

Nucleon Axial FF with HISQ

Yin Lin 林胤

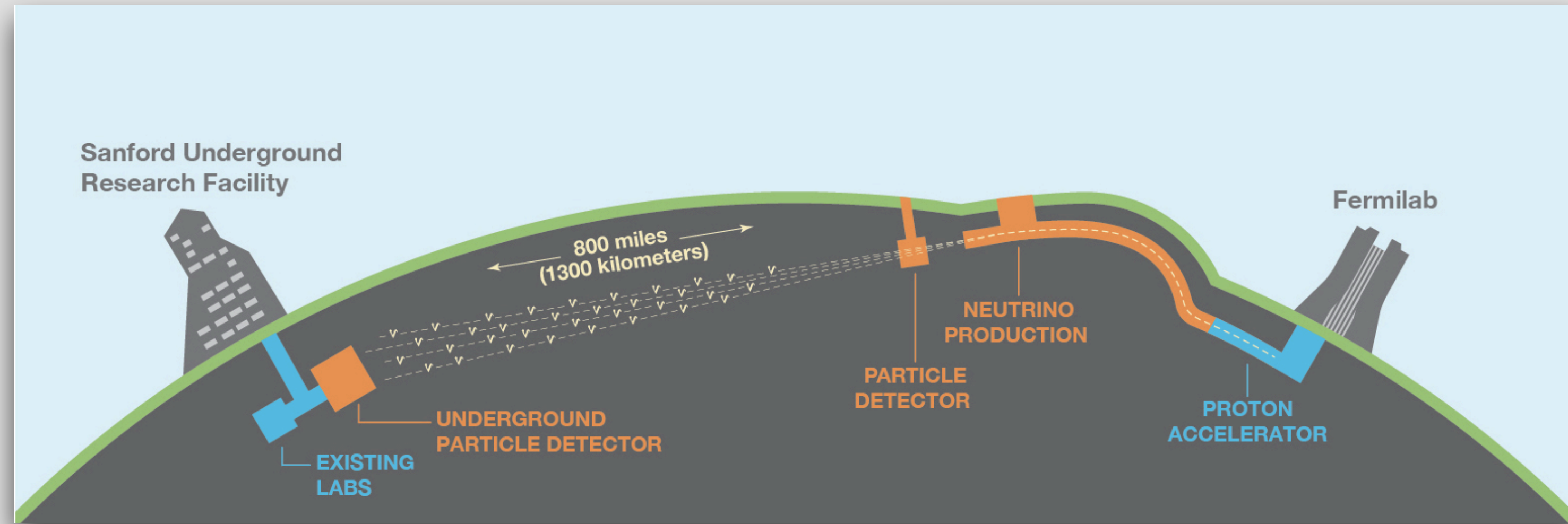
yin01@mit.edu

Fermilab/University of Chicago → MIT

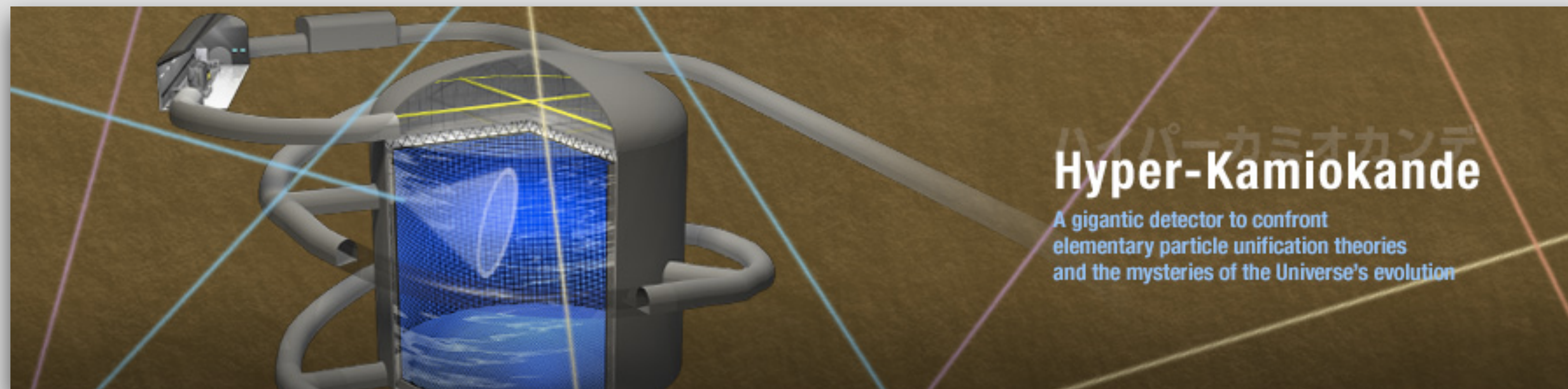


JULY 26-30 2021, ZOOM/GATHER@MIT

Neutrino Oscillation Experiments

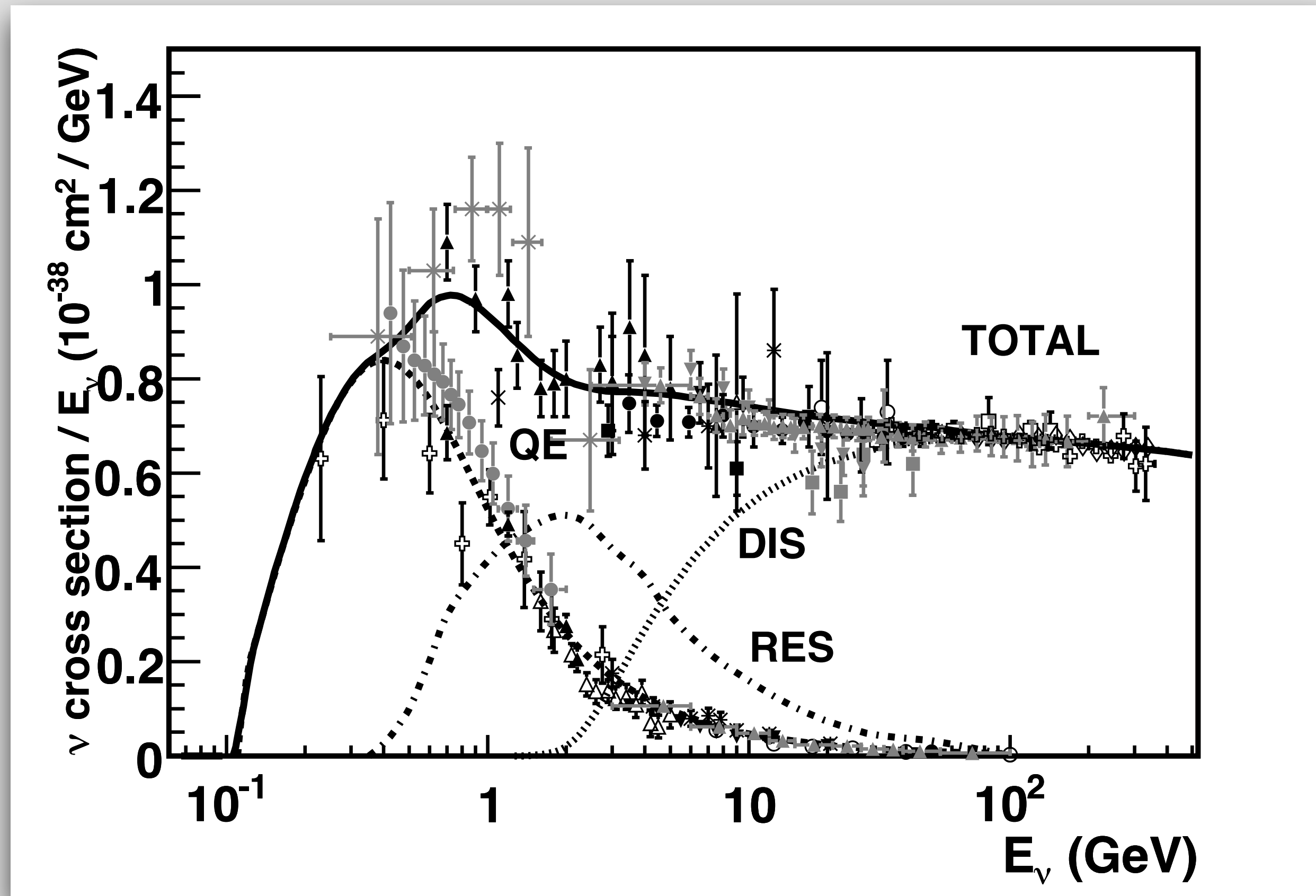


[DUNE Collaboration]



[Hyper-K Collaboration]

Neutrino Cross Section



(cross section per nucleon, isoscalar targets)

[Formaggio, Zeller, Rev. Mod. Phys. 84, 1307 (2012), [arXiv:1305.7513](https://arxiv.org/abs/1305.7513)]

E_ν



Deep-inelastic (DIS)

$\langle N | J^\mu J^\nu | N \rangle$, PDF, ...

Resonance Region (RES)

