Nucleon Charges on 2+1 flavor NME Clover Ensembles

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Rich Physics

Precision tests of the Standard Model

- V_{ud} from β-decay to test CKM unitarity, spin of the nucleon
- Searches for novel scalar and tensor interactions
- Dark matter and EDM phenomenology

Nucleon isovector charges probed in **neutron β decay** experiments

- g_A: neutron β decay
- g_S: scalar BSM interactions
- g_T: tensor BSM interactions and EDMs

Lattice Details

Ens. ID	$(\frac{L}{a})^3 \times \frac{T}{a}$	β	c_{SW}	a (fm)	M_π	M_πL	L (fm)	Total Lattices
a117m310	32^3 × 96	6.1	1.249310	0.117	310	5.85	3.7	4865
a087m290L	48^3 × 128	6.3	1.205366	0.087	289	6.16	4.2	6223
a087m230	48^3 × 128	6.3	1.205366	0.087	233	5.0	4.2	5200
a087m230X	48^3 × 128	6.3	1.205366	0.087	228	5.0	4.2	3167
a086m180L	64^3 × 128	6.3	1.205366	0.086	179	5.1	5.5	6622
a068m290	48^3 × 128	6.5	1.170082	0.068	290	4.18	3.3	7620
a067m230	64^3 × 192	6.5	1.170082	0.068	234	5.2	4.4	3604
a067m175	72^3 × 192	6.5	1.170082	0.068	175	4.4	4.9	5556
a067m135	96^3 × 192	6.5	1.170082	0.067	135	4.4	6.4	2904
a053m295	64^3 × 192	6.7	1.142727	0.053	295	4.8	3.4	5301
a053m230	72^3 × 192	6.7	1.142727	0.053	226	4.5	3.8	3331

Status

Lattice calculation of nucleon matrix elements

- Eleven 2+1-flavor NME Clover Ensembles

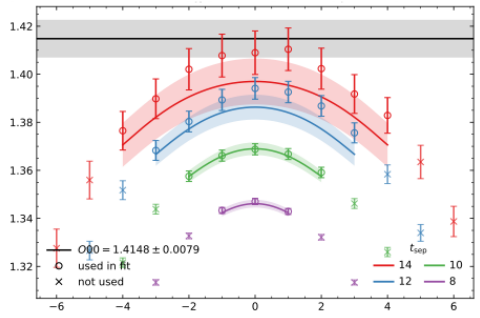
- Spectrum and scale setting: **arXiv:2601.10857**

- Isovector Nucleon Charges g_A, g_S, g_T (under analysis)
- Axial Form factors (under analysis)
- Electric and Magnetic form factors (under analysis)
- Second Mellin moments: $\langle x \rangle_q, \langle x \rangle_{\Delta q}, \langle x \rangle_{\delta q}$ (To appear on arXiv next week)

Controlling systematics:

- Removing contributions of excited states
- Chiral – continuum - finite volume extrapolation
- Renormalization **arXiv:2601.10857**

Signal: Isovector Axial Charge



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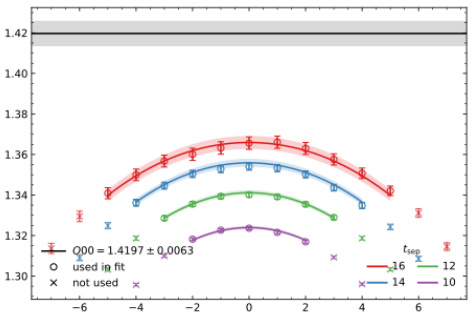
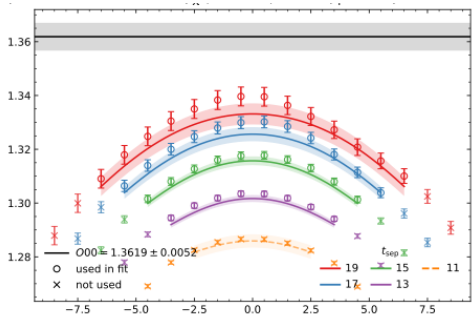


