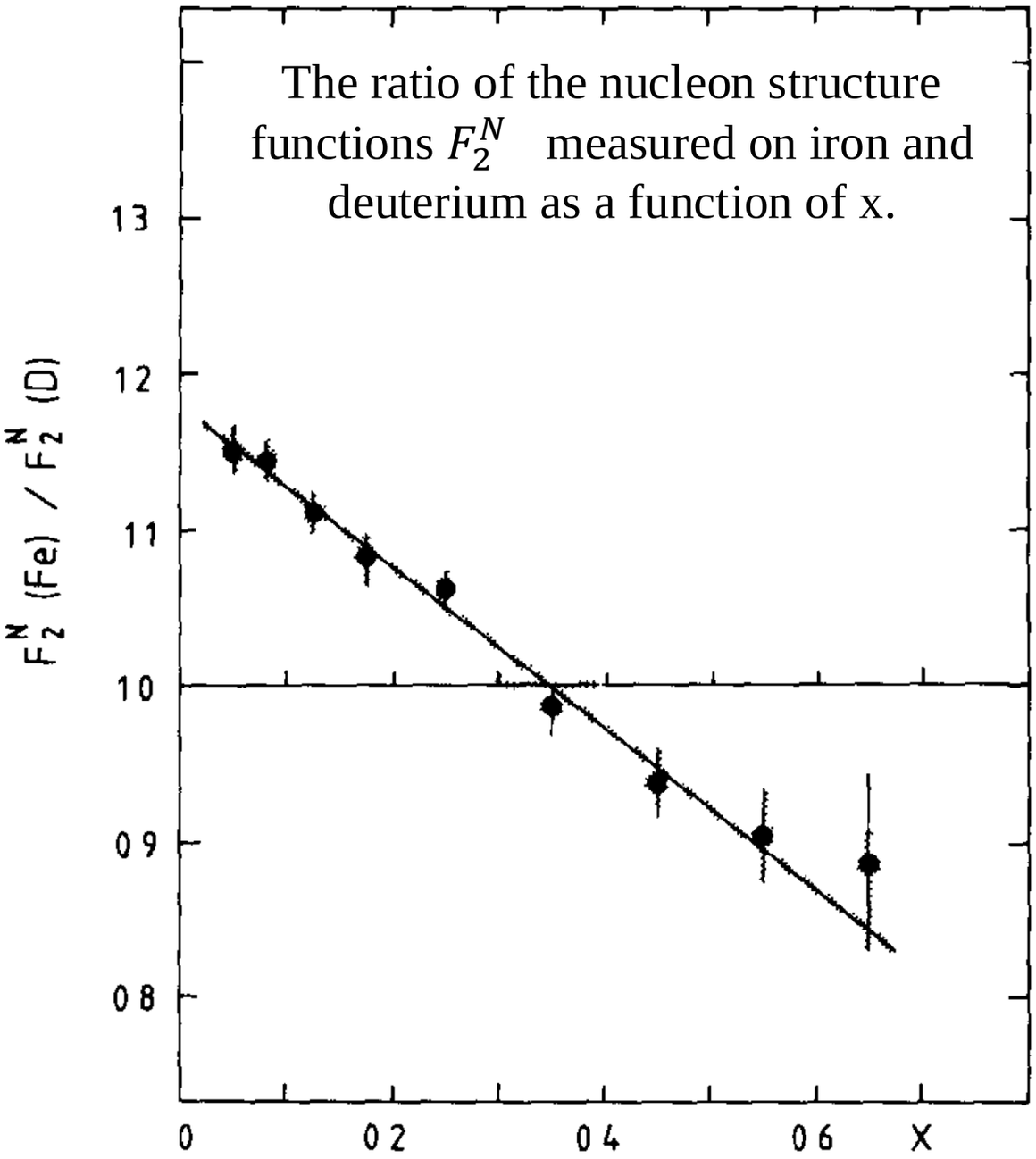
UNIVERSITY OF MICHIGAN

Studying gluonic EMC effect with ePIC @ EIC

Biweekly eA Study Group Meeting
November 12, 2024

Ievgen Lavrukhin

EMC Effect Introduction



Measured by **European Muon Collaboration** (1983) in DIS of μ on Fe and D:

- Expection: a flat line scaled with number of Nucleons in the target.
- Results: The slope of the ratio between $0.3 < x < 0.7$.

