UV Suppression by Smearing and Screening Correlators

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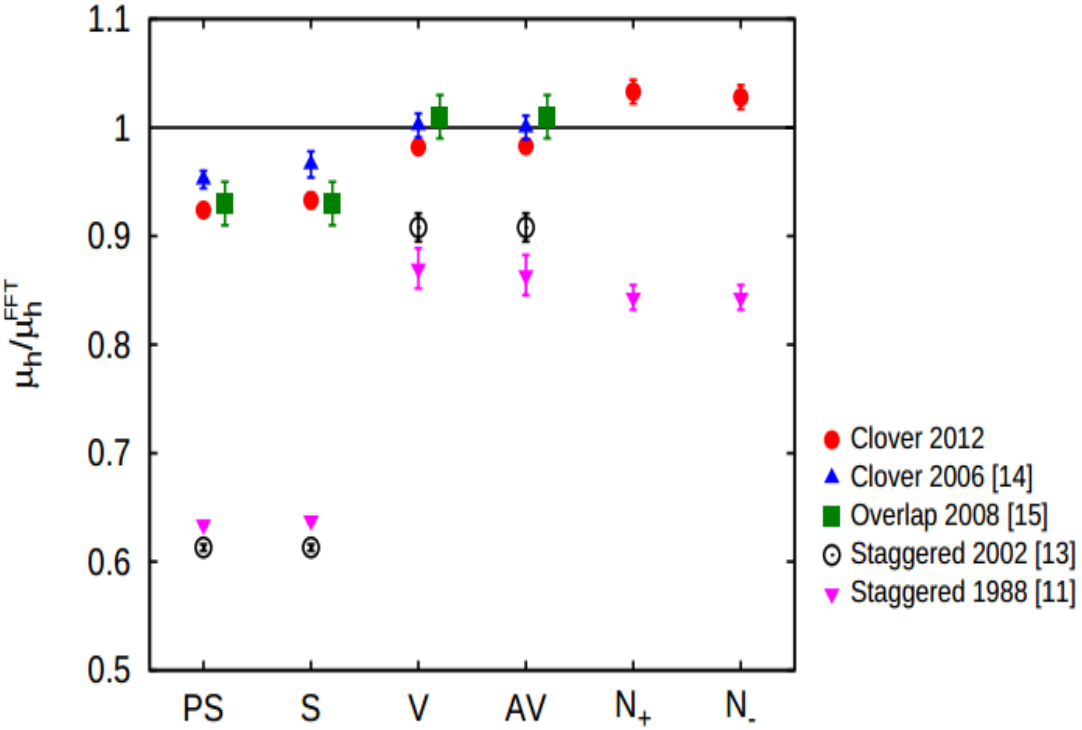
Table of Contents

Motivations

- Increasing interest in hypercubic smearing with the advent of HEX due to differentiability and locality. Do such schemes change IR drastically?
- Understand the mechanism of gauge link smearing directly by looking at the effect on Fourier modes.

- Inconsistency of staggered hadron screening masses with results from other fermion actions. $\mathcal{O}(\alpha a^2)$ taste breaking responsible?



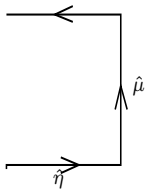
S. Datta *et al.*, 2012

Table of Contents

Method

- Tunable parameter ϵ has to be optimized
- Optimization: UV modes suppressed, IR less affected.

