Precision computation of nucleon scalar and tensor couplings at the physical point

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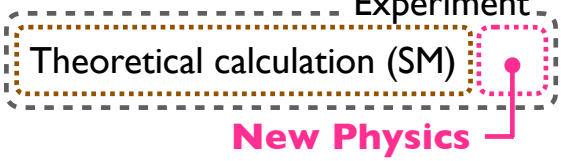
Introduction -Nucleon structure and New physics

Intensity Frontier



In the standard model of modern particle physics, protons and neutrons (nucleons) have non-trivial structures governed by Quantum Chromodynamics (QCD). From the new physics search aspects, highly precise determination by both experiment and theory is required to eliminate the ambiguities. We measured the renormalized transition matrix elements related to non-standard β decay interactions[1] using lattice QCD at the physical point for the high-precision calculation.

Scalar $g_S=\langle p|\bar{u}1d|n\rangle$ and Tensor $g_T=\langle p|\bar{u}\sigma_{\mu\nu}d|n\rangle$ couplings

For detail, see [2] and references therein.

◇ PACS gauge configuration[2]

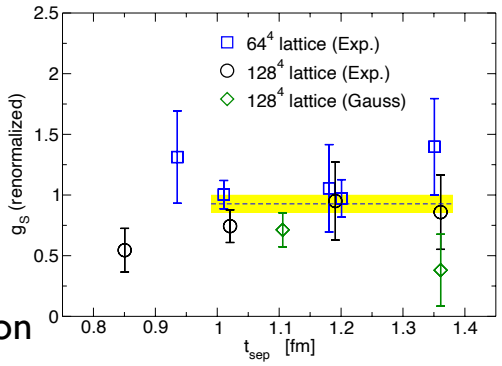
	V [fm^3]	a^{-1}	M_π
128^4	$(10.9)^3$	2.3	0.135
64^4	$(5.5)^3$	2.3	0.138

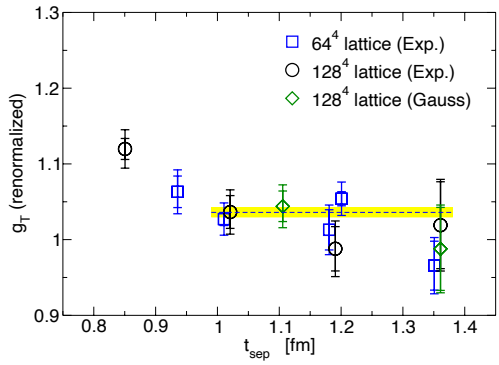
◇ Non-perturbative renormalization

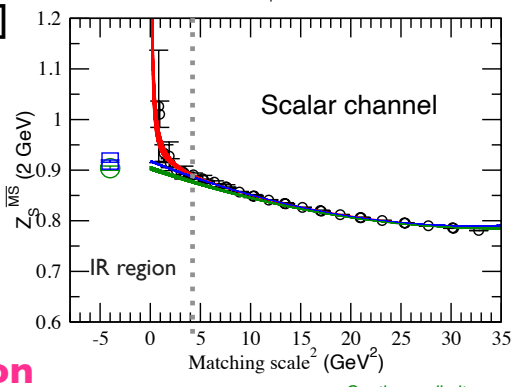
- Rome-Southampton method [3]
- RI/SMOM scheme [4]

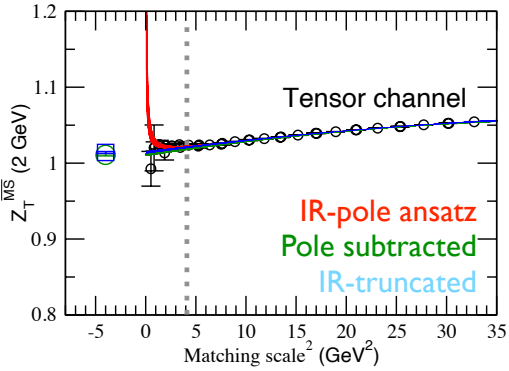
Error budget	Z_S	Z_T
Statistical	0.34 %	0.12 %
Systematic	2.54 %	1.90 %
Total	**2.56 %**	**1.90 %**

A few percents level precision
= Comparable with bare couplings









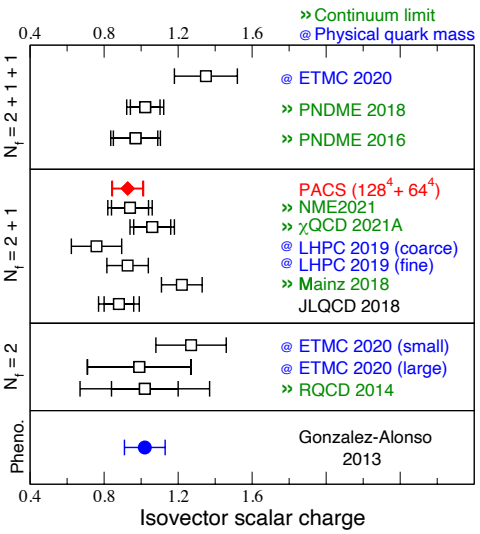
◇ Renormalized couplings

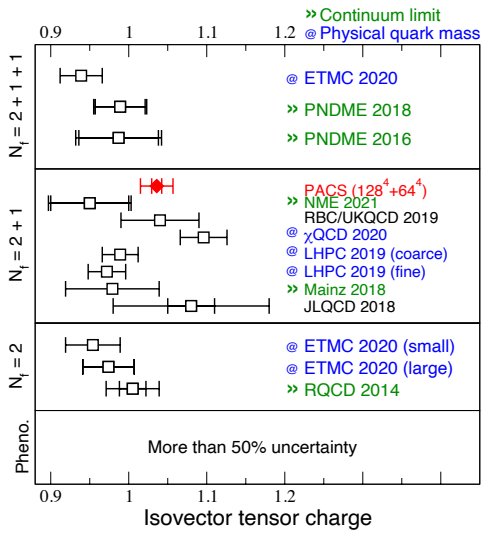
$$g_A = 1.288(14)_{\text{stat.}}(9)_{\text{syst.}}$$

$$g_S = 0.927(83)_{\text{stat.}}(22)_{\text{syst.}}$$

$$g_T = 1.036(6)_{\text{stat.}}(20)_{\text{syst.}}$$

Precise determination, 8% for g_S and 3% for g_T using *fully-dynamical* lattice QCD at the physical point!





Summary

We evaluated the renormalized scalar and tensor couplings. Our results are enough precise to reveal **physics in Intensity frontier**. Further studies are proceeding towards **the continuum limit**.

References

[1] V.Cirigliano et al., Prog. Part. Nucl. Phys. 71, 93-118 (2013).
[2] R.Tsuji et al., Phys. Rev. D **106,** 094505 (2022).
[3] G. Martinelli et al, Nucl. Phys. B **445,** 81-108 (1995).
[4] Y.Aoki et al., Phys. Rev. D **78,** 054510 (2008).