a087m290



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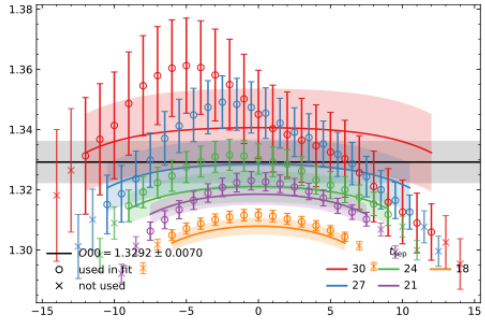
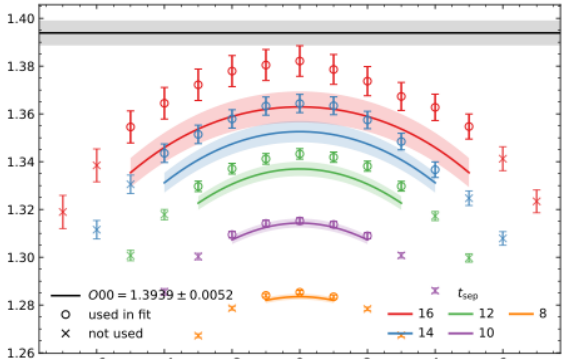


a057m295



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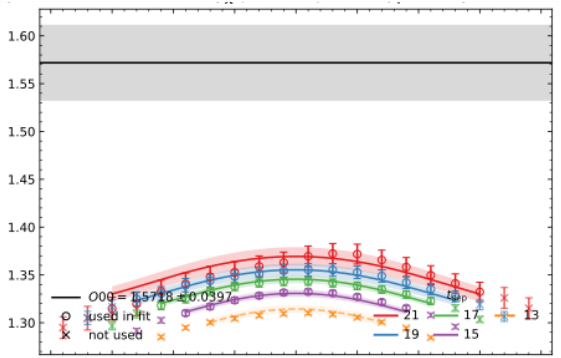

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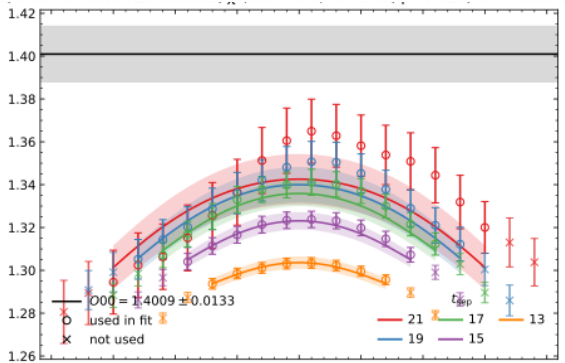
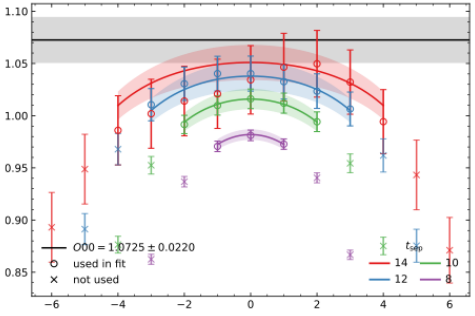


a067m135

Signal: Isovector Scalar Charge



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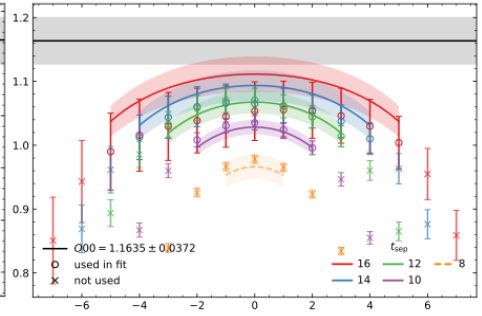

