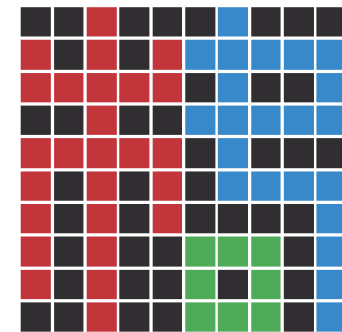


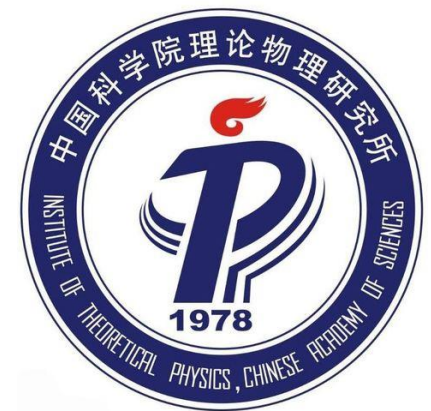
Accurate nucleon iso-vector scalar and tensor charge at physical point

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CLQCD



Introduction

The nucleon iso-vector scalar and tensor charges, g_S and g_T , are fundamental quantities for characterizing nucleon structure. They can be used to:

- determine the proton–neutron mass difference,
- constrain parton distribution functions,
- probe possible scalar and tensor interactions beyond the Standard Model
- ...

They can only be reliably computed from first principles using lattice QCD, but precise calculations are challenging due to excited-state contamination and increased statistical noise at large time separations.

In this work, we use the **blending method** [1] and **current-inspired interpolating fields** [2,3] to reduce statistical errors and better control excited-state effects.

[1]. Z.-C. Hu, J.-H. Wang, X. Jiang, L. Liu, S.-H. Su, P. Sun, and Y.-B. Yang, (2025), arXiv:2505.01719 [hep-lat].

[2]. L. Barca, G. Bali, and S. Collins, Phys. Rev. D 111, L031505 (2025), arXiv:2412.13138 [hep-lat].

[3]. L. Barca, (2025), arXiv:2508.09006 [hep-lat].