$$U'_\mu(x) = (1-\epsilon) \uparrow + \frac{\epsilon}{6} \sum_{\pm\eta\neq\mu}$$

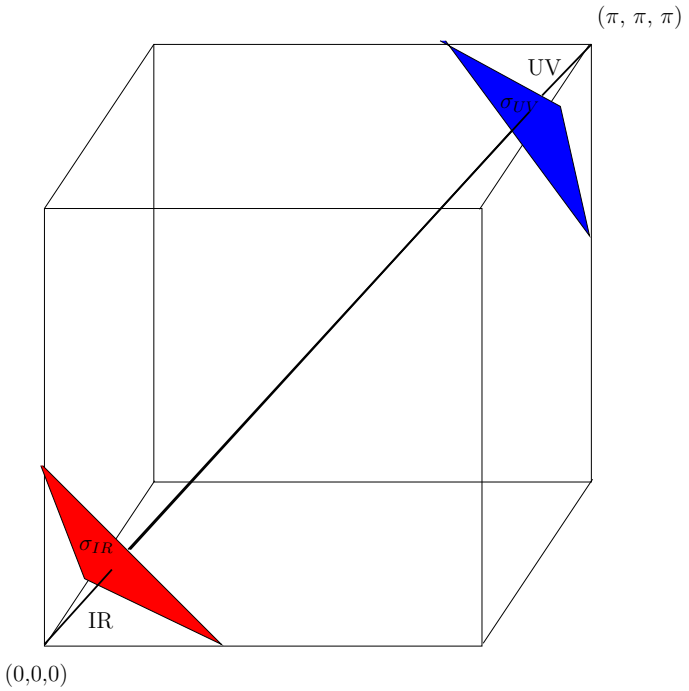


Power spectrum of plaquette $P(x)$

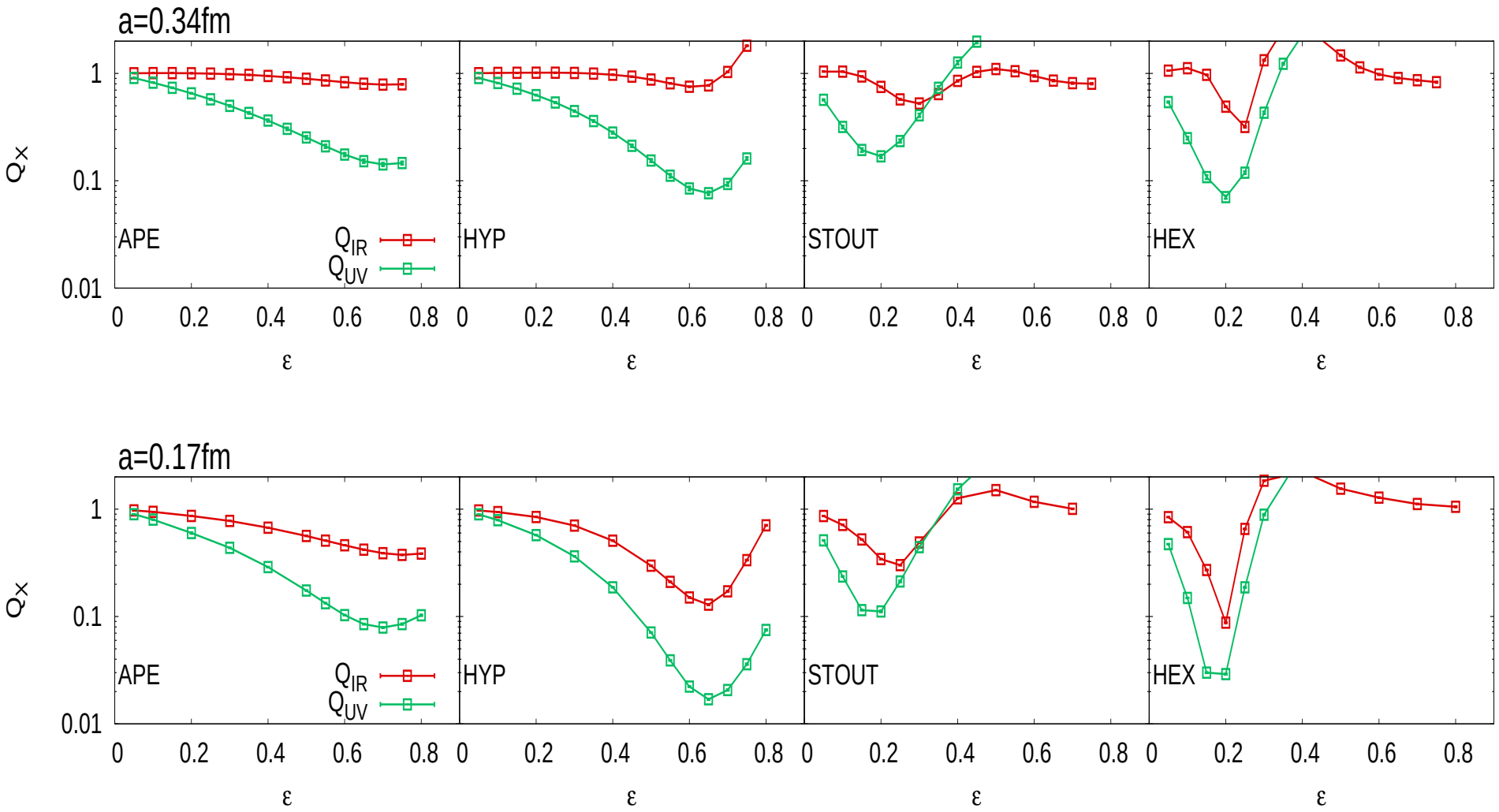
- Divide Brillouin zone into UV, IR and generic
- *Fourier*: $c(k) = \sum_x P(x) \exp(ik.x)$
- *Power*: $E(k) = |c(k)|^2$
- E_X : Total power in IR or UV
- *Suppression*:

$$Q_X = \frac{E_X(\epsilon)}{E_X(0)}$$

for X in IR or UV



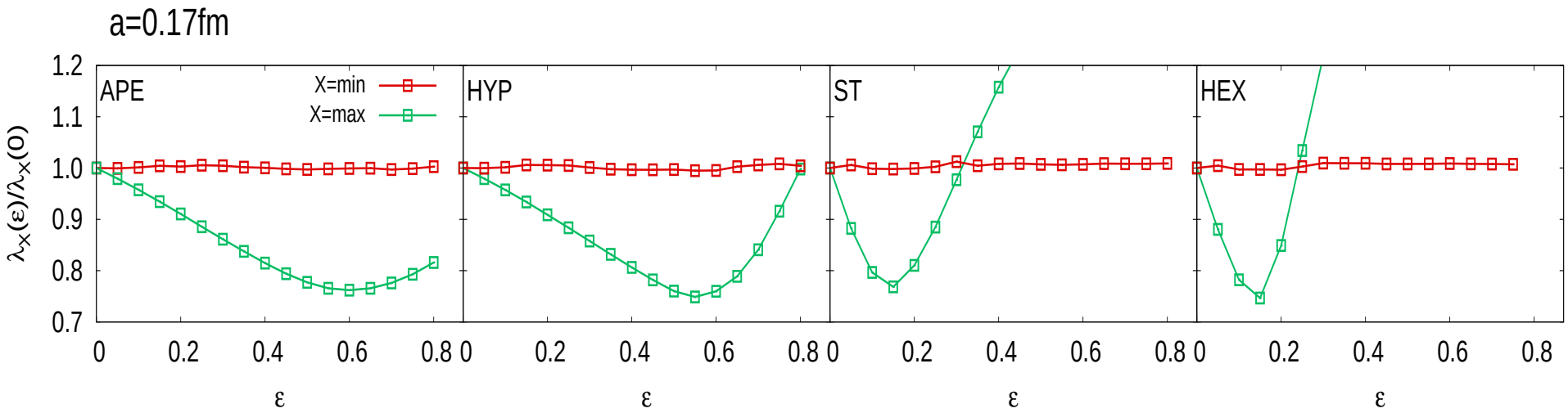
UV is suppressed: Glue sector



$m_\pi \approx 240 MeV$

UV is Suppressed: Quark Sector

- λ_{min} and λ_{max} $\rightarrow$ Extremal eigenvalues of $D^\dagger D$ $\quad D \rightarrow$Massive staggered
- Change in λ_{min} much smaller than m^2



Decrease in condition number $\kappa = \lambda_{max}/\lambda_{min} \implies$ CG speed-up