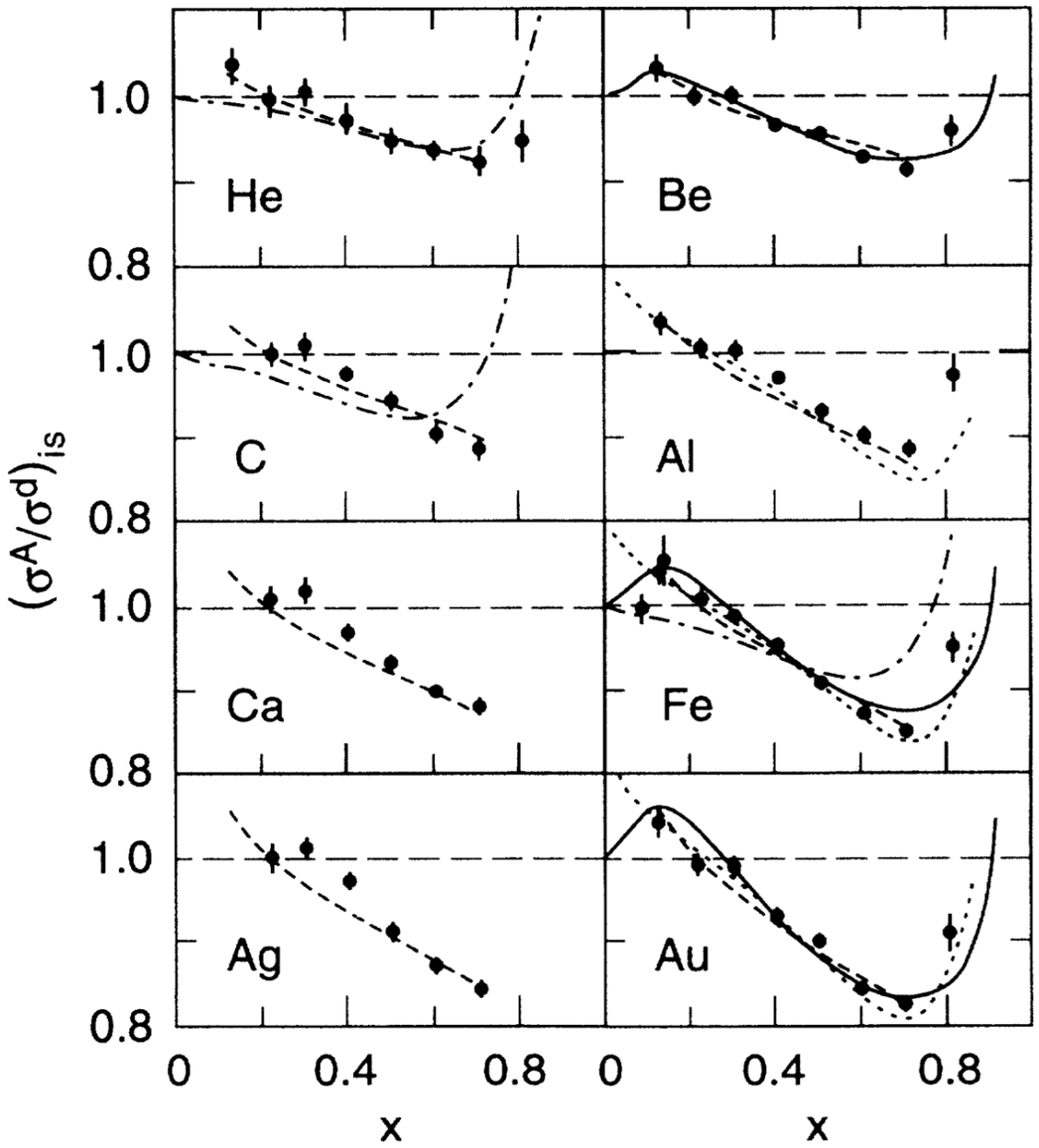
  => **size of the EMC effect**

Quark momentum distributions differ in bound vs. free nucleons!

