Strangeness in the nucleon
from a mixed action calculation

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Motivation

- Learn something about disconnected diagrams in the MILC/DWF mixed action scheme
- Extract some physics while we're at it ...

$\longrightarrow$ Combined analysis of experimental data on strange axial form factor of nucleon: S. Pate, D. McKee and V. Papavassiliou, Phys. Rev. **C 78** (2008) 015207.

Observables:

$$f_{T_s} = \frac{m_s \langle N|\bar{s}s|N\rangle}{m_N}$$

$$\Delta s = \langle N, \uparrow |\bar{s}\gamma_i\gamma_5 s|N, \uparrow\rangle$$

Obtain matrix elements from lattice correlator ratios:

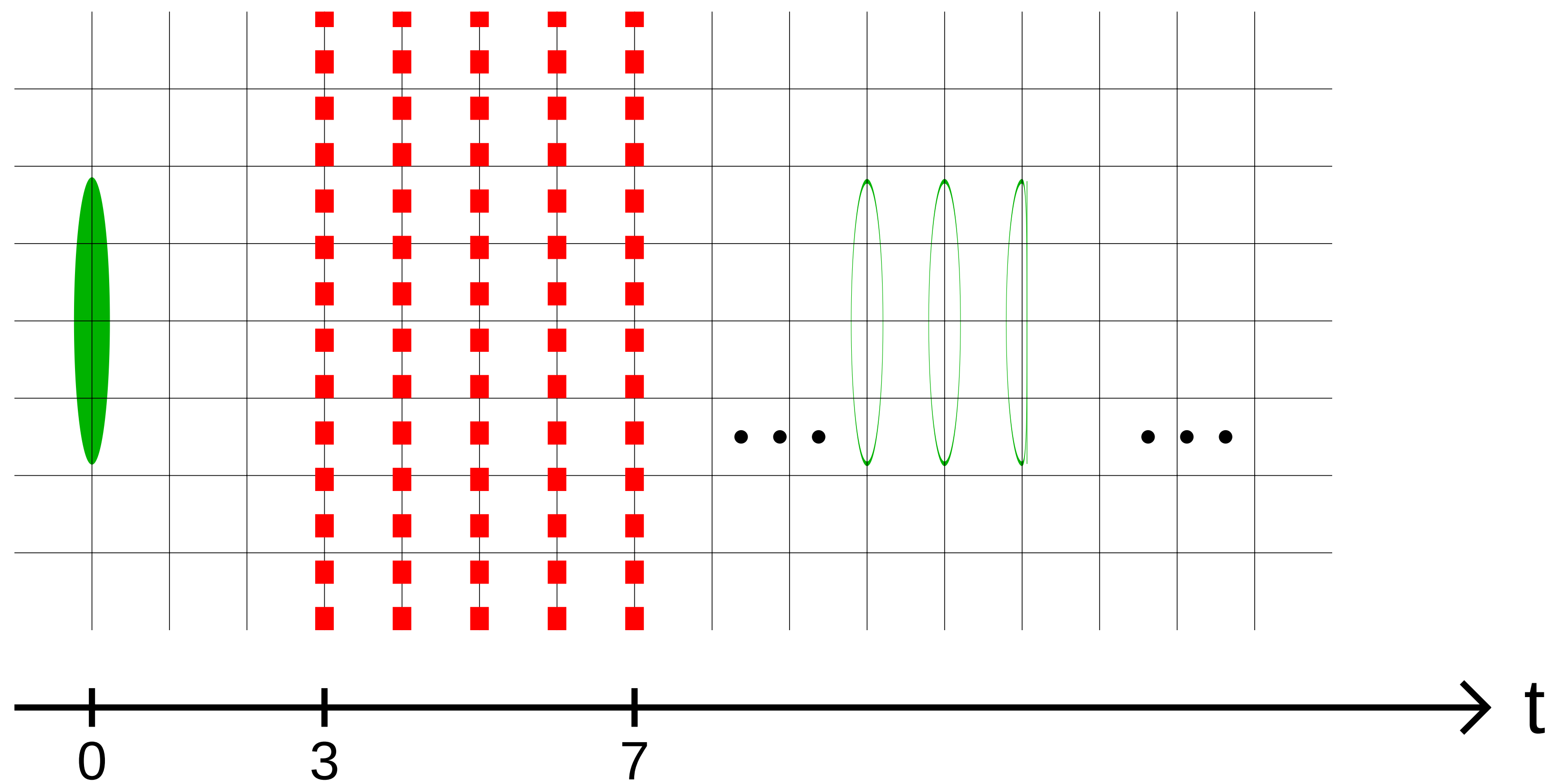
$$R[\ \Gamma^{nuc}, \Gamma^{obs}\ ](t) = \frac{\left\langle \left[\mathrm{Tr}\ \Gamma^{nuc}\ \Sigma_{\vec{x}}\ N(\vec{x},t)\bar{N}(0,0)\right] \cdot \left[\mathrm{Tr}\ \Gamma^{obs} s\bar{s}\right] \right\rangle}{\left\langle\ \mathrm{Tr}\ \Gamma^{unpol}\ \Sigma_{\vec{x}}\ N(\vec{x},t)\bar{N}(0,0)\ \right\rangle}$$