Cost comparison

The comparison of costs at the physical point for different collaborations

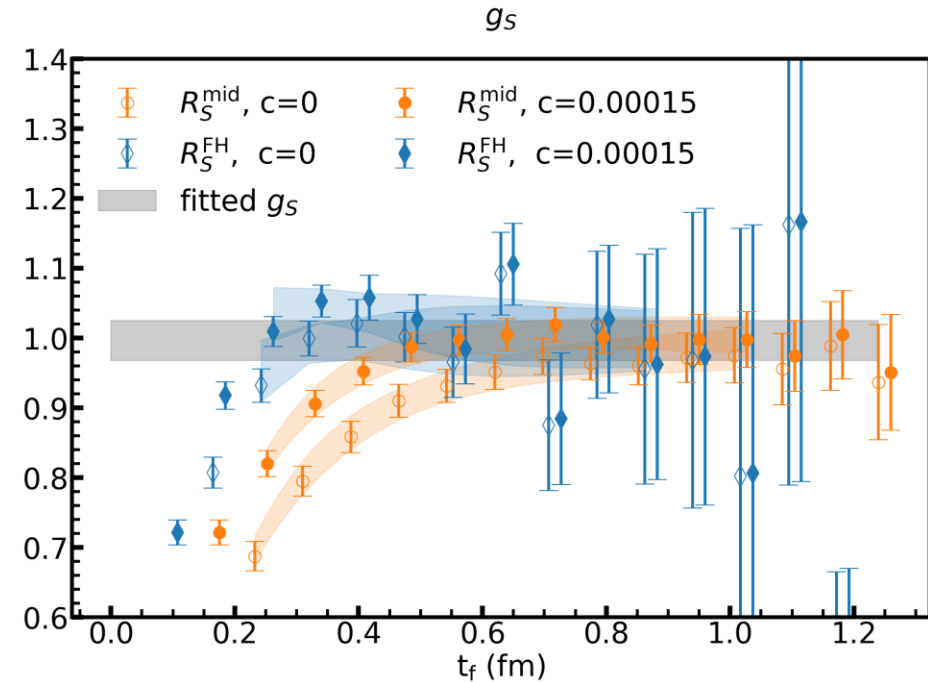
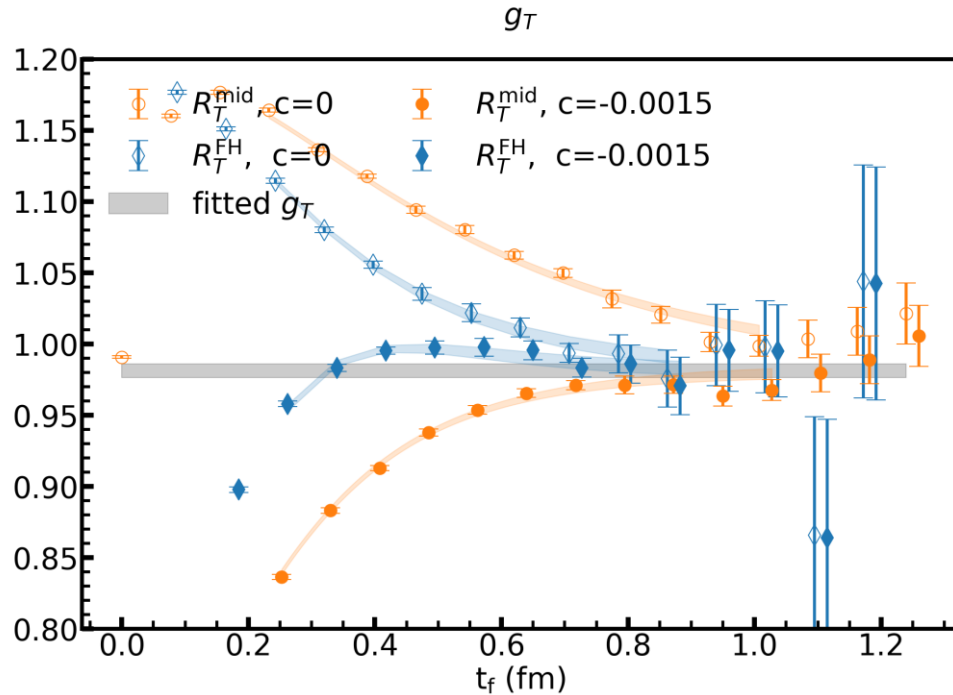
	Ensembles	L	T	$a(\text{fm})$	$m_\pi(\text{MeV})$	n_{cfg}	g_T^{u-d}	Propagators	Propagators for 1% error
CLQCD	F64P13	64	128	0.074	134	40	0.98(01)	0.34M	0.08M
ETMC	cB211.072.64	64	128	0.080	139	750	0.94(03)	1.71M	12.5M
RQCD	D452	64	128	0.076	156	1000	0.86(11)	0.01M	1.2M
PNDME	a09m130	64	96	0.090	138	1290	0.96(02)	1.69M	8.1M

Our method is significantly more efficient than traditional approaches and also offers better control of excited-state contamination by providing more information across different source–sink separations and nucleon interpolating fields.

Results on physical point

The results on F64P13($a=0.074\text{fm}$, $m_\pi = 131\text{MeV}$)

$$\mathcal{R}_X^{\text{FH}}(t_f) \equiv \sum_{t=t_c}^{t_f+a-t_c} \mathcal{R}_X(t_f+a, t) - \sum_{t=t_c}^{t_f-t_c} \mathcal{R}_X(t_f, t) = \langle \mathcal{O}_X \rangle_N + \mathcal{O}(e^{-\delta m t_f}),$$