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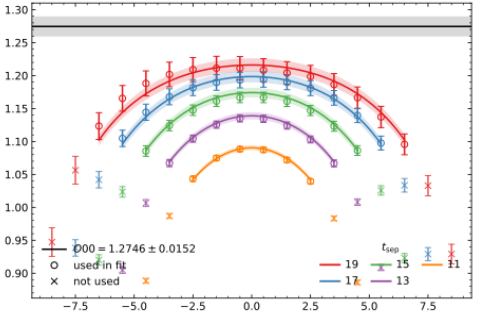

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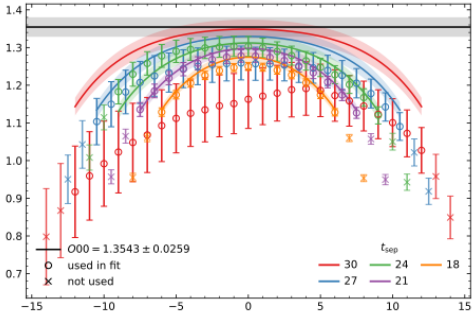

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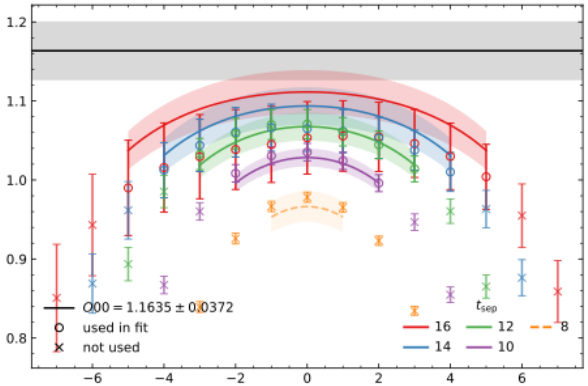

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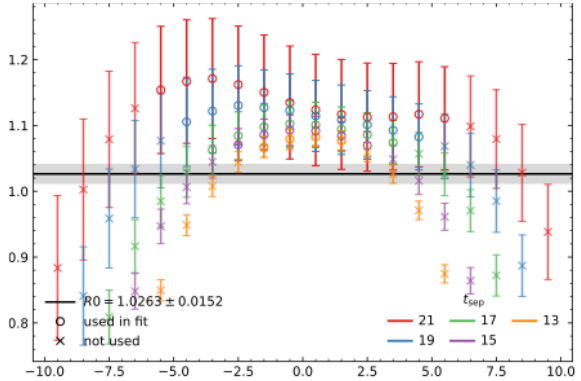

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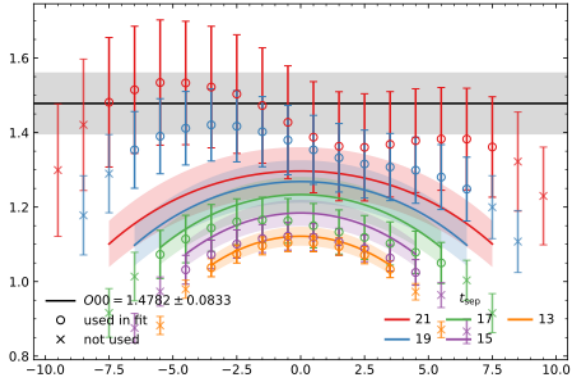

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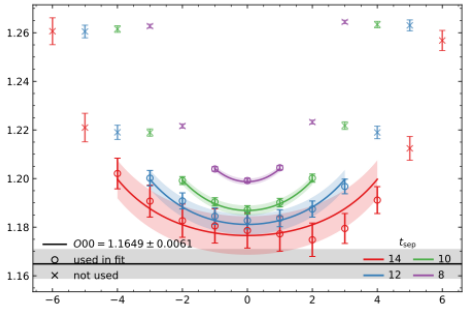
Signal: Isovector Tensor Charge



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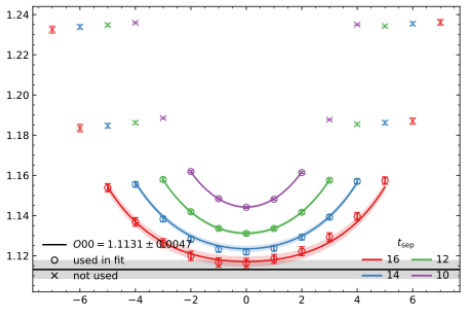

