Interpolating operators

Standard: $\chi_1 = \epsilon_{abc}(u_a^T C\gamma_5 P_+ d_b)u_c$, where $P_+ = (1+\gamma_4)/2$ and the quarks are Wuppertal smeared.

Hybrid operators contain the chromomagnetic field $B_i = \epsilon_{ijk}G_{jk}$, here built using the clover definition of $G_{\mu\nu}$ with spatially stout-smeared links. First constructed in J. J. Dudek and R. G. Edwards, PRD **85**, 054016 [1201.2349] and recently tested (using distillation) on nucleon charges in C. Egerer *et al.*, PRD **99**, 034506 [1810.09991].

These operators can be written as

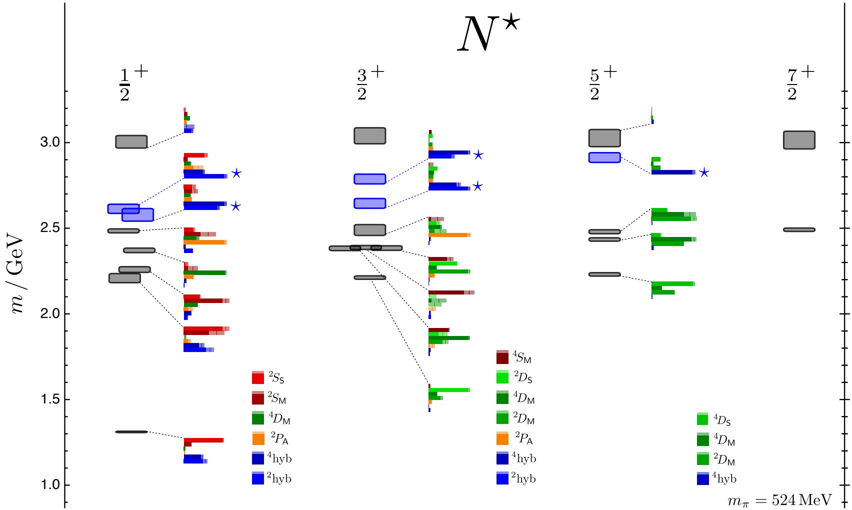
$$\chi_2 = \epsilon_{abc}\left[(B_i\tilde{u})_a^T C\gamma_j P_+ \tilde{d}_b\right]\gamma_i\gamma_j\tilde{u}_c - \epsilon_{abc}\left[\tilde{u}_a^T C\gamma_j P_+ (B_i\tilde{d})_b\right]\gamma_i\gamma_j\tilde{u}_c,$$

$$\chi_3 = \epsilon_{abc}\left[(B_i\tilde{u})_a^T C\gamma_j P_+ \tilde{d}_b\right]P_{ij}\tilde{u}_c - \epsilon_{abc}\left[\tilde{u}_a^T C\gamma_j P_+ (B_i\tilde{d})_b\right]P_{ij}\tilde{u}_c,$$

where $P_{ij} = \delta_{ij} - \frac{1}{3}\gamma_i\gamma_j$.

Our basis has three operators. No additional propagators are needed for two-point functions. For three-point functions, any linear combination of these operators at the source and sink can be encoded into the sequential propagator.