(where $\Gamma^{unpol} = (1+\gamma_4)/2$)

$$\frac{m_s}{m_N}\left(R[\ \Gamma^{unpol}, 1\ ](t)\ -\ [\mathrm{VEV}]\right) \longrightarrow f_{T_s}$$

$$-i\ \cdot 2 \cdot R[\ (-i\gamma_i\gamma_5/2)\ \Gamma^{unpol}, \gamma_i\gamma_5\ ](t) \longrightarrow \Delta s$$

Lattice setup

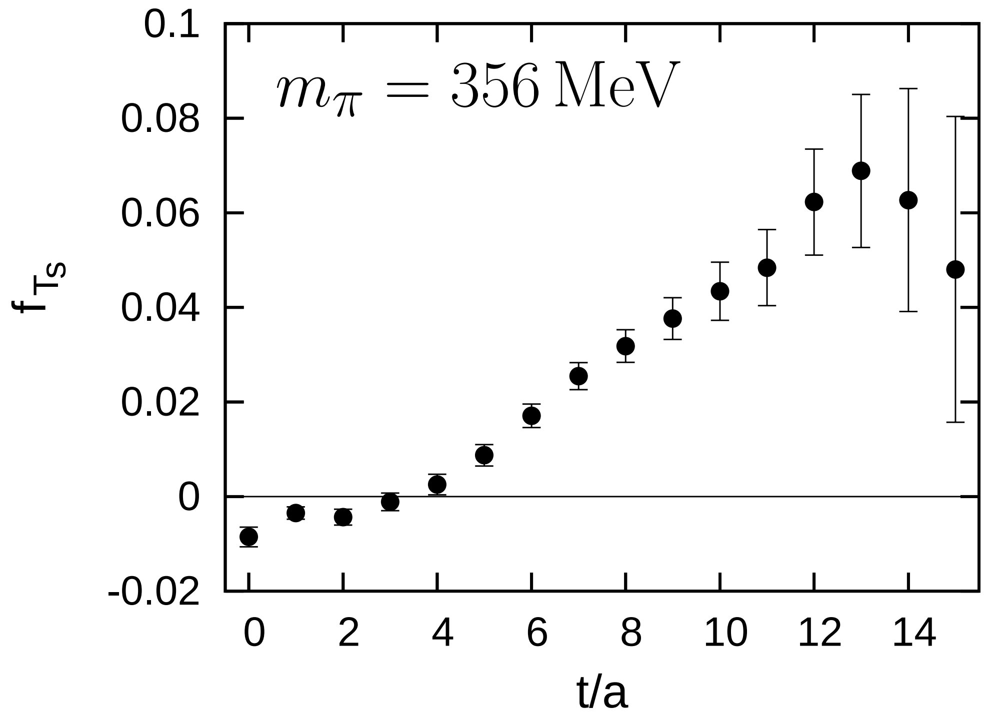


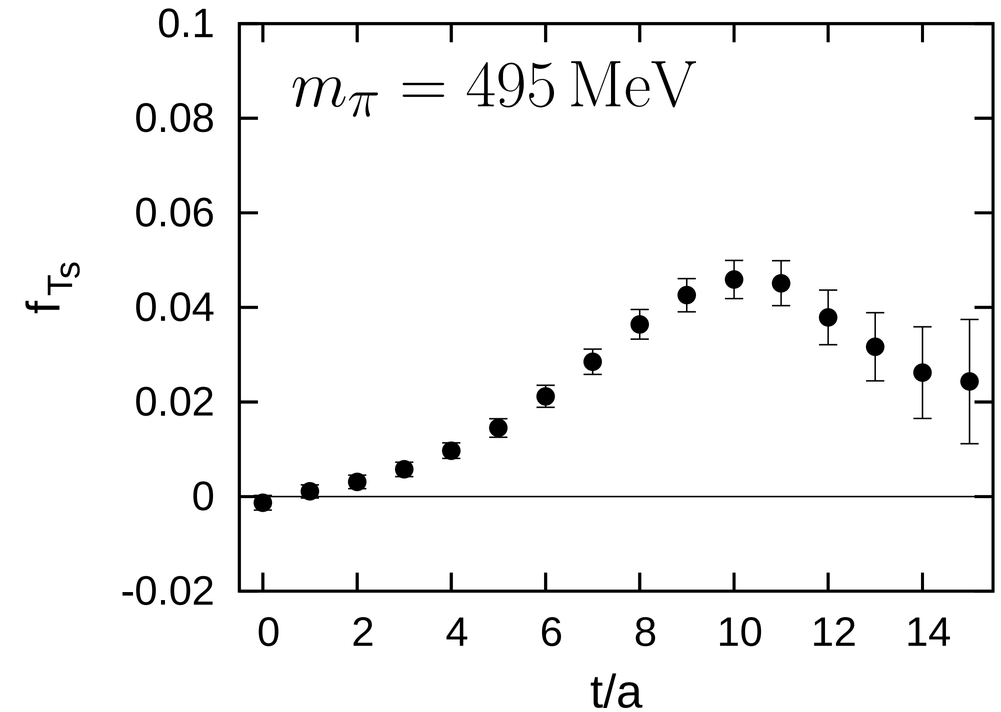
- Averaging observable over 5 time slices, $\sum_{t=3...7} \sum_{\vec{x}} \Gamma^{obs}\ s\bar{s}$
- 600-1200 bulk stochastic sources in this region
- 4-8 separate spatial positions for nucleon source

Further calculational details

- Use HYP-smeared MILC $20^3 \times 64$ asqtad configurations with lattice spacing $a = 0.124$ fm at two pion masses, $m_\pi = 356\,\mathrm{MeV}\,, 495\,\mathrm{MeV}$.
- Carry out described scheme in three separate temporal regions of the $20^3 \times 64$ lattices.
- Average Δs over three spatial directions.