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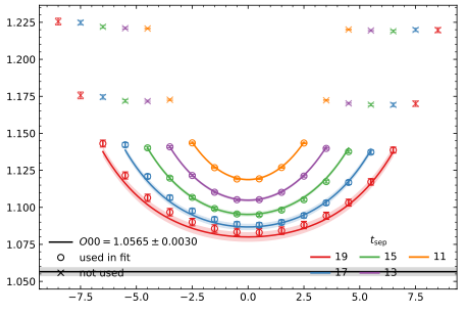

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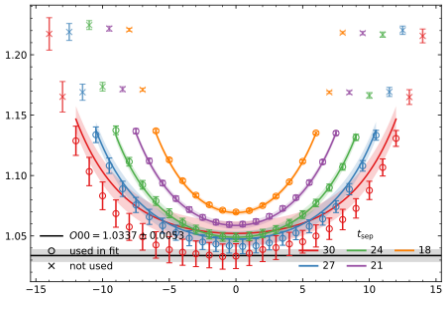

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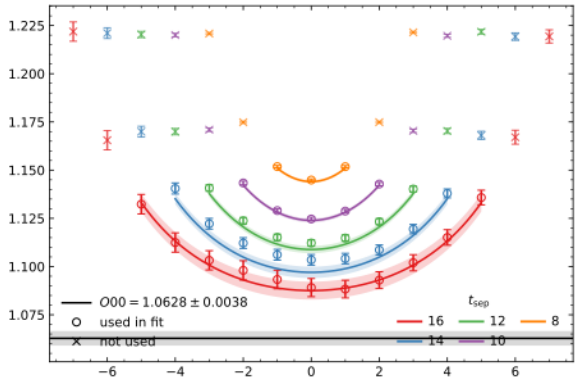

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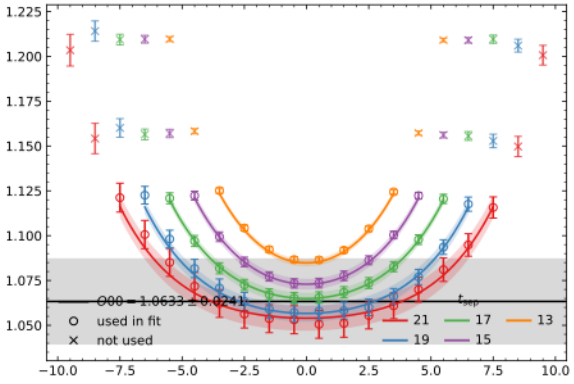

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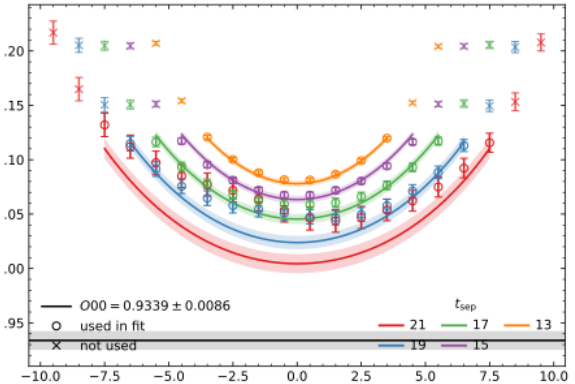

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Moments of distributions

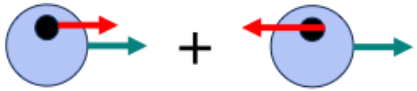
JHEP 21, 004 (2020);
arXiv:

$$\langle x \rangle_q = \int_0^1 x[q(x) + \overline{q}(x)]dx$$

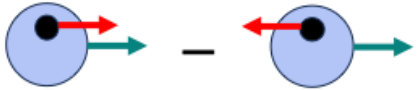
$$\langle x \rangle_{\Delta q} = \int_0^1 x[\Delta q(x) + \Delta\overline{q}(x)]dx$$

$$\langle x \rangle_{\delta q} = \int_0^1 x[\delta q(x) + \delta\overline{q}(x)]dx$$