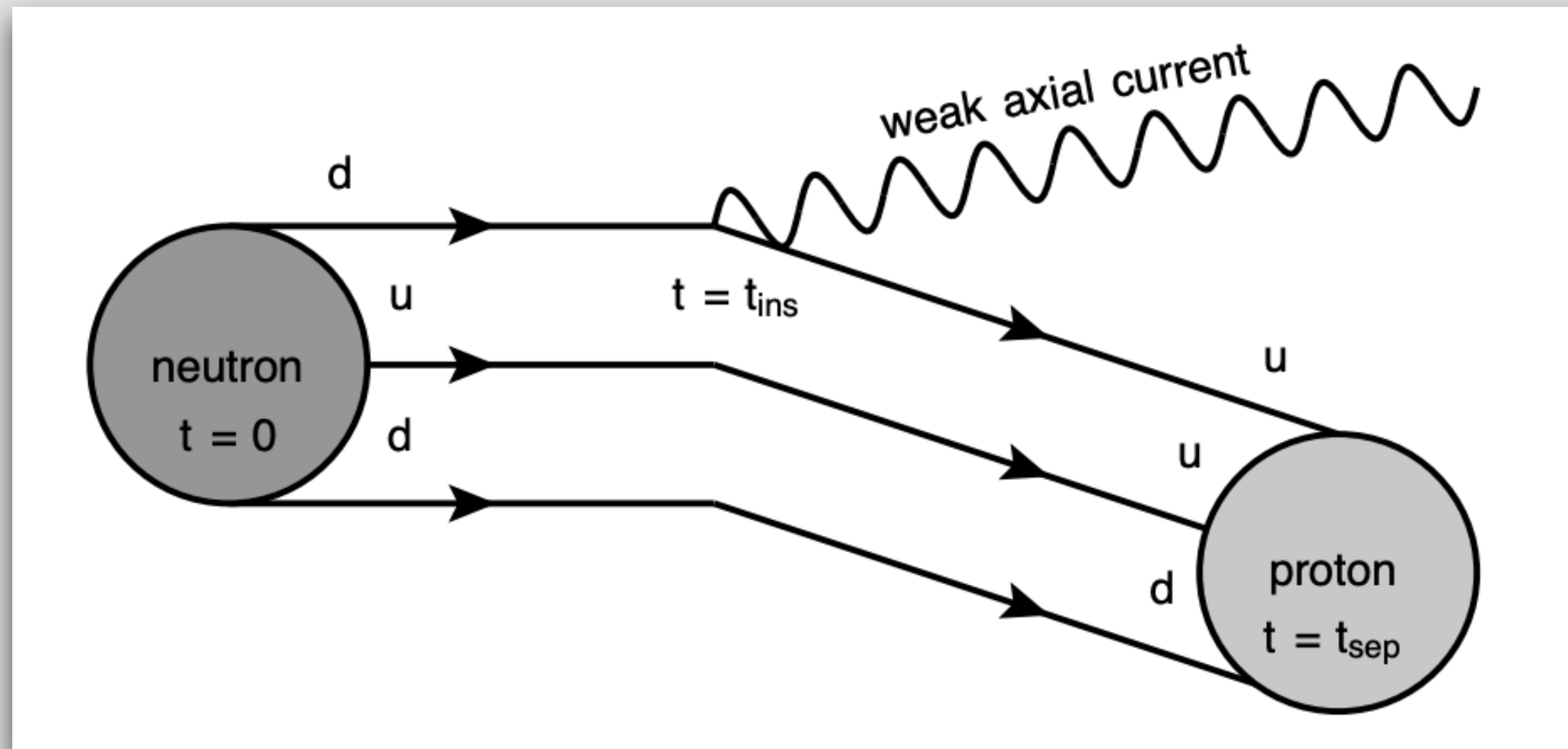
$\langle N | J^\mu | \text{res.} \rangle$, ...

Quasi-elastic (QE)

$\langle N | J^\mu | N \rangle$, ...

[USQCD white paper, [arXiv:1904.09931](https://arxiv.org/abs/1904.09931)]

Charged Current Nucleon Axial FF

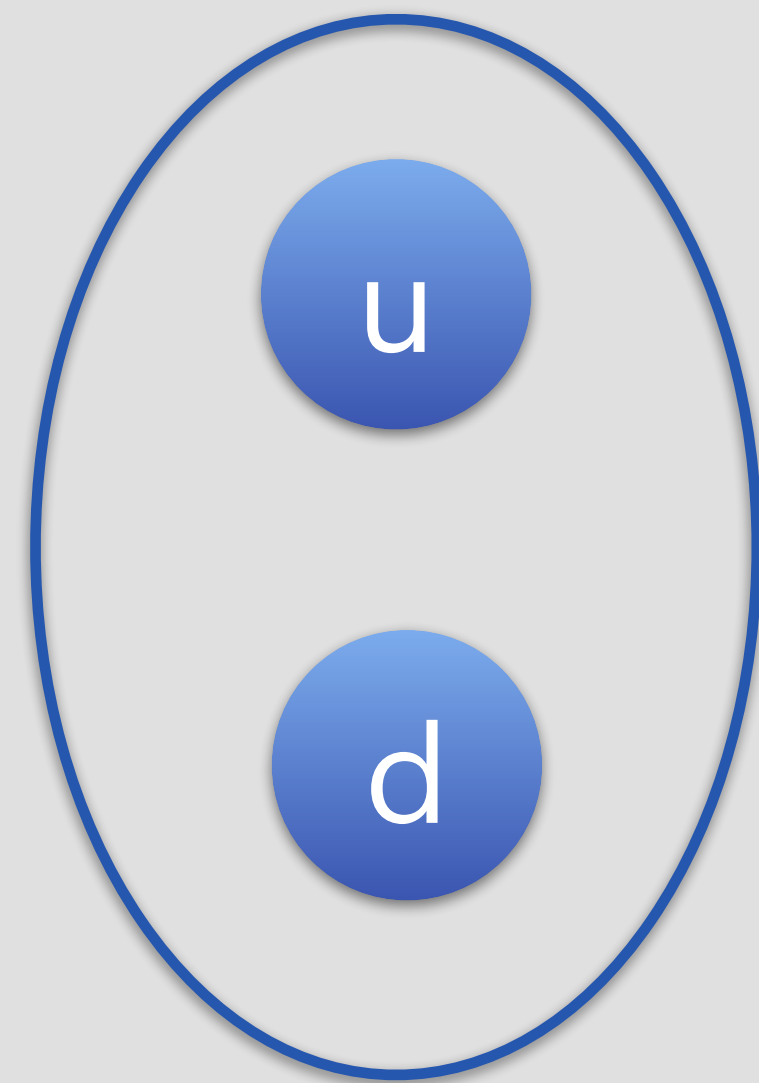


[C.C Chang et al, Nature 558, 91-94 (2018), [arXiv:1805.12130](https://arxiv.org/abs/1805.12130)]