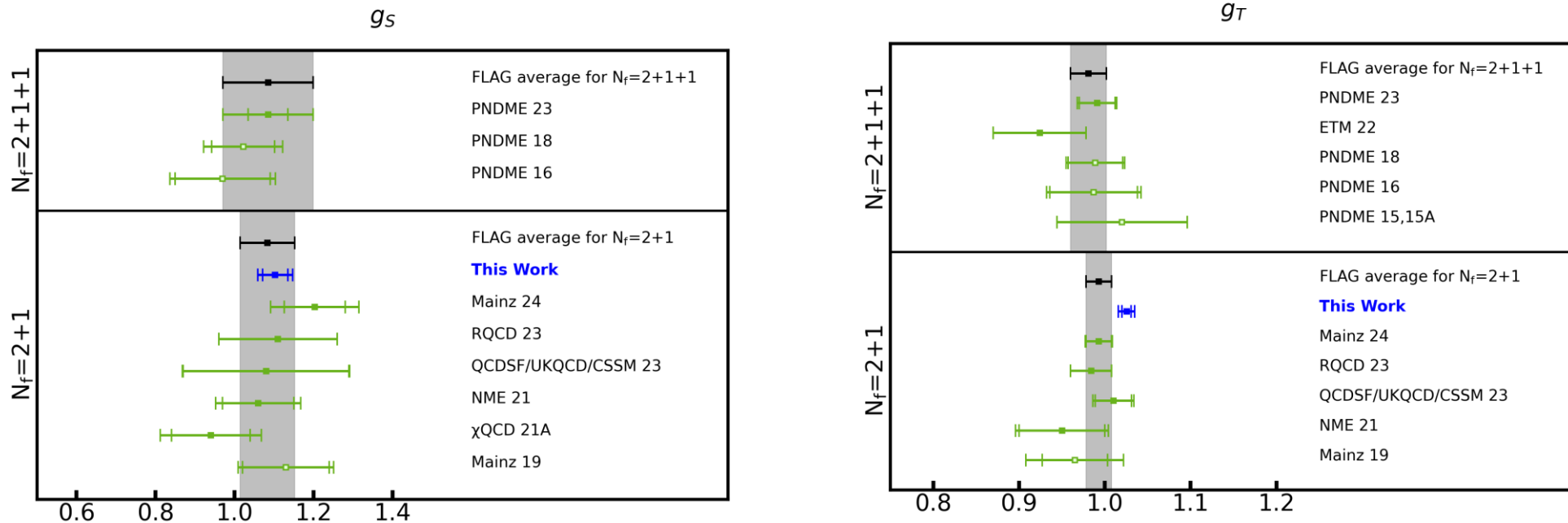
we achieve results with very small statistical errors on ensembles with physical pion masses !

Final Results

The final results of target physical value g_X^{QCD} are:

$$g_T^{\text{QCD}} = 1.022[11]_{\text{tot}}(06)_{\text{stat}}(05)_a(07)_{\text{FV}}(01)_\chi(05)_{\text{ex}}(01)_{\text{re}}$$

$$g_S^{\text{QCD}} = 1.115[47]_{\text{tot}}(33)_{\text{stat}}(04)_a(32)_{\text{FV}}(01)_\chi(10)_{\text{ex}}(07)_{\text{re}}$$



Our final value has a total uncertainty 1/3 smaller than the current $N_f = 2 + 1$ FLAG average

neutron-proton mass difference

Using $m_d - m_u = 2.35(12)$ MeV[1] (from the FLAG average) and a QED correction of $-1.00(7)(14)$ MeV, we predict the neutron-proton mass difference as

$$m_n - m_p = 1.62[0.23]_{\text{tot}}(0.11)_{g_S}(0.13)_{\text{ISB}}(0.16)_{\text{QED}}.$$

which agrees with the experimental value (1.293 MeV) within 1.3σ .

[1]. S. Borsanyi et al. (BMW), Science 347, 1452 (2015), arXiv:1406.4088 [hep-lat].

[2]. J. Gasser, H. Leutwyler, and A. Rusetsky, Phys. Lett. B814, 136087 (2021), arXiv:2003.13612 [hep-ph].

Thank you !!!