Results for f_{T_s}





$f_{T_s}|_{t=10} = 0.043(6)$

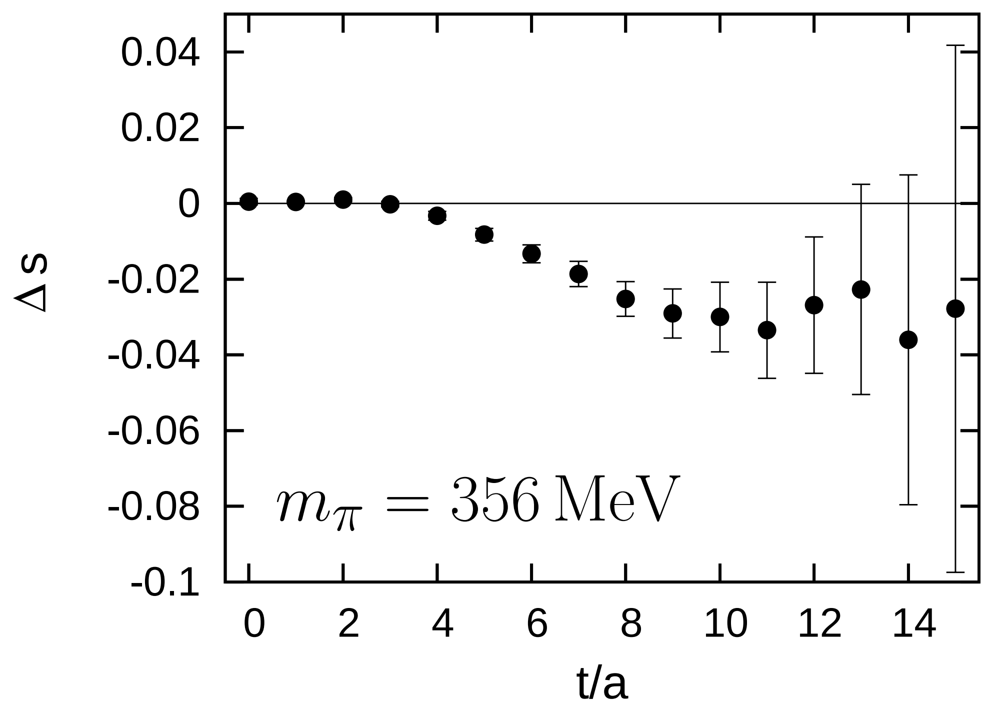
$f_{T_s}|_{t=10\ldots14} = 0.057(11)$

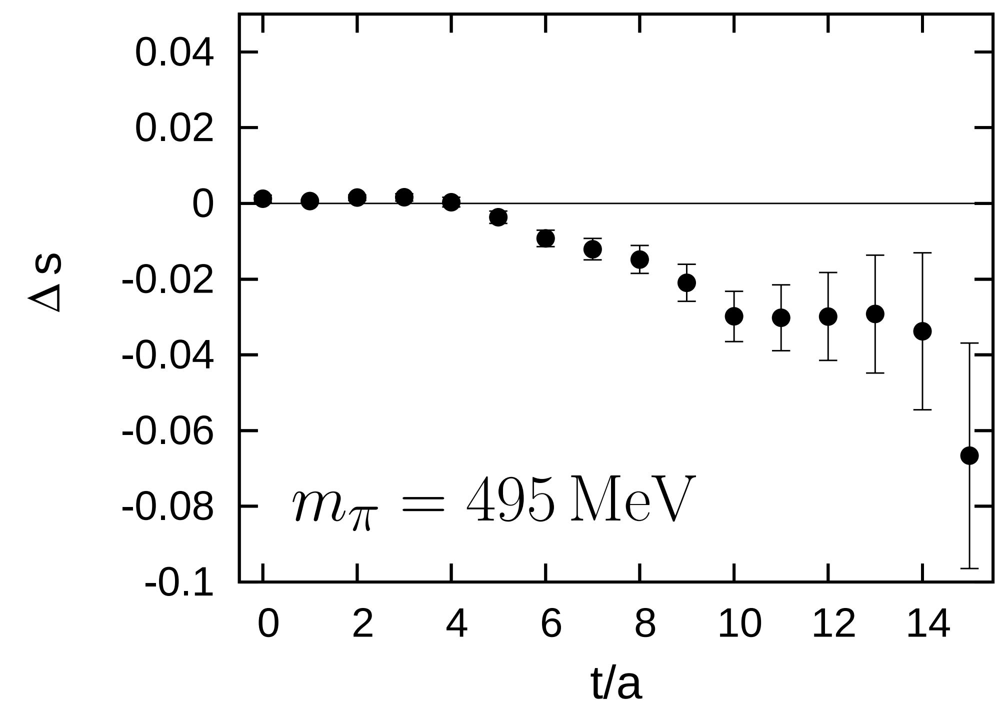
$f_{T_s}|_{t=10} = 0.046(4)$

$f_{T_s}|_{t=10\ldots14} = 0.037(5)$

Note: f_{T_s} values revised by an overall factor compared to slides used in talk