$$F_A(Q = 0) = g_A = 1.2756 \pm 0.0013$$

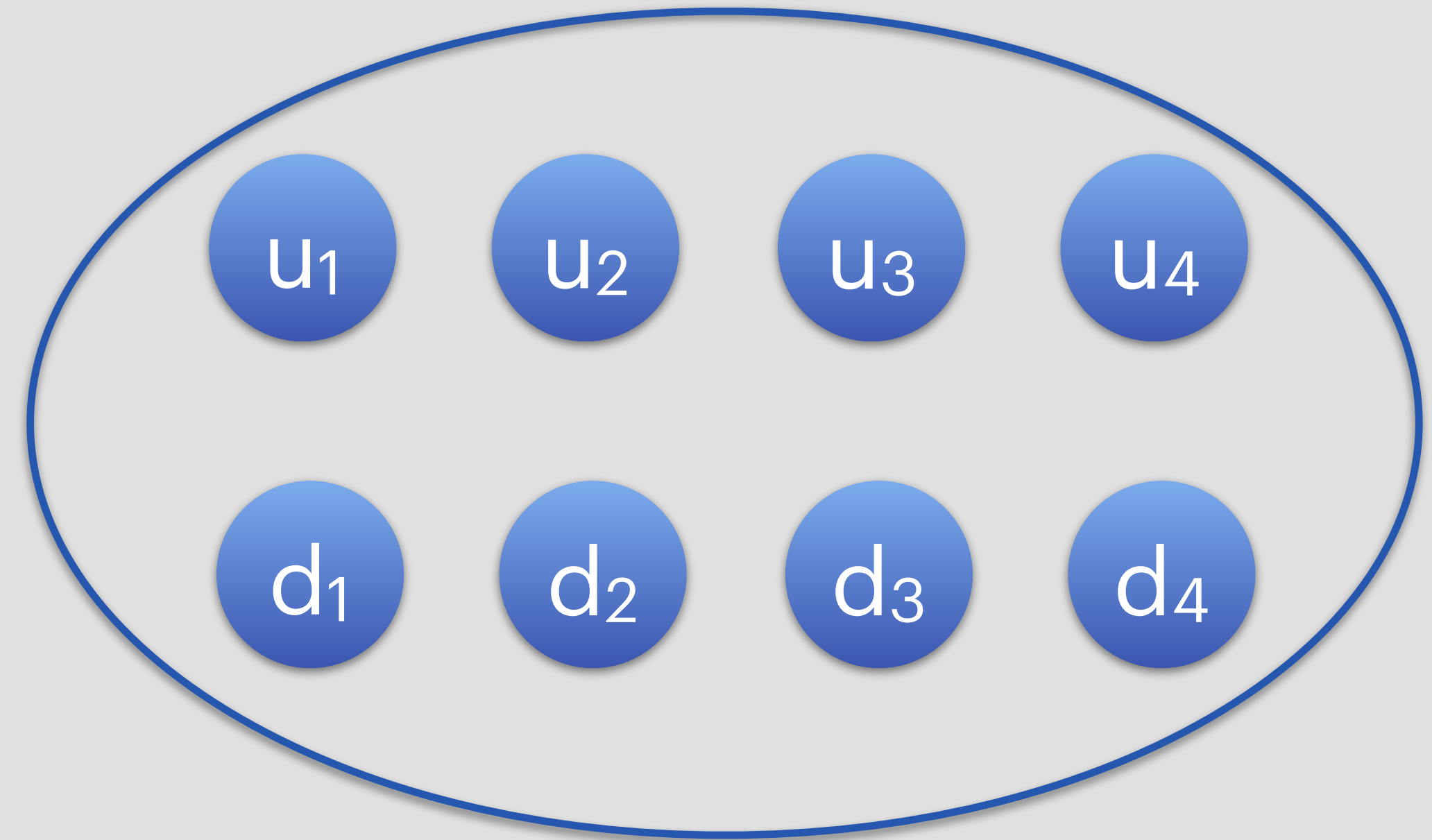
Staggered QCD extends QCD

Physical QCD



$SU(2)_F$

Staggered QCD

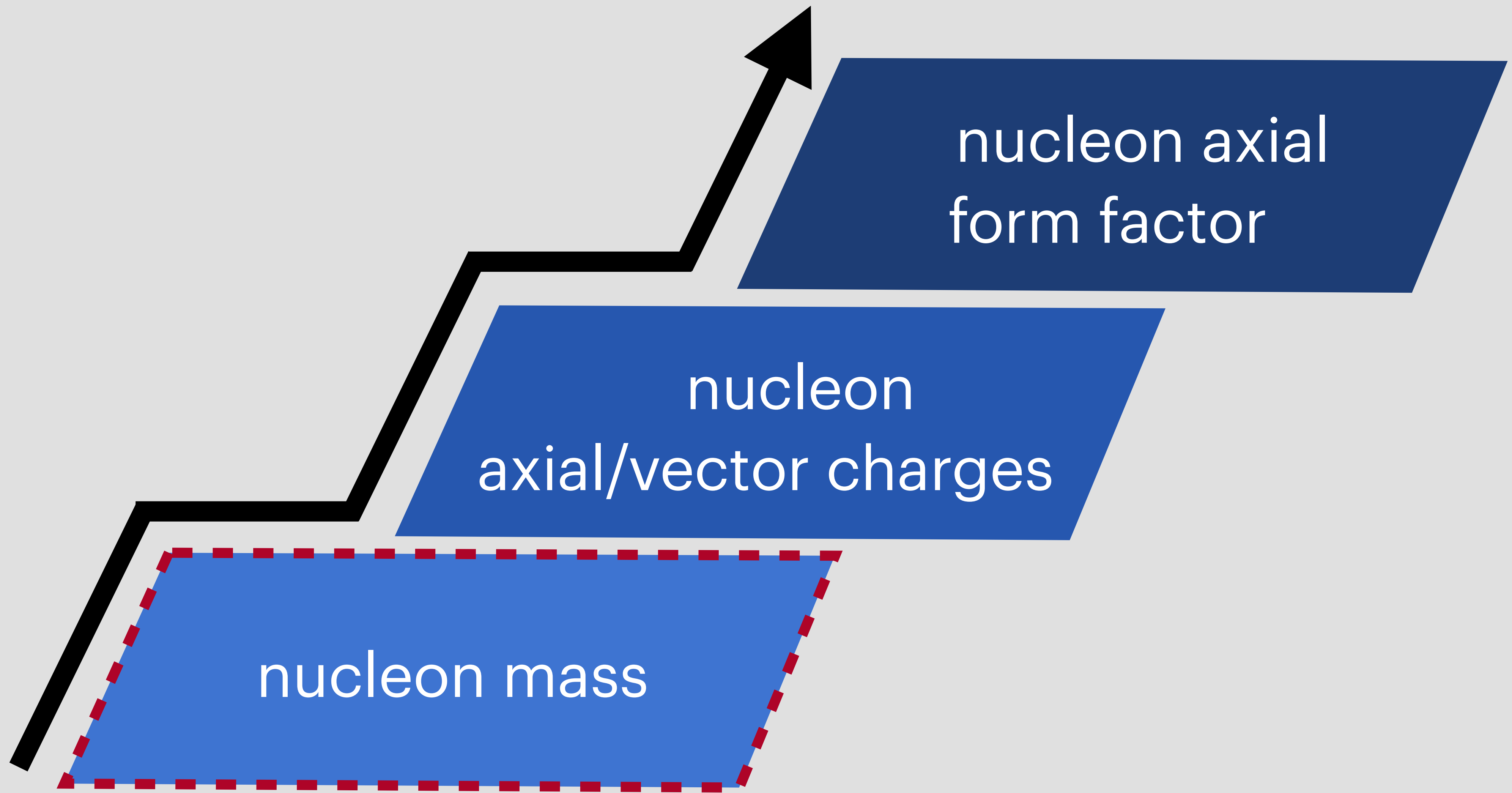


$SU(8)_{FT} \supset SU(2)_F \times SU(4)_T$

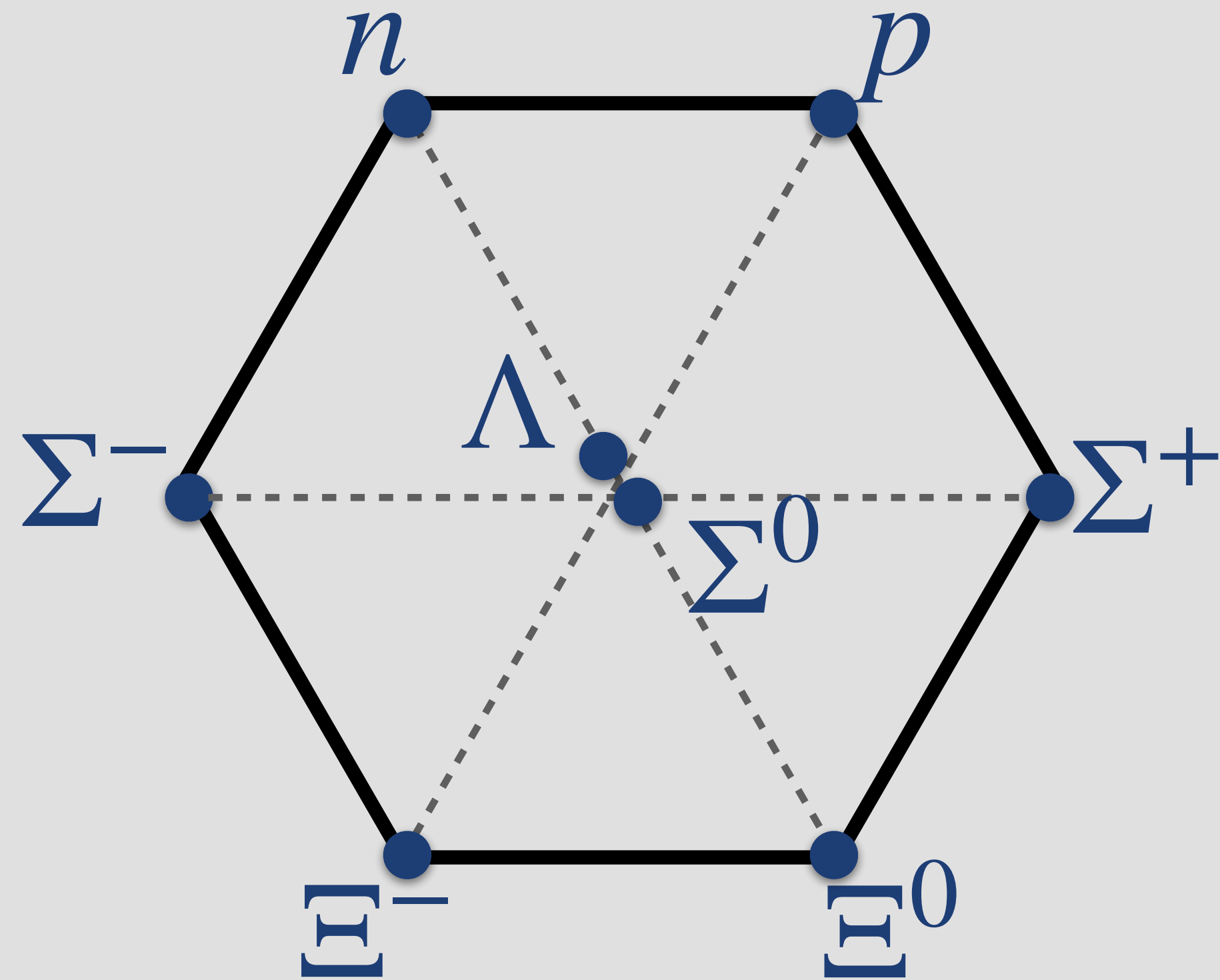
Single-taste observables are physical



QCD \subset Staggered QCD



168-fold Way of Staggered Nucleons



spin

flavor

$$SU(2)_S \times SU(3)_F$$

$$\left(\frac{1}{2}, 8_M \right)$$

$SU(3)_F$ QCD

Baryons in the octet are degenerate

irrep notation:

SU(2) group - spin notation

other group - dimension + possible subscript

spin

flavor-taste

$$SU(2)_S \times SU(8)_{FT}$$

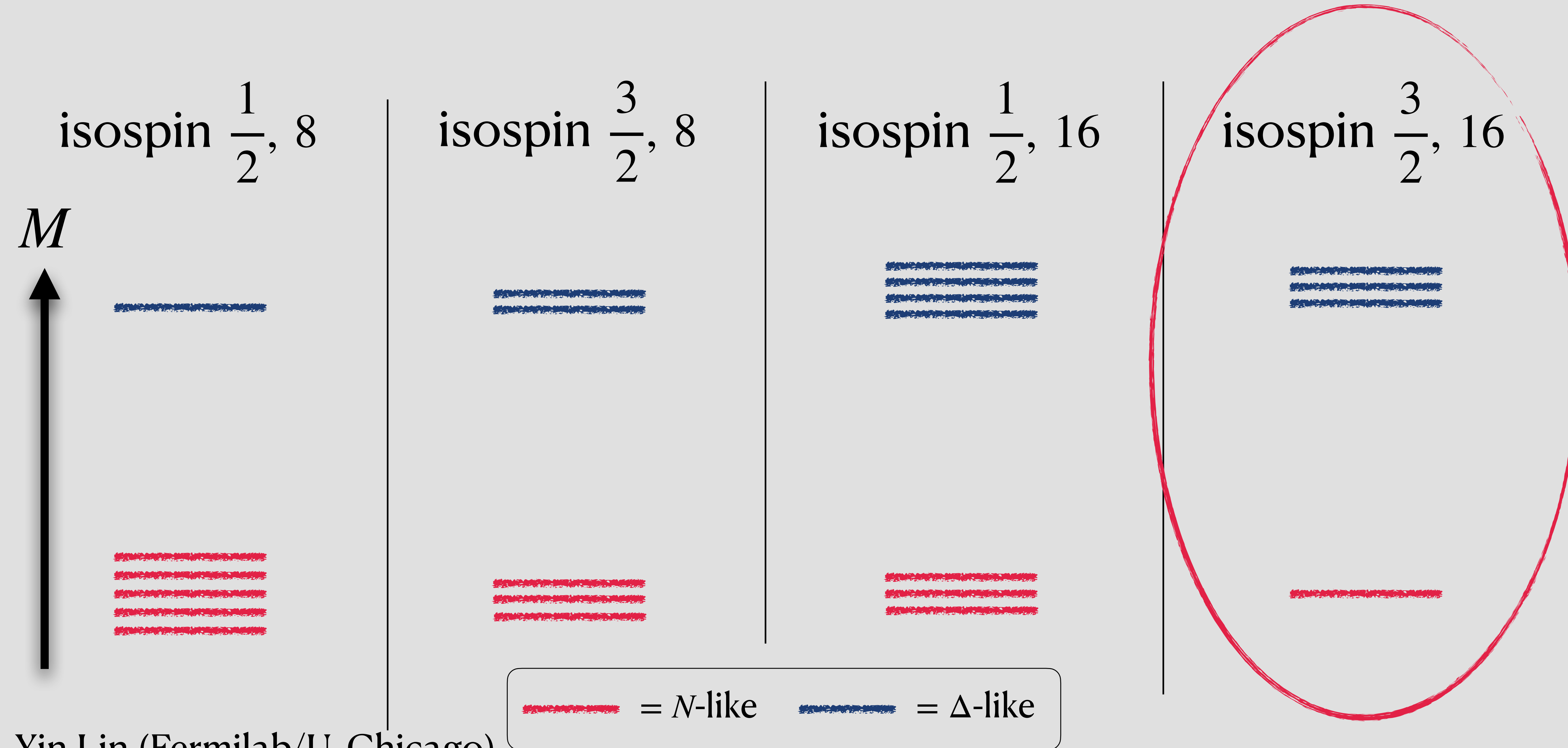
$$\left(\frac{1}{2}, 168_M \right)$$

contains single-taste nucleons

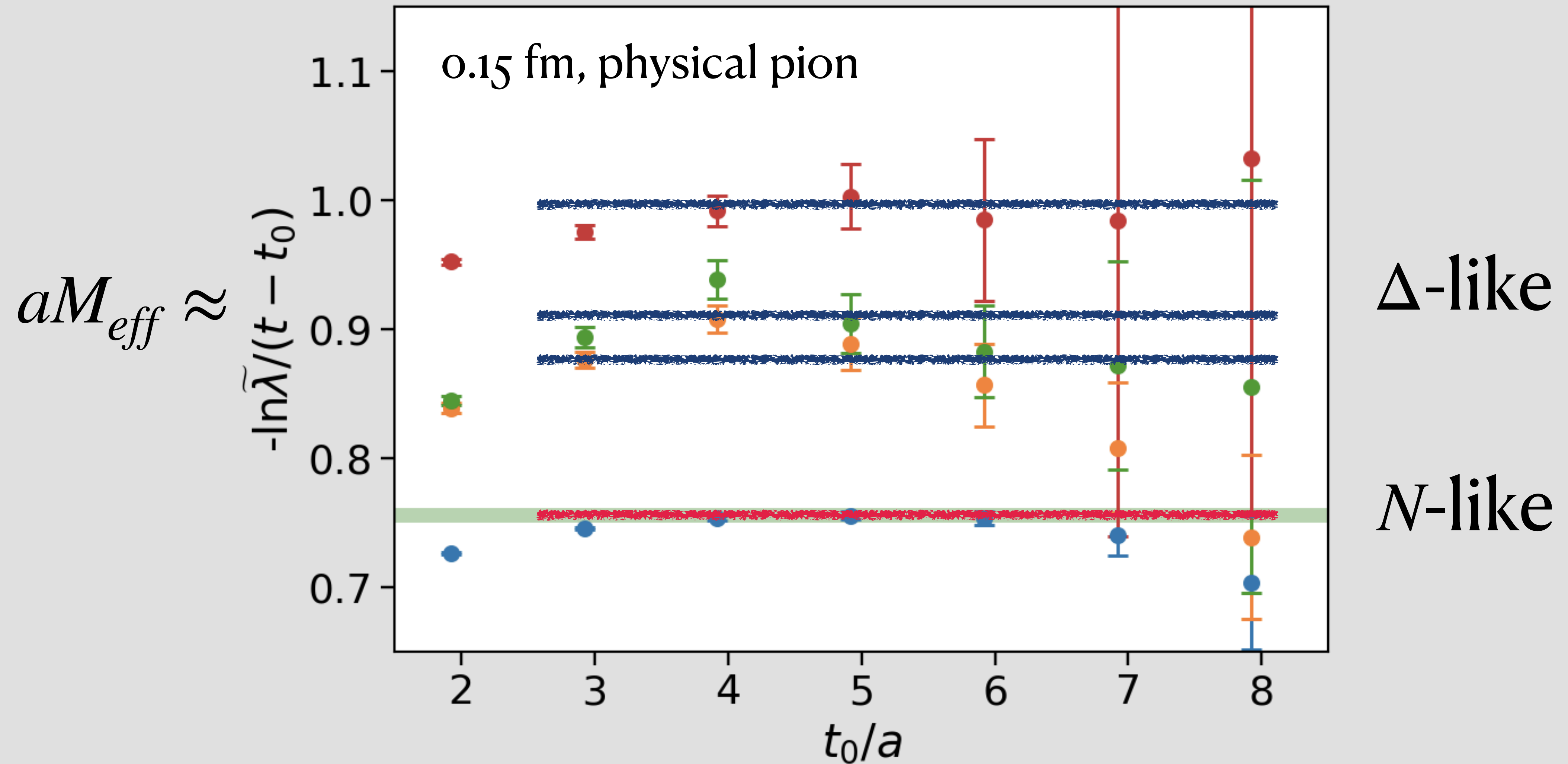
Staggered QCD

Baryons in the 168-plet are degenerate

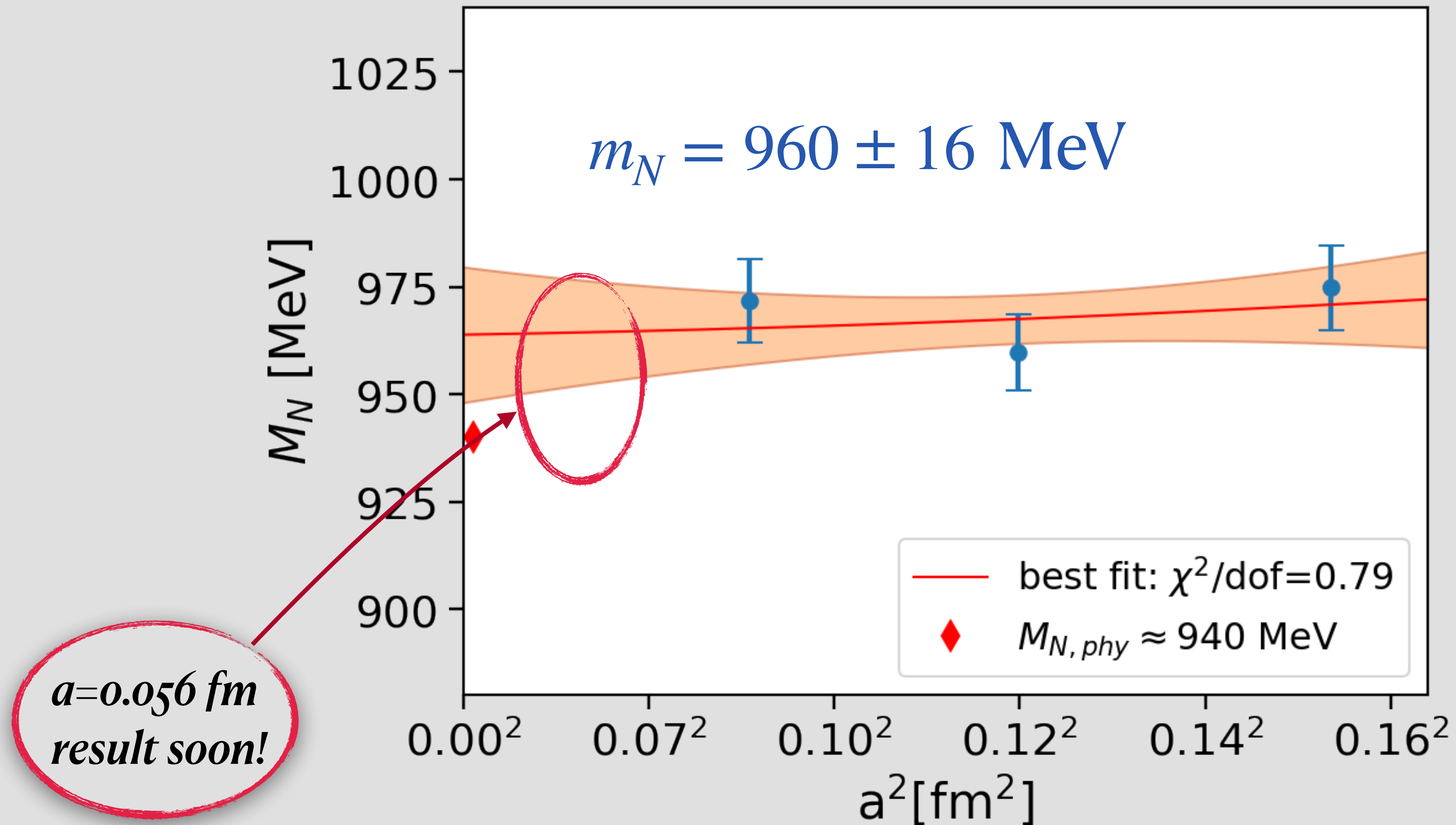
Spectrum of Staggered Nucleons with $SU(2)_F$