[Physics Letters B Volume 123, Issues 3–4, 31 March 1983, Pages 275-278]

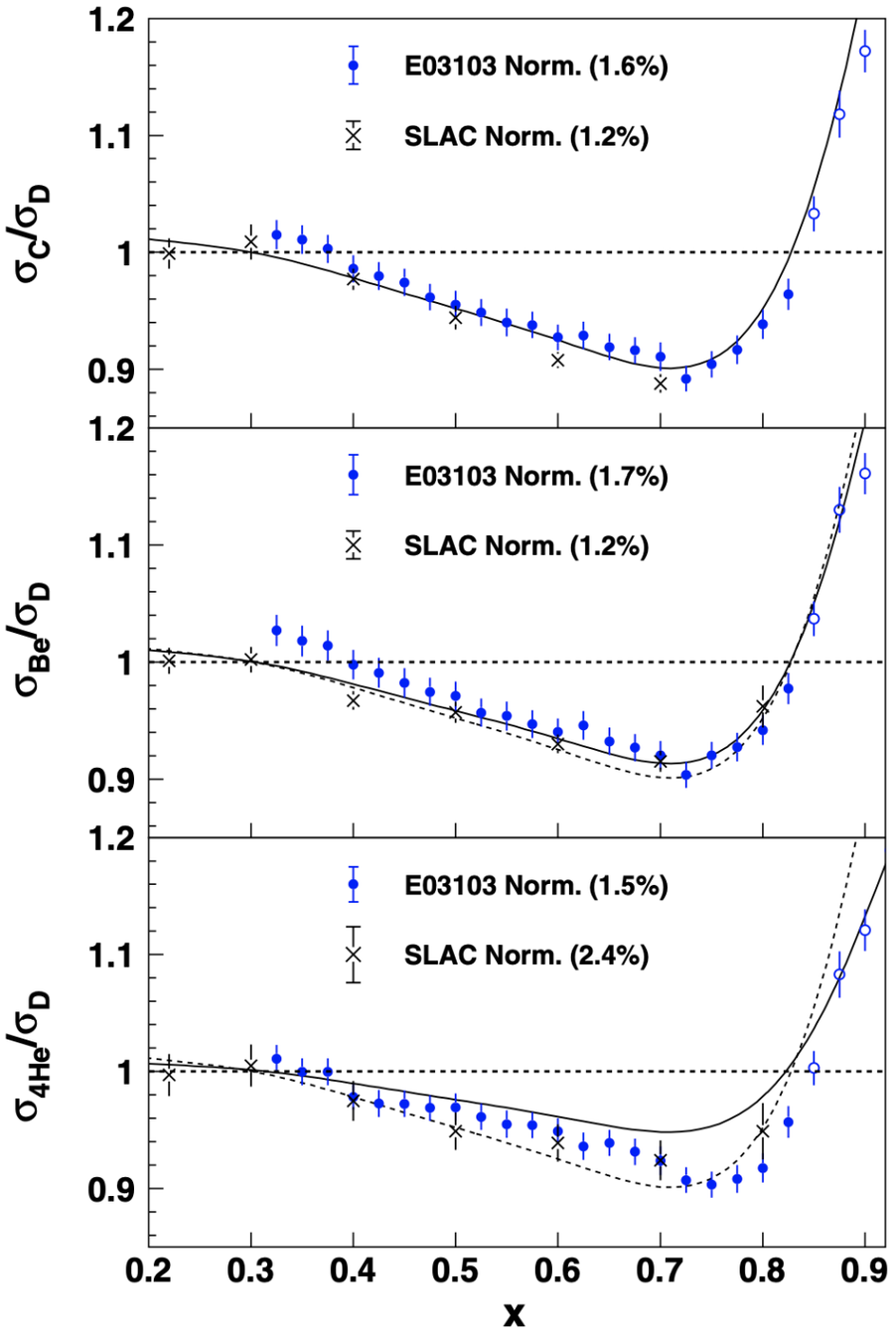
Experimental studies of EMC Effect

A dependence of DIS @ SLAC



[Phys. Rev. D **49**, 4348,1 May 1994]