HadSpec study



J. J. Dudek and R. G. Edwards, Phys. Rev. D **85**, 054016 (2012) [1201.2349]

Variational approach

Compute the correlator matrix

$$C_{ij}(t) = \langle \chi_i(t) \chi_j^\dagger(0) \rangle,$$

and solve a generalized eigenvalue problem

$$C(t)v = \lambda C(t_0)v.$$

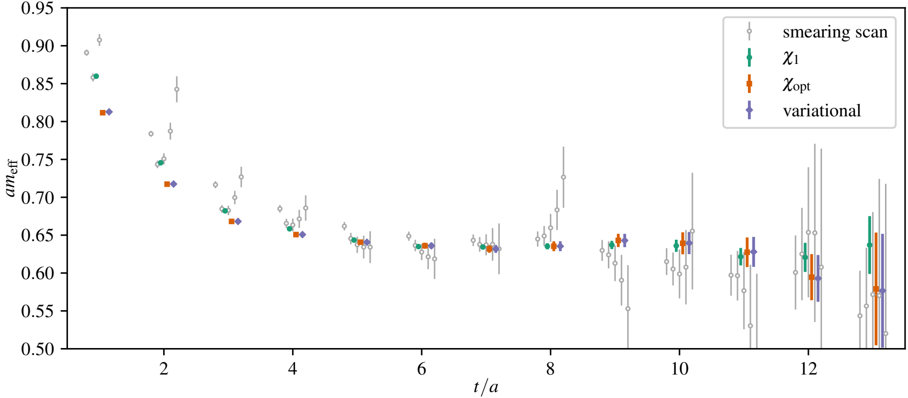
Then define $\chi_{\text{opt}} = v_i^* \chi_i$.

Lattice setup

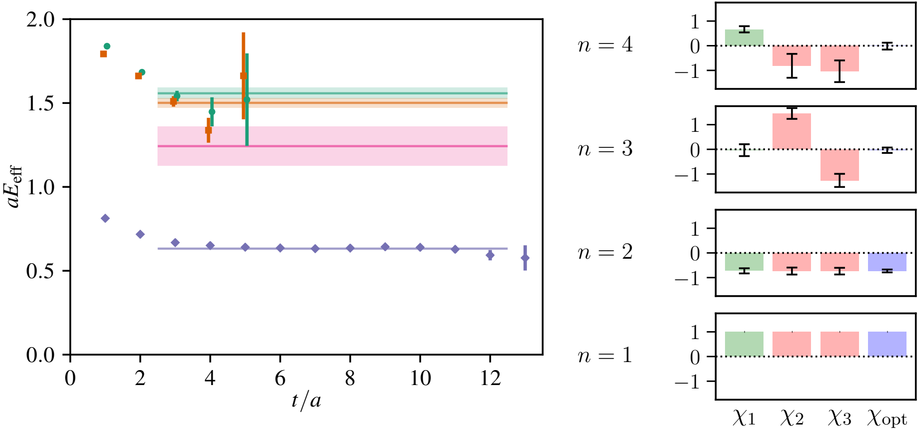
- BMW 2HEX-clover ensemble, $\beta = 3.31$ ($a = 0.116$ fm)
- $m_\pi \approx 250$ MeV, $24^3 \times 48$ ($m_\pi L = 3.6$)
- 600 configs used with 48 sources, yielding $600 \times 48 \times 2 = 57600$ samples.
- Source-sink separations $T/a = 6, 8, 10$.

JRG *et al.*, arXiv:1907.11950

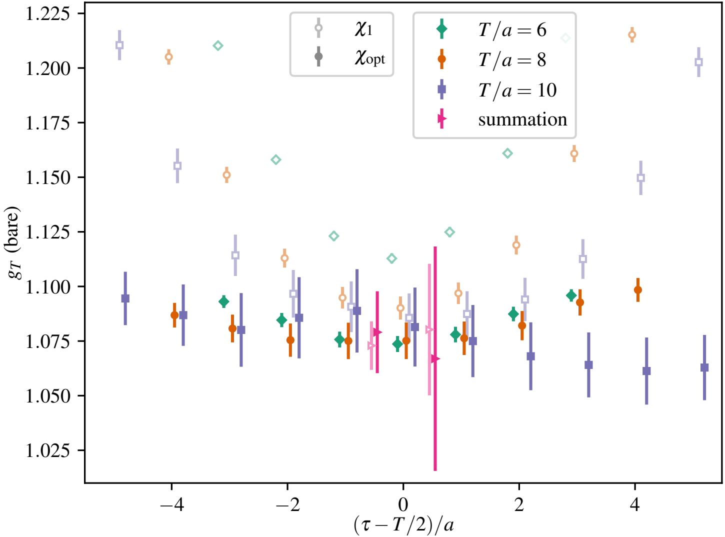
Effective mass



Four-state fit



Tensor charge



Axial charge