Results for Δs





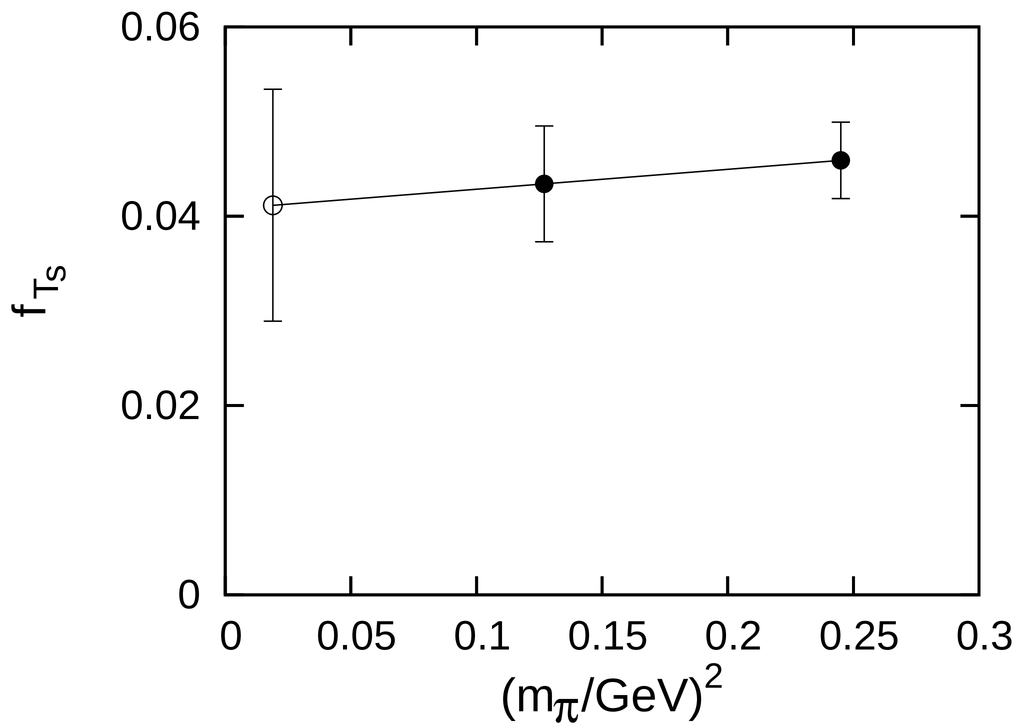
$\Delta s|_{t=10} = -0.030(9)$

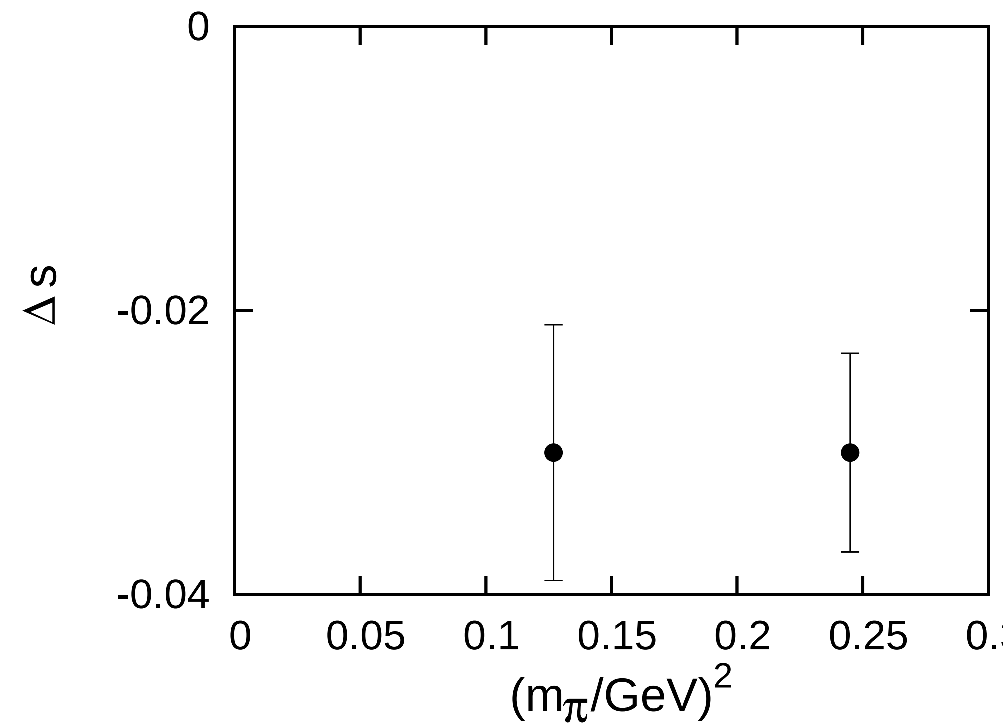
$\Delta s|_{t=10...14} = -0.030(19)$

$\Delta s|_{t=10} = -0.030(7)$

$\Delta s|_{t=10...14} = -0.031(11)$

Pion mass dependence





$\longrightarrow$ Renormalization factors connecting this lattice scheme to $\overline{MS}$ at scale 2 GeV generally very close to 1.1

Note: f_{T_s} values revised by an overall factor compared to slides used in talk

Summary

- Signals obtained for f_{T_s} and Δs at $m_\pi = 356\,\mathrm{MeV},\ 495\,\mathrm{MeV}$.
- Stochastic estimator for scalar matrix element converges much more rapidly than for axial vector; implementation of acceleration schemes desirable for latter case.
- Tentative extrapolation of f_{T_s} to physical point yields $f_{T_s} = 0.041(12)$, corresponding to $m_s\langle N|\bar{s}s|N\rangle = 39(12)\,\mathrm{MeV}$.
- No indication of unnaturally large Δs contribution to nucleon spin.

Note: f_{T_s} values revised by an overall factor compared to slides used in talk