)
\]

**Experiment**

Motivation: Discovery of the EMC Effect

PREDICTION (PRE-1983)

$$F_2^A(x) = Z F_2^p(x) + N F_2^n(x)$$

EXPERIMENT

Quark distributions are modified in nuclei???
Motivation: Discovery of the EMC Effect

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- The EMC Effect remains one of the biggest unsolved mysteries in nuclear physics.
- **1000s of papers** have been written about the EMC Effect in the last 40 years - **still no consensus.**
Motivation: Quantifying the EMC Effect

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- A density-dependent fit does an alright job for larger nuclei, but totally fails for light ($A<12$) nuclei.
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• The “size” of the EMC Effect in a given nucleus is determined from the slope in the range: $0.35 < x < 0.7$

• A density-dependent fit does an alright job for larger nuclei, but totally fails for light (A<12) nuclei.

• What is the driving force behind the EMC Effect?
Physics Goals: EMC Effect in $^3$He

- $^3$He/D ratio requires a large isoscalar correction to extract the EMC Effect.
Physics Goals: EMC Effect in 3He

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- Resonance structure pushed out to x>0.8 at large Q2, allowing for comparison with 3He/D data out to larger x to validate isoscalar correction model.
Physics Goals: EMC Effect in Light Nuclei

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• Light nuclei provide a great environment to study nuclear structure and clustering within the nucleus.
Physics Goals: Flavor Dependence of EMC Effect

- We will study possible flavor dependence of the EMC Effect through measurements of $^{40}\text{Ca}$ and $^{48}\text{Ca}$. 

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{chart.png}
\caption{\textsuperscript{40}Ca/$^{48}$Ca Relative Norm. (1.4\%)}
\end{figure}
Physics Goals: Flavor Dependence of EMC Effect

• We will study possible **flavor dependence of the EMC Effect** through measurements of $^{40}$Ca and $^{48}$Ca.

• The flavor-dependent CBT Model predicts a ~3% difference between $^{40}$Ca and $^{48}$Ca at $x=0.6$.

• On the other hand, we would expect a difference of <1% if there is no flavor dependence.
Physics Goals: n/p ratio

• We will be able to extract the n/p ratio in nuclei by comparing cross sections of adjacent nuclei.

• This may provide insight into nuclear modeling that is required to extract n/p cross sections from D/p.
Physics Goals: EMC-SRC Correlation

• There is a strong correlation between the size of the EMC Effect and SRCs.

• With data from our experiment and the x>1 experiment that will be discussed in the next talk, we will add many more nuclei to investigate this connection.
Outline

Physics Motivation

E12-10-008 Physics Goals

E12-10-008 Targets & Kinematics

Phase I Preliminary Results
Upcoming Run: Targets

- Coverage of large range of target masses, densities, and n/p values.
- Many new light targets (cluster structure).
Upcoming Run: Kinematics

• Kinematic coverage for both EMC and x>1 experiments.
• EMC and x>1 will run in parallel in the hall, utilizing both the SHMS and HMS detectors.
• Coverage of a large range of angles to examine Q2 dependence of structure functions.
• Total 23 PAC days for Phase I and II
  • Phase I completed in 2018 (2 days)
Outline

Physics Motivation

E12-10-008 Physics Goals

E12-10-008 Targets & Kinematics

Phase I Preliminary Results
Preliminary Results: Canonical EMC Plots

- Phase I – Collected data for several light nuclei
- Data showing characteristic EMC Effect shape.
Preliminary Results: EMC Slope v. Density

- Filled points are 12 GeV data
- Unfilled points are 6 GeV data
Summary

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  • E12-10-008 will add EMC data for several new nuclei
    • Light nuclei will provide insight to **nuclear clustering**
    • Light nuclei are also more amenable to comparison with theoretical calculations
  • 40Ca and 48Ca will allow us to study **possible flavor dependence of the EMC Effect**, as predicted in several models.
  • More nuclei for **EMC-SRC comparison**

![Graph of EMC data with various nuclei shown]
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• Phase II will run this summer!
Questions?