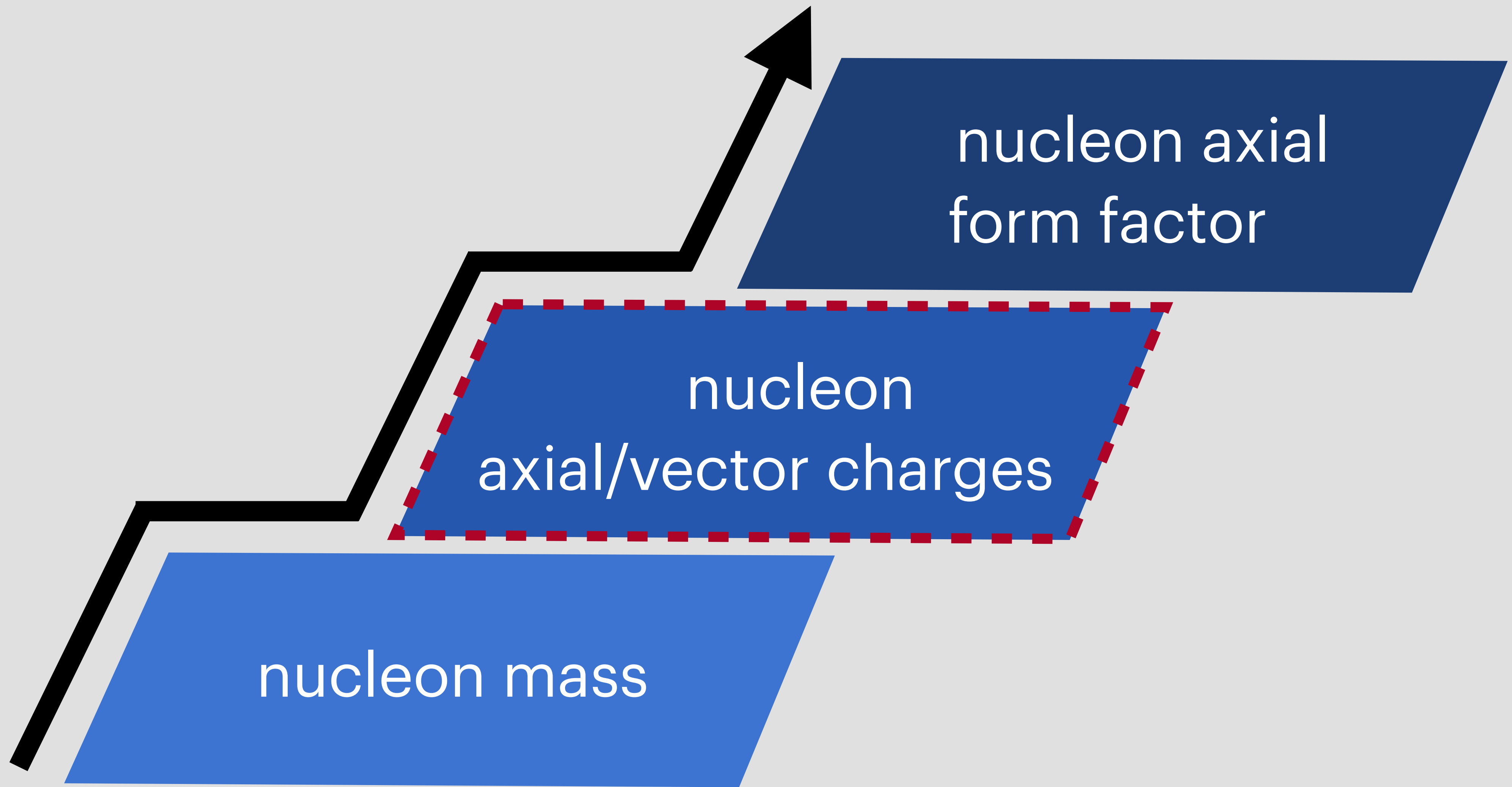


Two-point Correlators of Isospin-3/2, 16 Irrep

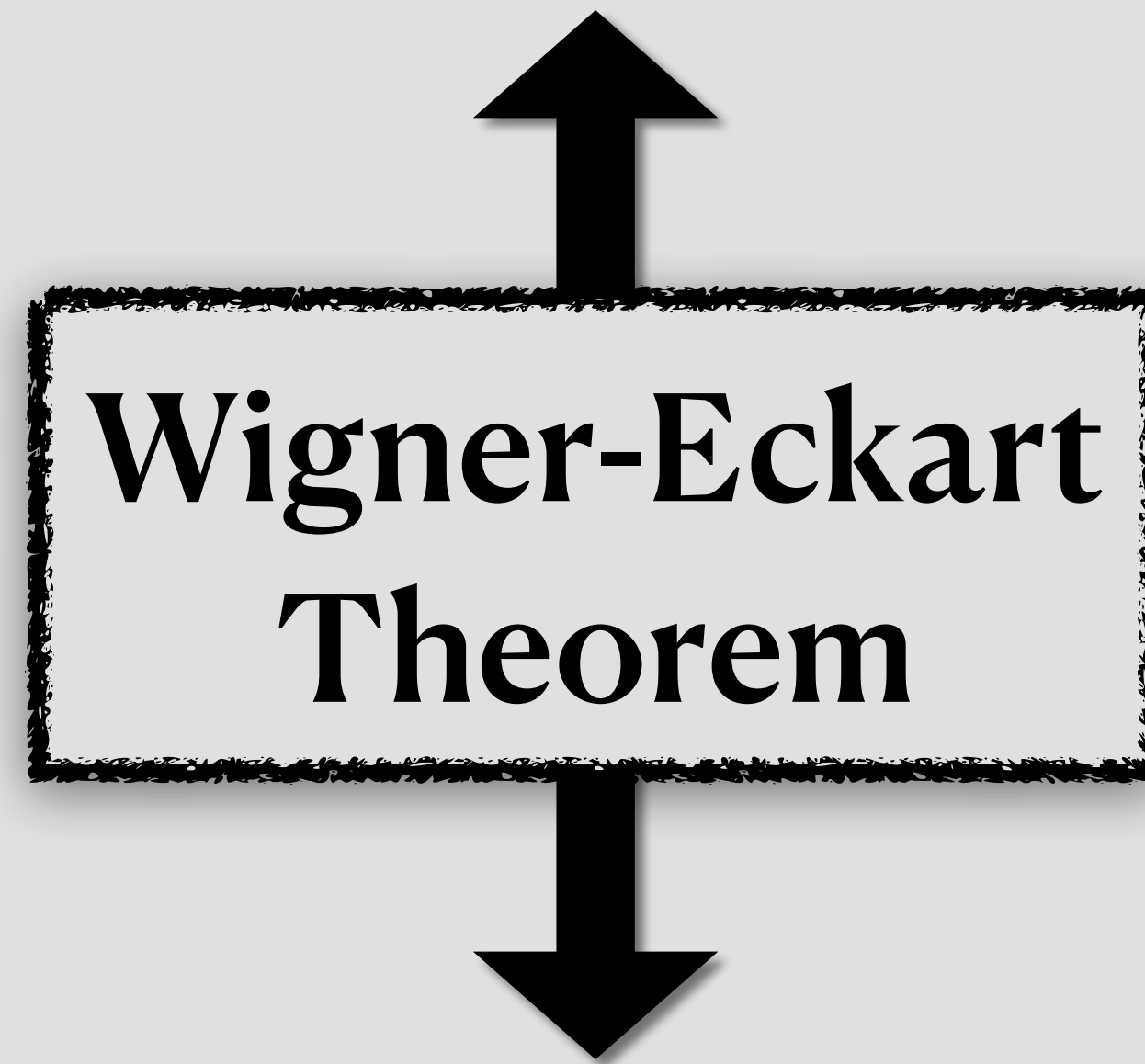


Continuum Extrapolation of Nucleon Masses



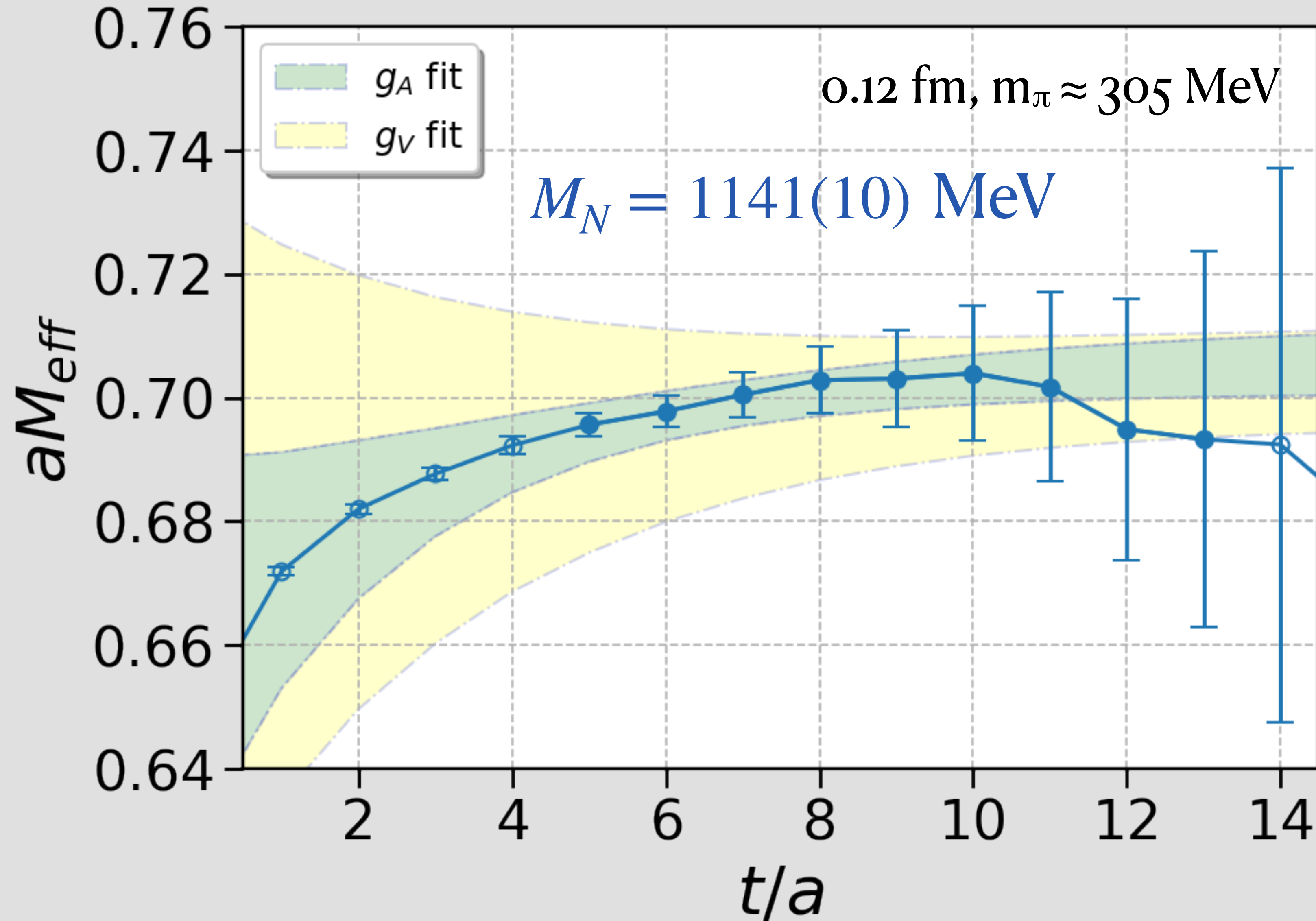


Single-taste matrix elements are physical