Momentum fraction (unpolarized) $\langle x \rangle_q$



Helicity moment (polarized) $\langle x \rangle_{\Delta q}$



Transversity moment (polarized) $\langle x \rangle_{\delta q}$

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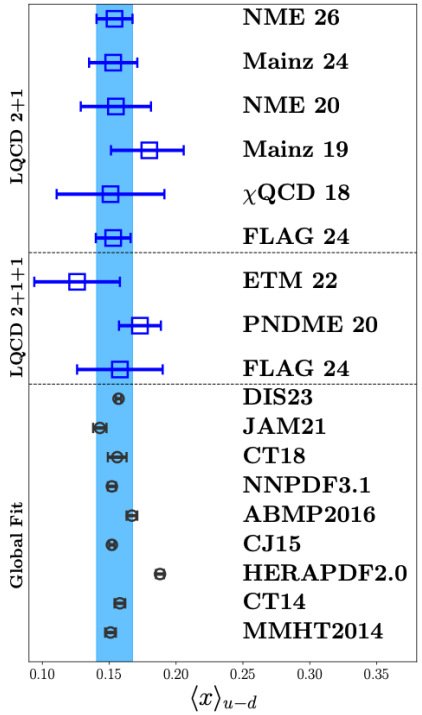
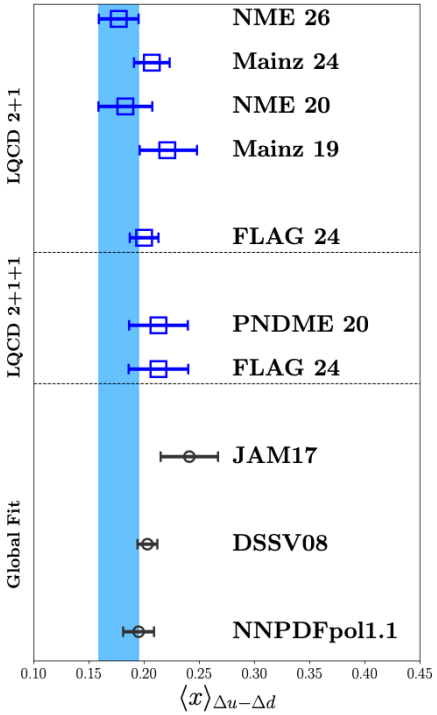
New results: NME 26

$\langle x \rangle_q = 0.154(10)(9)$



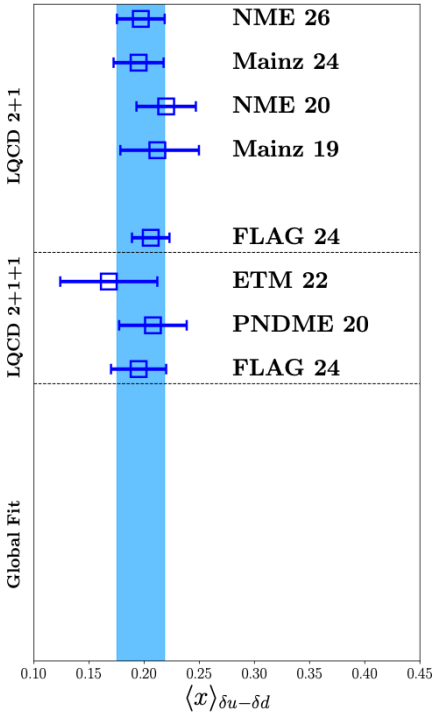
Momentum Fraction

$\langle x \rangle_{\Delta q} = 0.177(10)(15)$



Helicity Moment

$\langle x \rangle_{\delta q} = 0.197(12)(18)$



Transversity Moment

Conclusions

Steady Improvement in results, however

- Need higher statistics
- Need more ensembles

For establishing data driven procedure for removing excited-state contributions

All these results to be published by the end of this year