EMC Effect @ Jlab E03-103

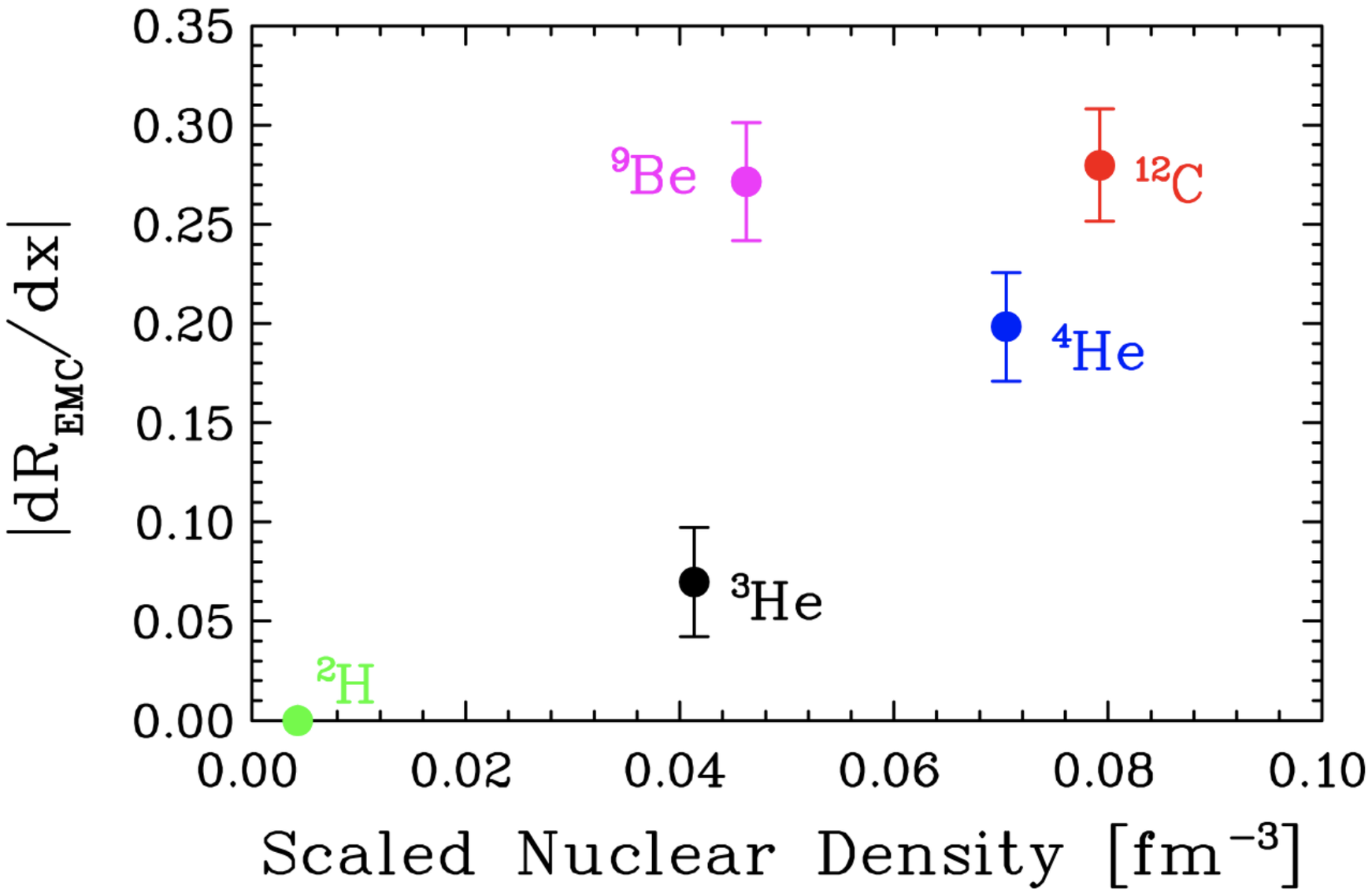


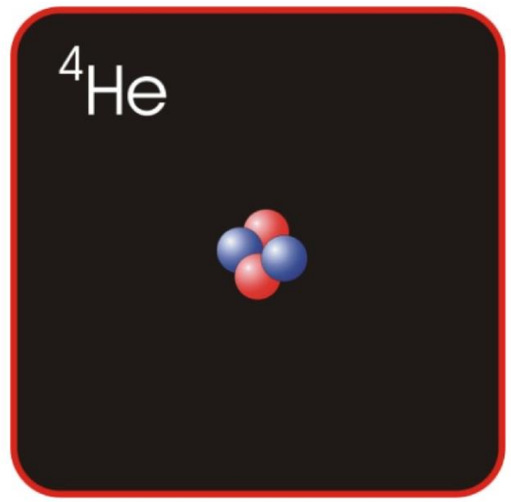
[Phys. Rev. Lett. **103**, 202301,13 November 2009]