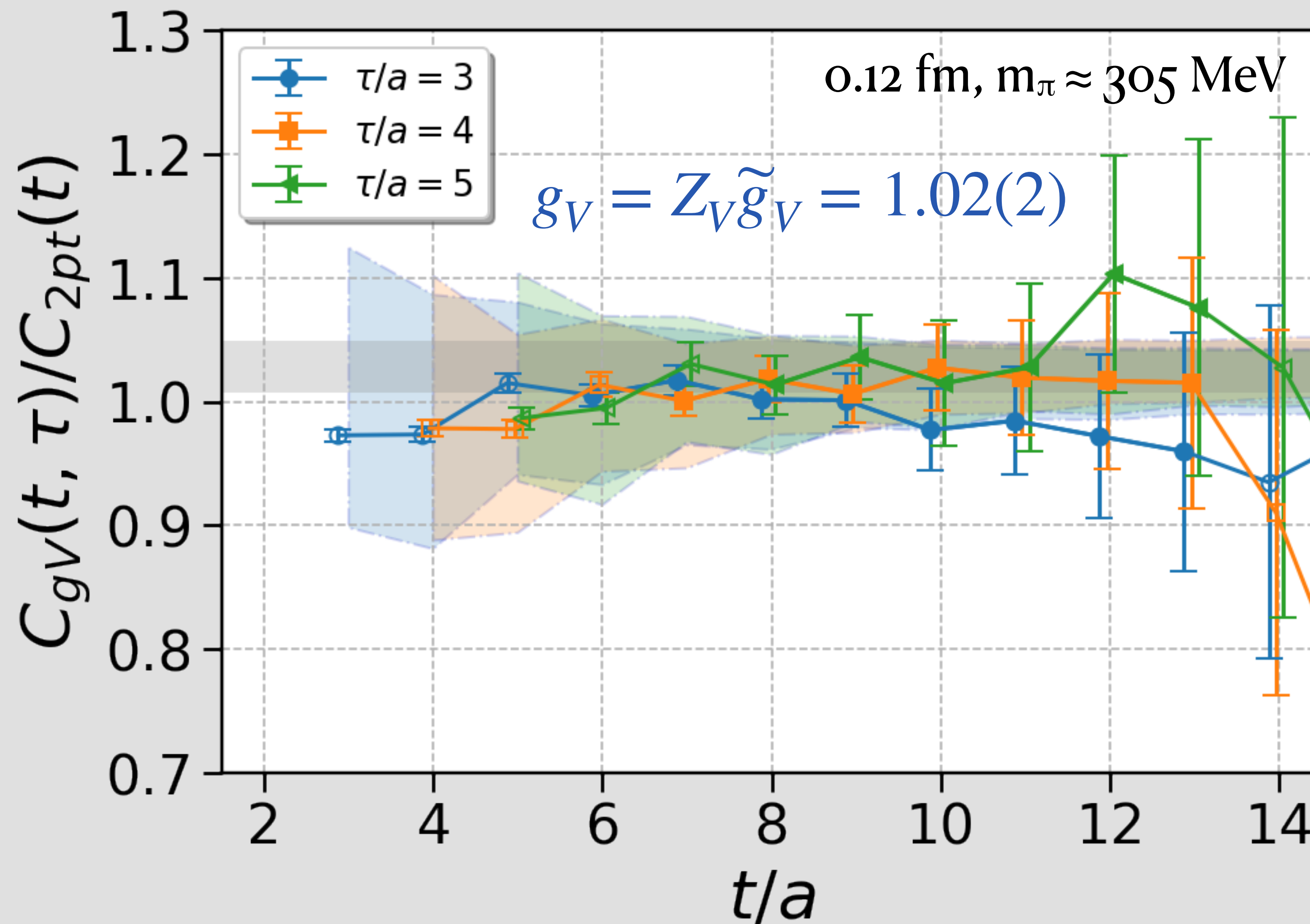


Non-single-taste matrix elements are practical

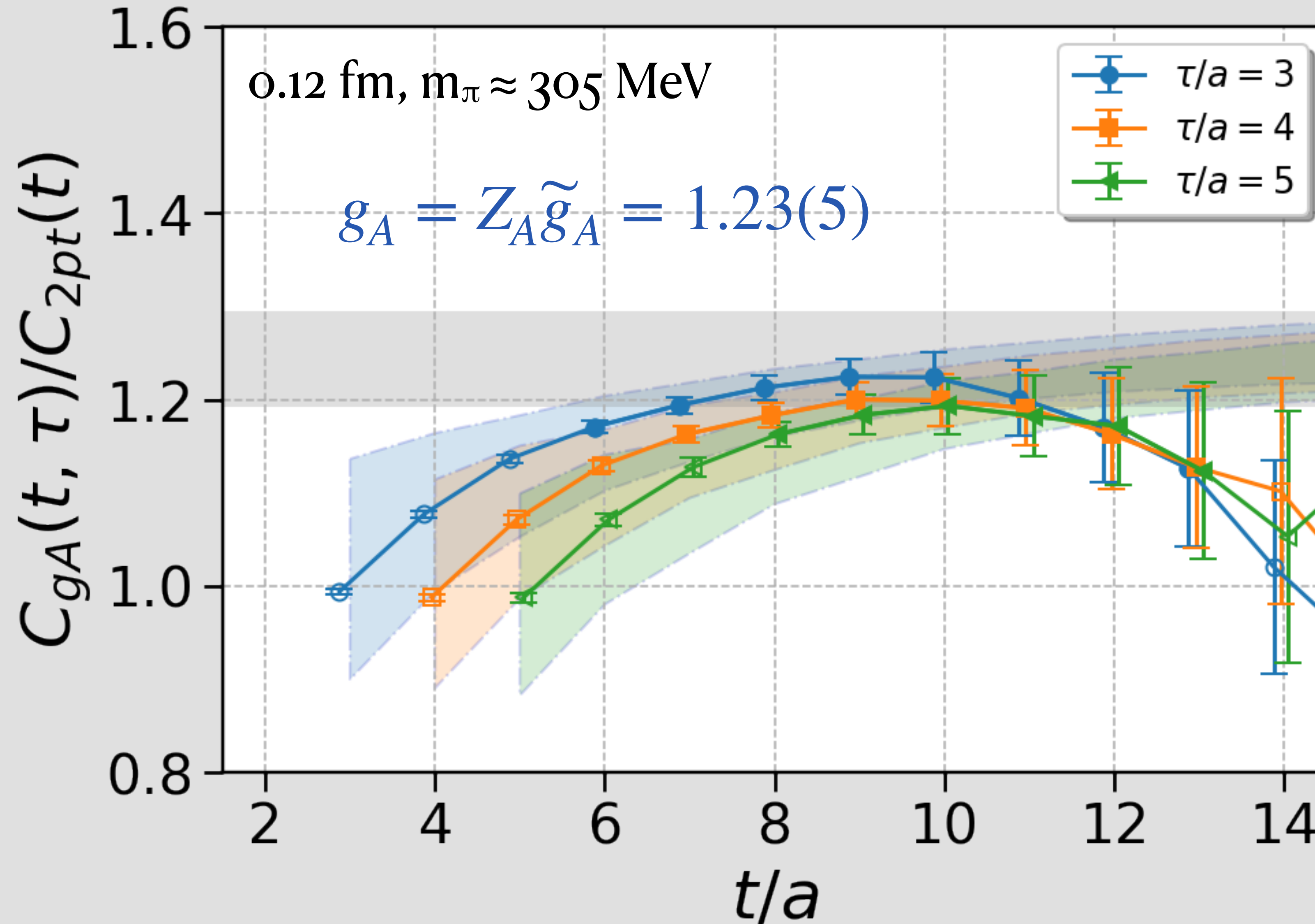
Two-point Correlators

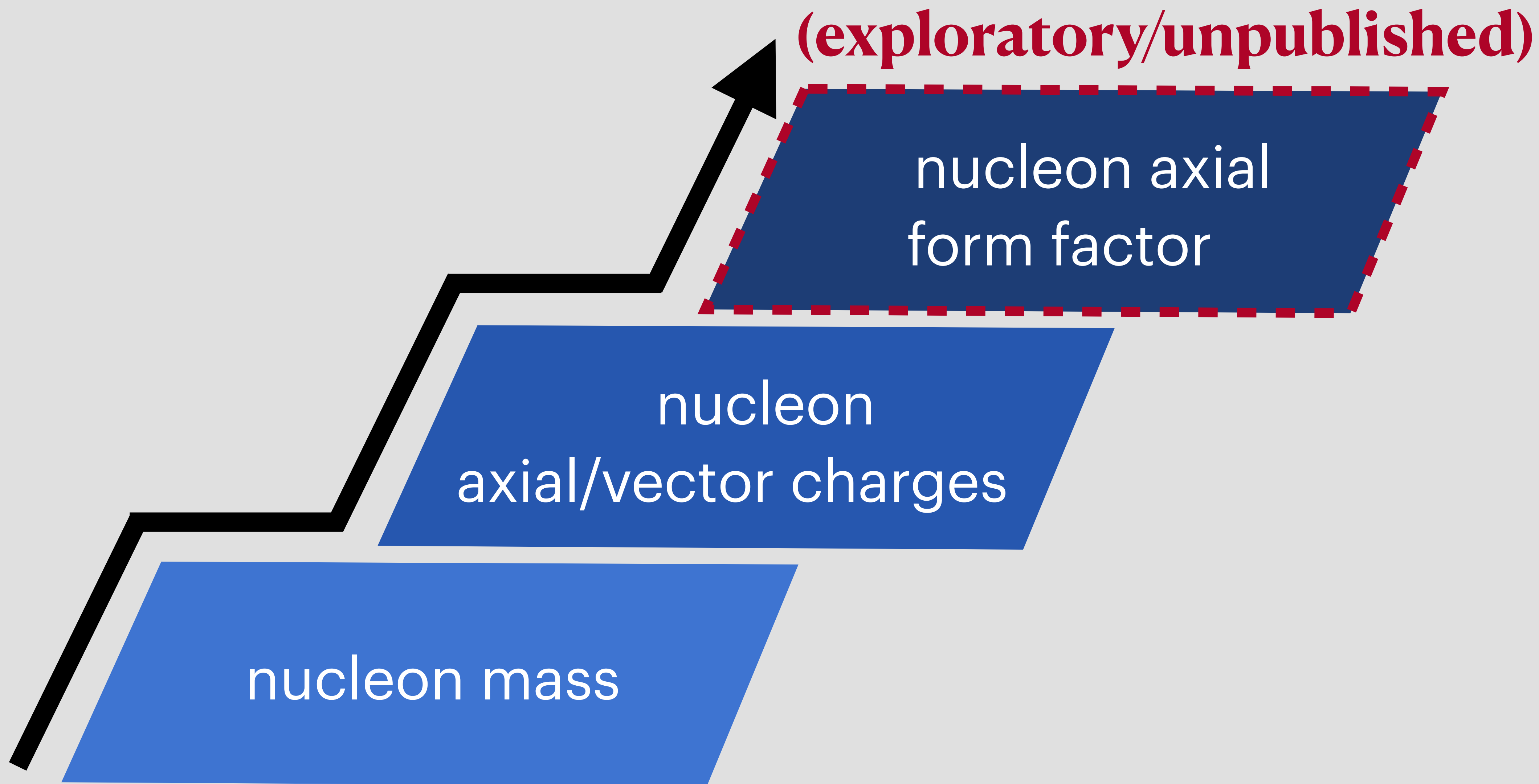


Three-point Correlators: g_V

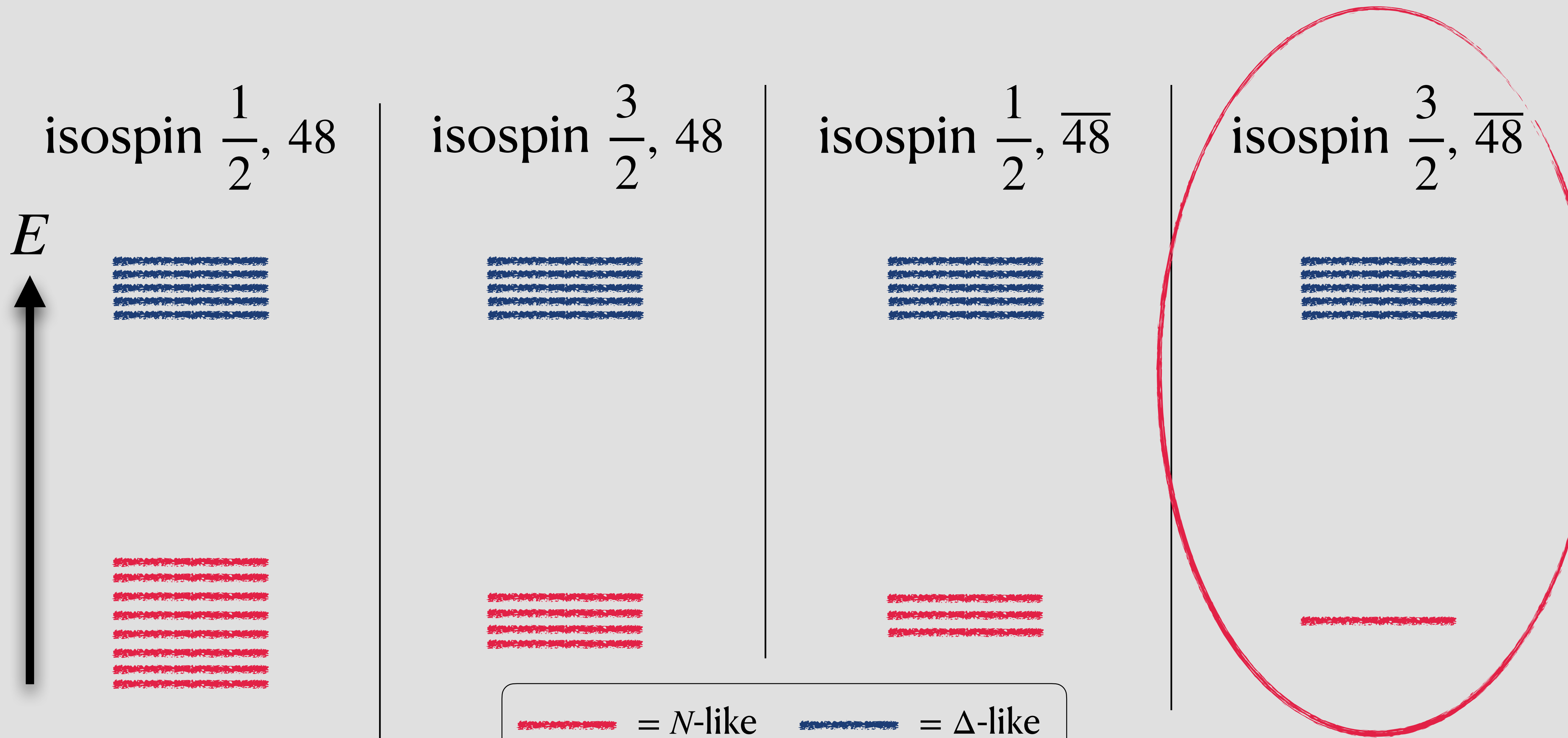


Three-point Correlators: g_A





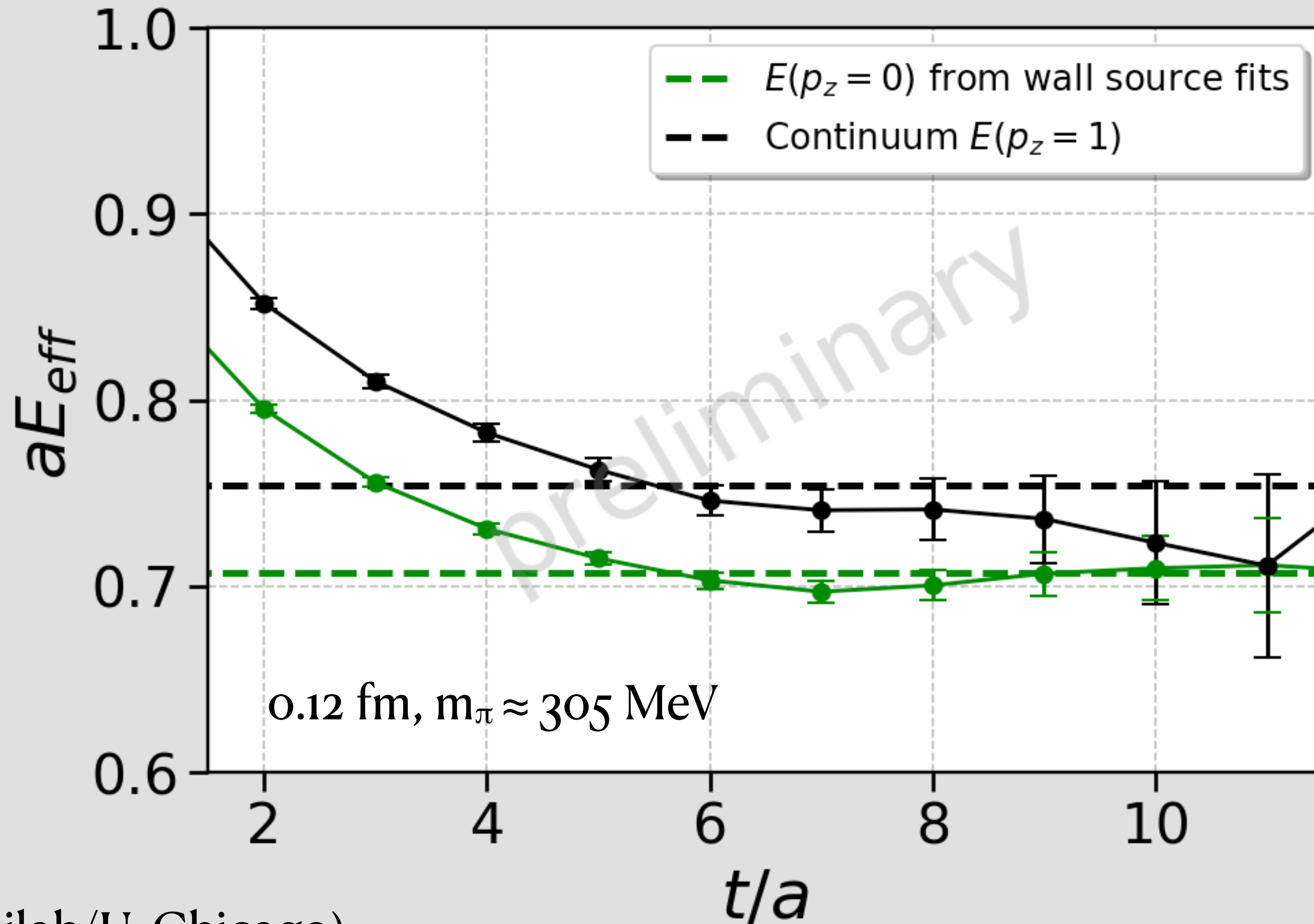
Spectrum of Staggered Nucleons with On-axis Momentum



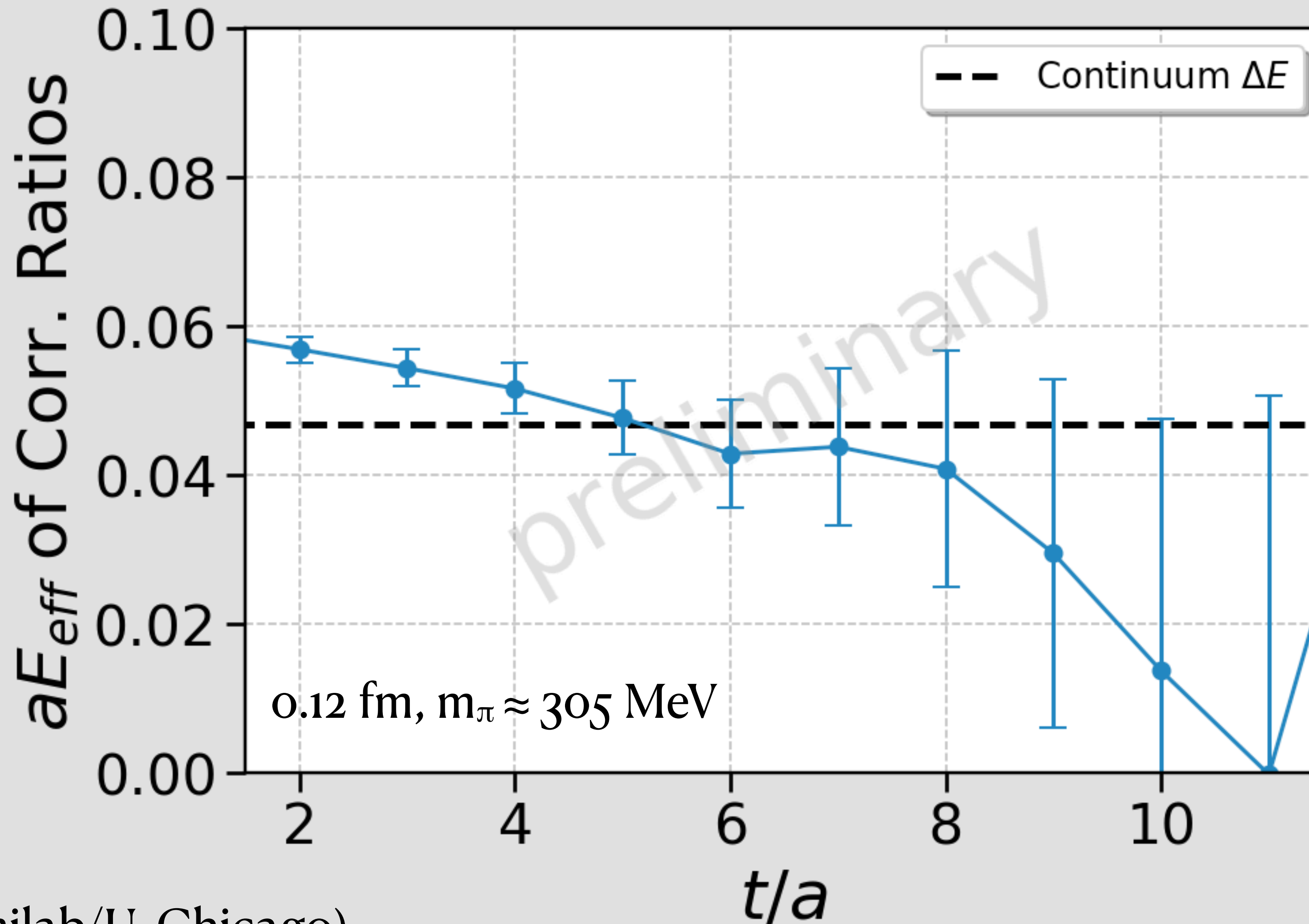
Yin Lin (Fermilab/U. Chicago)