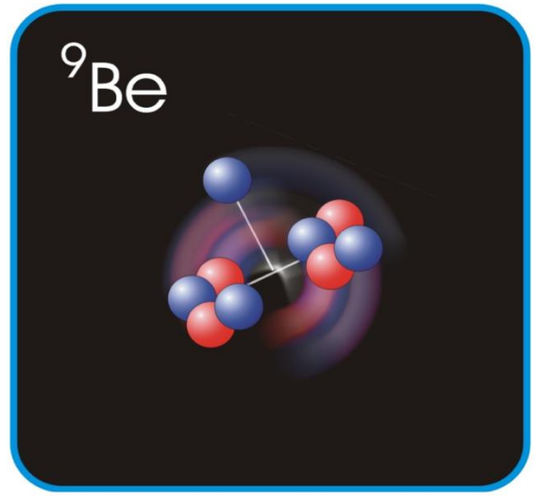
+ Also measured @ CERN, FNAL, DESY

Experimental studies of EMC Effect

The slope of EMC effect as a function of average nuclear density (Jlab E03-103)







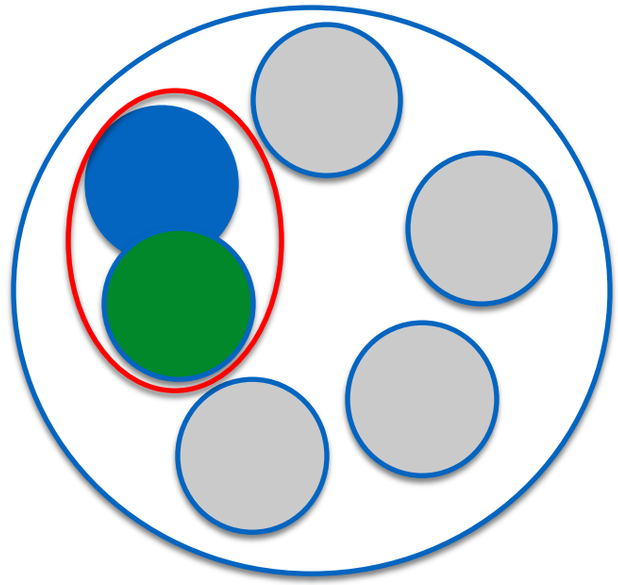
[Phys. Rev. Lett. **103**, 202301,13 November 2009]

Possible Explanations of EMC Effect

- **Short-range correlations (SRC):**

  => most nucleons at any one time are unmodified, but some are substantially modified

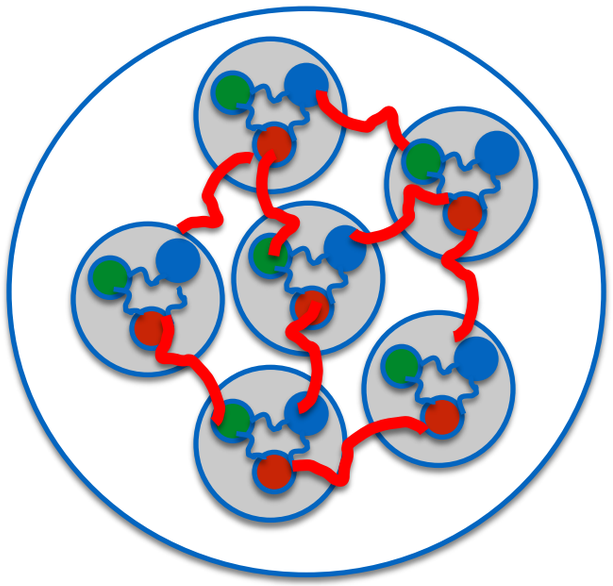
  => size of the EMC effect in different nuclei correlates linearly with the density of SRC pairs.