[Aaron Meyer, unpublished notes]

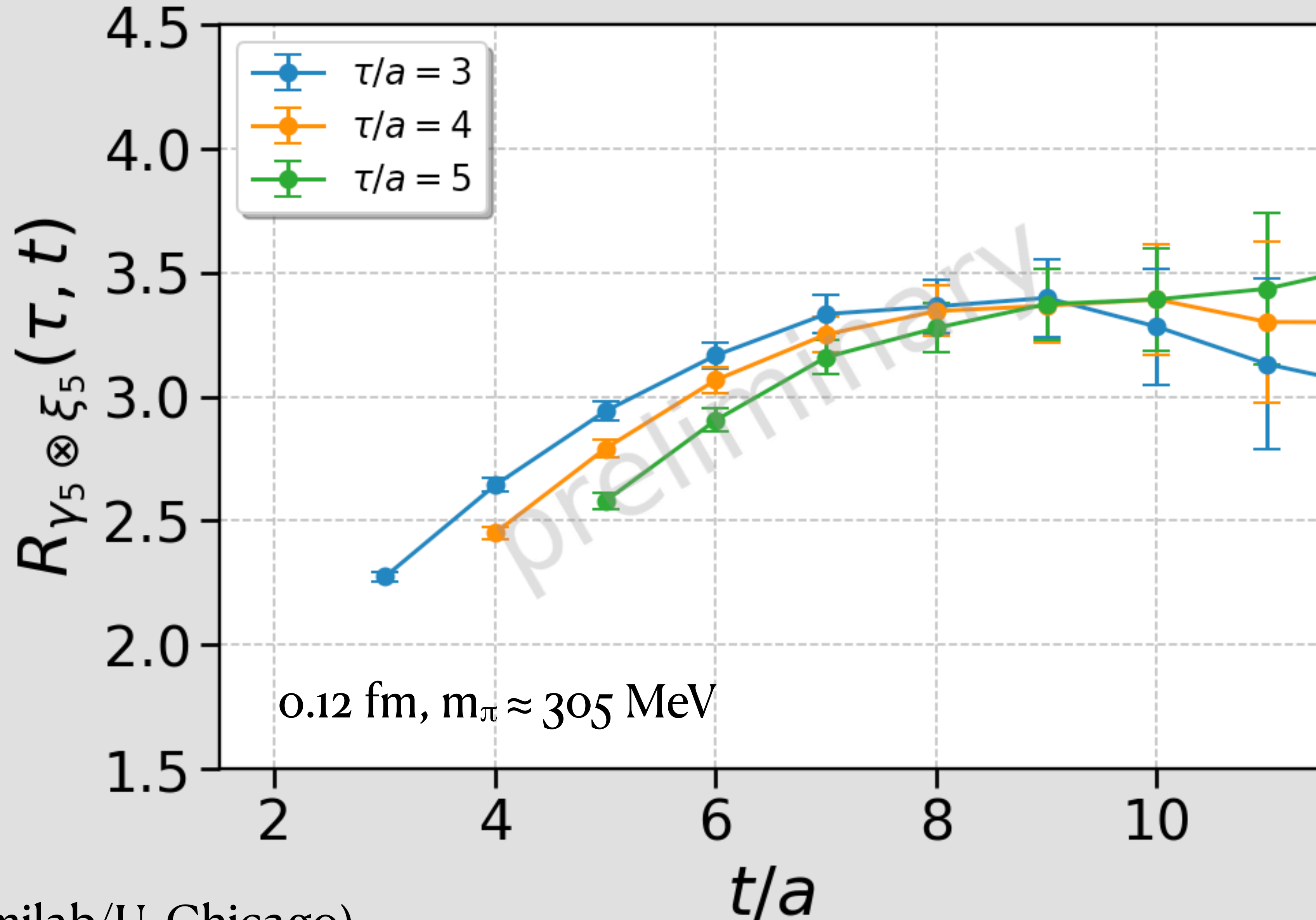
Nucleon Energy at $\mathbf{p} = (0,0,1)$



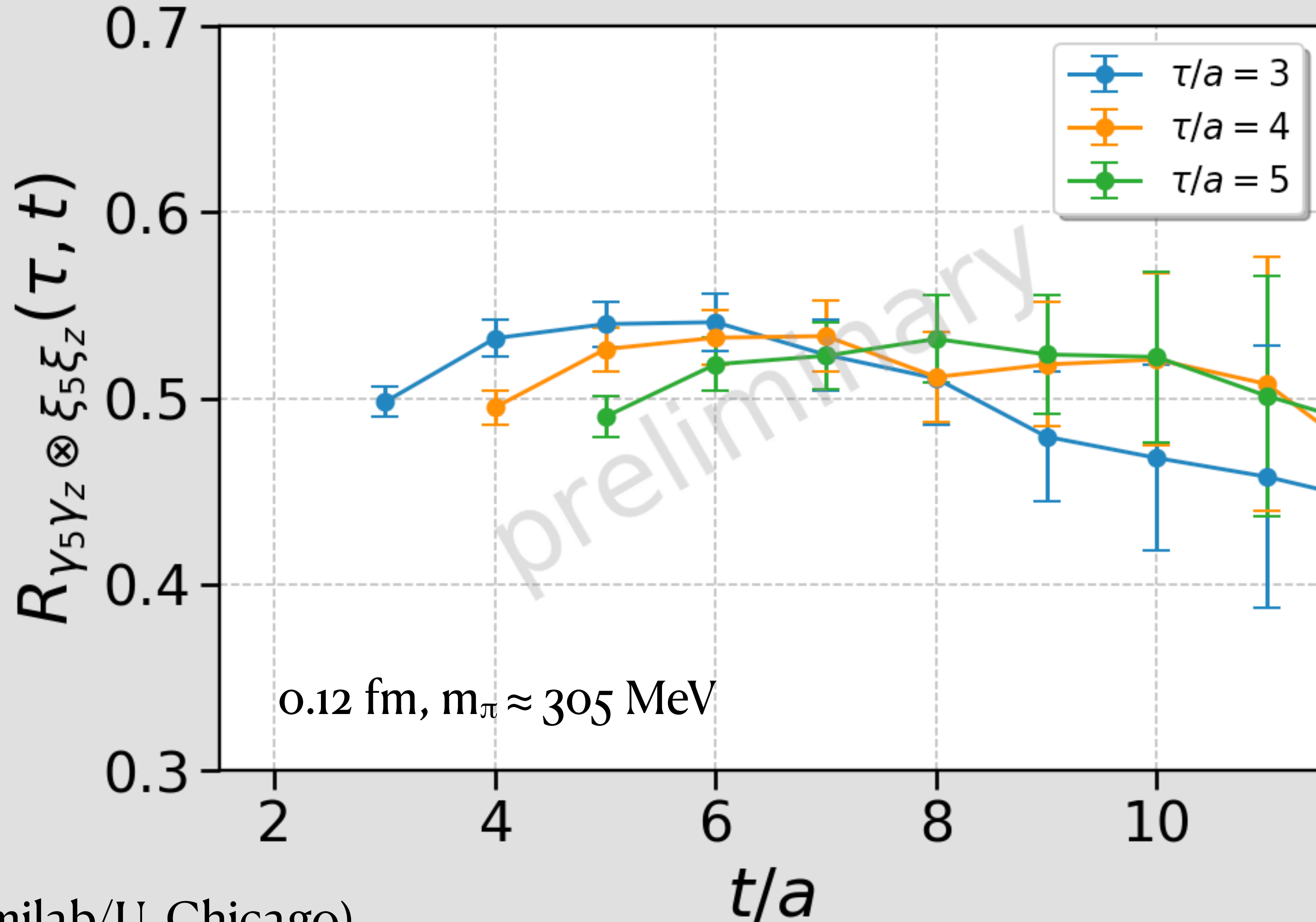
Nucleon Energy at $\mathbf{p} = (0,0,1)$



Nucleon Pseudoscalar ME at $\mathbf{p} = (0,0,1)$



Nucleon Axial Vector ME at $\mathbf{p} = (0,0,1)$



0.12 fm, $m_\pi \approx 305$ MeV

Summary

- Group theory well understood
- Exploring optimal strategies to extract the form factors from the correlators
 - More configurations (0.12fm, $m_\pi \approx 305$ MeV)
 - Different momentum insertions
- Omega baryon for scale settings

Collaborators

- Aida X. El-Khadra (UIUC)
- Elvira Gámiz (Universidad de Granada)
- Steven Gottlieb (Indiana University)
- Ciaran Hughes (Fermilab → CERN)
- Andreas Kronfeld (Fermilab)
- Aaron Meyer (LBNL and UC Berkeley)
- James Simone (Fermilab)
- Alexei Strelchenko (Fermilab)
- Fermilab Lattice and MILC collaborations

Yin Lin (Fermilab/U. Chicago)

The Nucleon Axial Form Factor and Staggered Lattice QCD

Meyer, Aaron S.

The study of neutrino oscillation physics is a major research goal of the worldwide particle physics program over the upcoming decade. Many new experiments are being bui [...]

📅 2017 | 📁 Physics | 📖 Dissertation

[\[Aaron Meyer PhD thesis\]](#)

Nucleon mass with highly improved staggered quarks

Yin Lin (林胤),^{1,2,*} Aaron S. Meyer^{①, 1,2,3,†} Ciaran Hughes,^{2,‡} Andreas S. Kronfeld^{①, 2,§}
James N. Simone,^{2,||} and Alexei Strelchenko^{2,¶}

(Fermilab Lattice Collaboration)

[\[PRD 103, 034501 \(2021\), arXiv:1911.12256\]](#)

Computing nucleon charges with highly improved staggered quarks

Yin Lin (林胤)^{①, 1,2,*} Aaron S. Meyer,^{3,†} Steven Gottlieb,⁴ Ciaran Hughes,² Andreas S. Kronfeld,^{2,‡}
James N. Simone,² and Alexei Strelchenko²

(Fermilab Lattice Collaboration)

[\[PRD 103, 054510 \(2021\), arXiv:2010.10455\]](#)

Nucleon Mass and Charges with Lattice Quantum Chromodynamics

Lin, Yin

Neutrino oscillation experiments are designed to measure neutrino masses and mixing parameters by scattering them off nuclei such as carbon, oxygen, and argon in detector [...]

📅 2021-06 | 📁 Physics | 📖 Dissertation

[\[Yin Lin PhD thesis\]](#)