- **Mean-field modification:**

  => nucleons may allow quarks in different nucleons to interact directly

  => all nucleons experience some degree of structure modification



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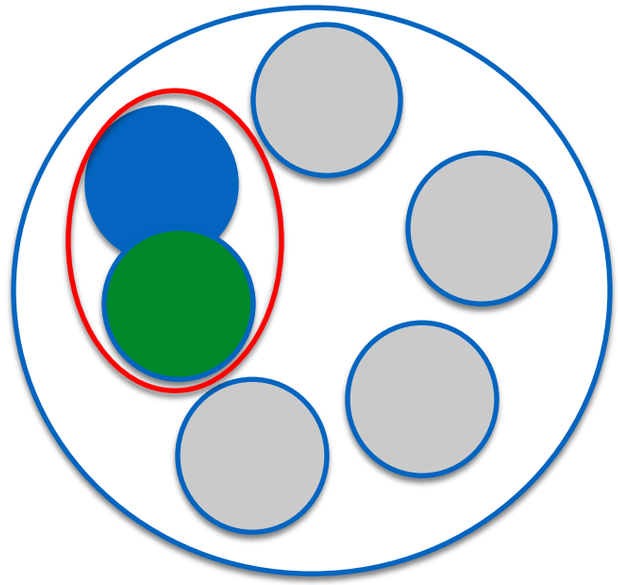

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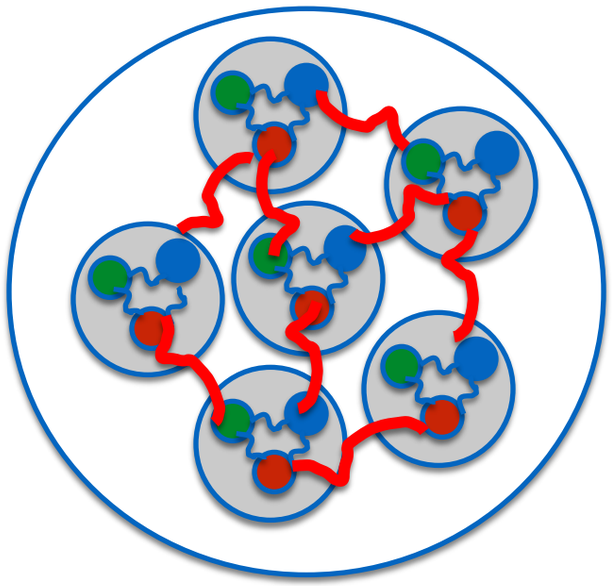


Gluon EMC Effects

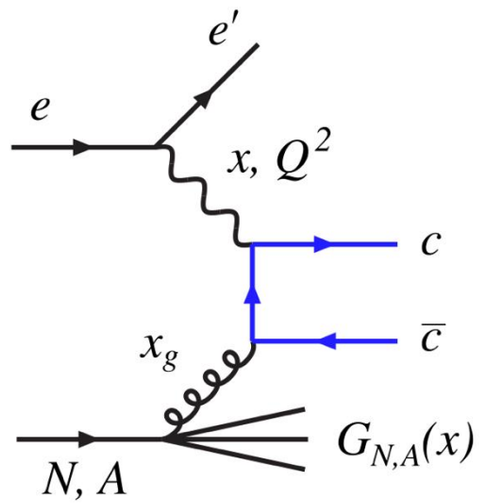
- Nucleon EMC Effect:

$$\frac{d\sigma}{dx} \propto F^2(x), \quad F^2(x) = x\sum_q e_q^2[q(x) + \bar{q}(x)] \qquad R_{EMC}(x) = \frac{F_A^2(x)}{F_D^2(x)}$$

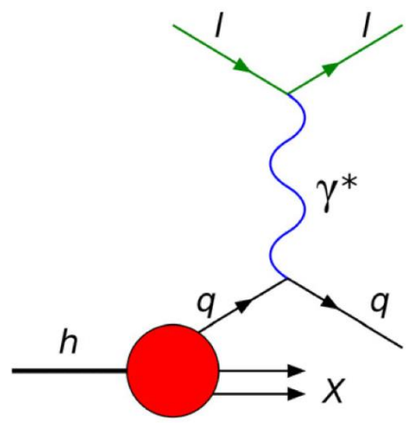
- Gluon (up)polarized EMC Effect:

$$R_{EMC}(x) = \frac{g^N(x)}{g^p(x)} \qquad \Delta R_{EMC}(x) = \frac{\Delta g^N(x)}{\Delta g^p(x)}$$

Direct Access (J/Psi production):



Indirect Access (pDIS):



$$\frac{d^2\sigma}{d\Omega dE'}^{\downarrow\Uparrow} - \frac{d^2\sigma}{d\Omega dE'}^{\uparrow\Uparrow} =$$

$$= \frac{4\alpha^2 E'}{Q^2 E_0 M \nu}\left[(E_0 + E'\cos\theta)g_1(x,Q^2) - 2xM g_2(x,Q^2)\right]$$

Should be good for wider x range

Might be sensitive to gluons contribution at x <<1

Gluon EMC Effects

Theoretical Predictions based on mean-field model of nuclear structure:

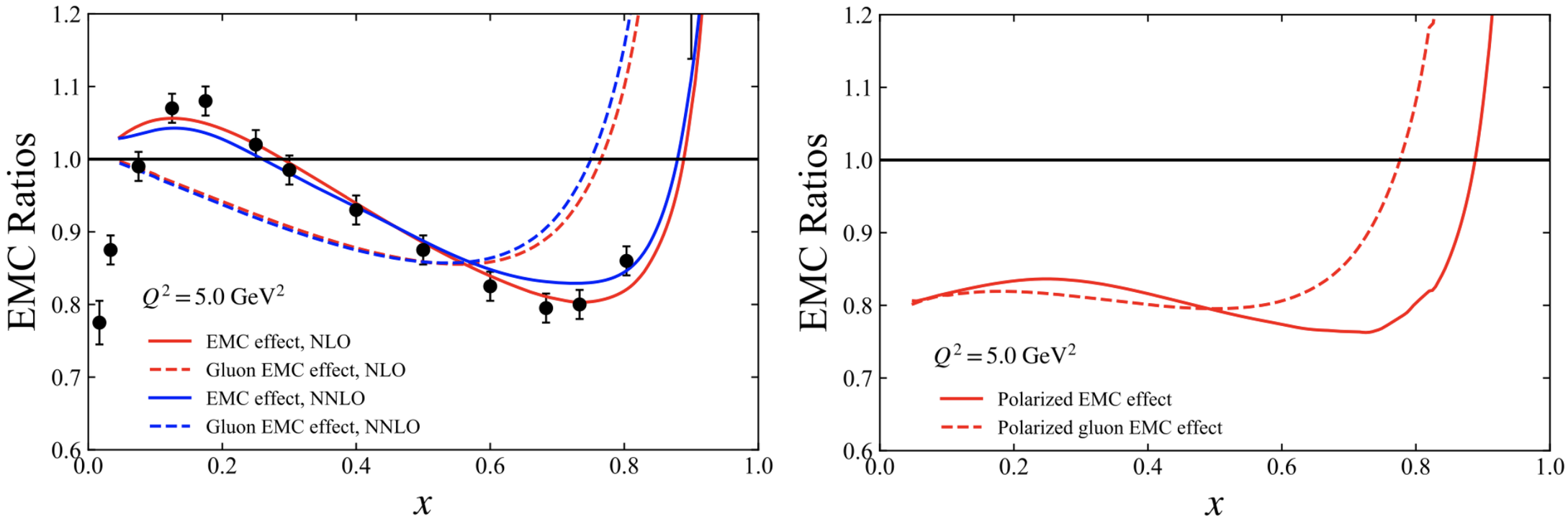


Figure 3. (Left panel) Unpolarized EMC ratios for the structure functions $F_{2A}(x)/F_{2N}(x)$ (solid) and the unpolarized gluon distributions $g_A(x)/g_p(x)$ (dashed). (Right panel) Polarized EMC ratios for the structure functions $g_{1A}(x)/g_{1p}(x)$ (solid) and polarized gluon distributions $\Delta g_A(x)/\Delta g_p(x)$ (dashed). The empirical data points are the unpolarized nuclear matter results for the EMC ratio from reference [53].

[X G Wang *et al* 2022 *J. Phys. G: Nucl. Part. Phys.* **49** 03LT01]

Current Plan

- Got BNL guest account last week. Still working on getting computing account.
- Interested in (up)polarized e+p and e + 3He to start with.
- First to look at unpolarized J/psi production (dimuon decay mode).

  => Kinematics;

  => Acceptance;

  => Can I get out Cross Section

  => Access to gluon PDF?
- Look at D meson production channel.
- Look at polarized physics in BeAGLE
- Look at what can we get out with polarized J/psi production pDIS.