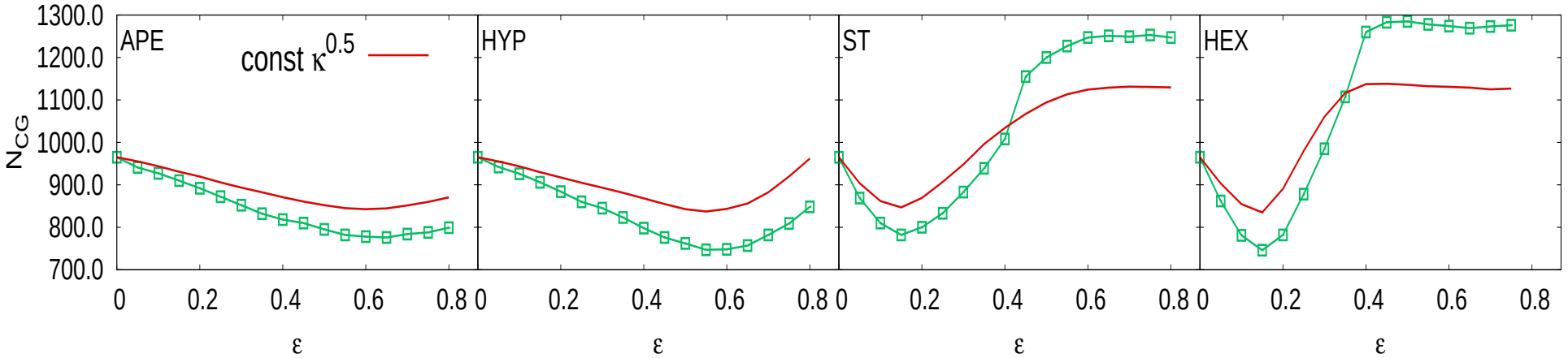


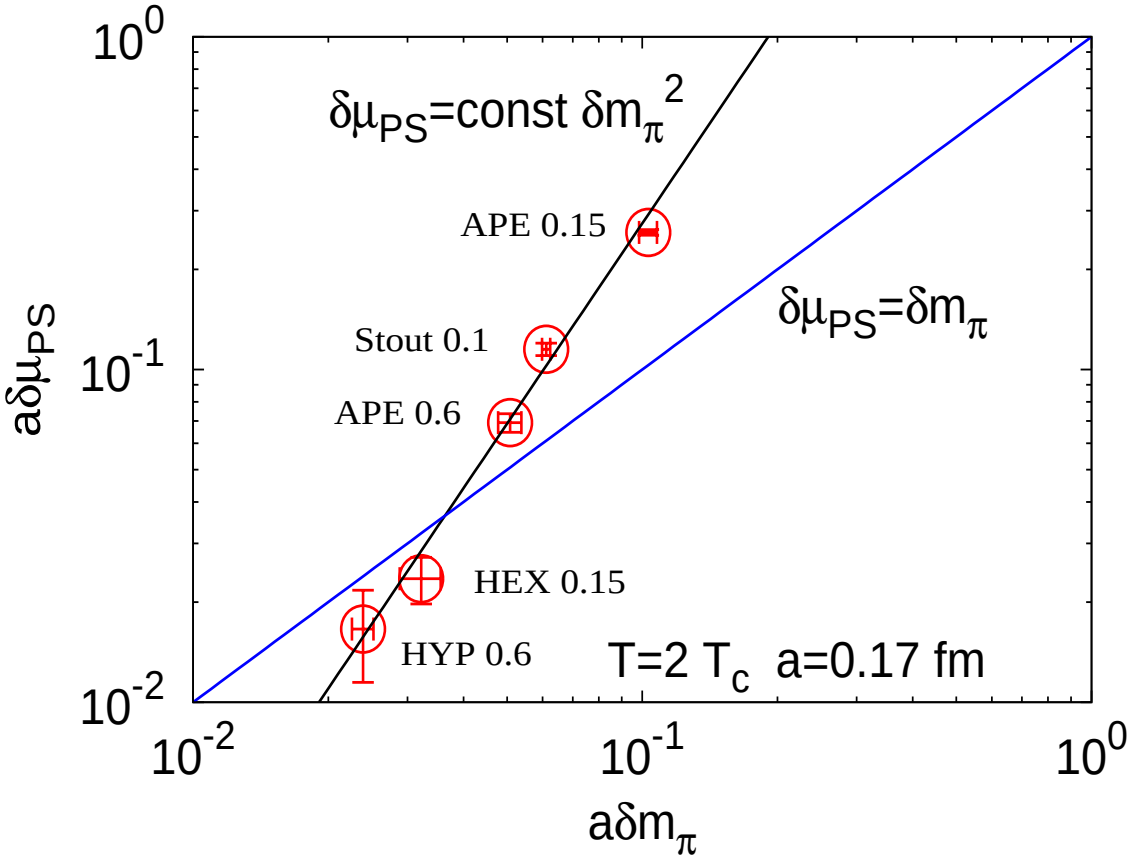
Table of Contents

Super-linearity of taste splitting at high T

- 16 pion taste partners : $\Gamma_{\rm spin} \bigotimes \Gamma_{\rm taste}$
- Measure of taste splitting:

$$\delta m_\pi = m_{\gamma_5\gamma_i} - m_{\gamma_5} \quad \text{(T=0)} \qquad \delta\mu_{PS} = \mu_{\gamma_5\gamma_i} - \mu_{\gamma_5} \quad \text{(Finite T)}$$

- Super-linear improvement at high T: $\delta\mu_{PS} \propto (\delta m_\pi)^2$

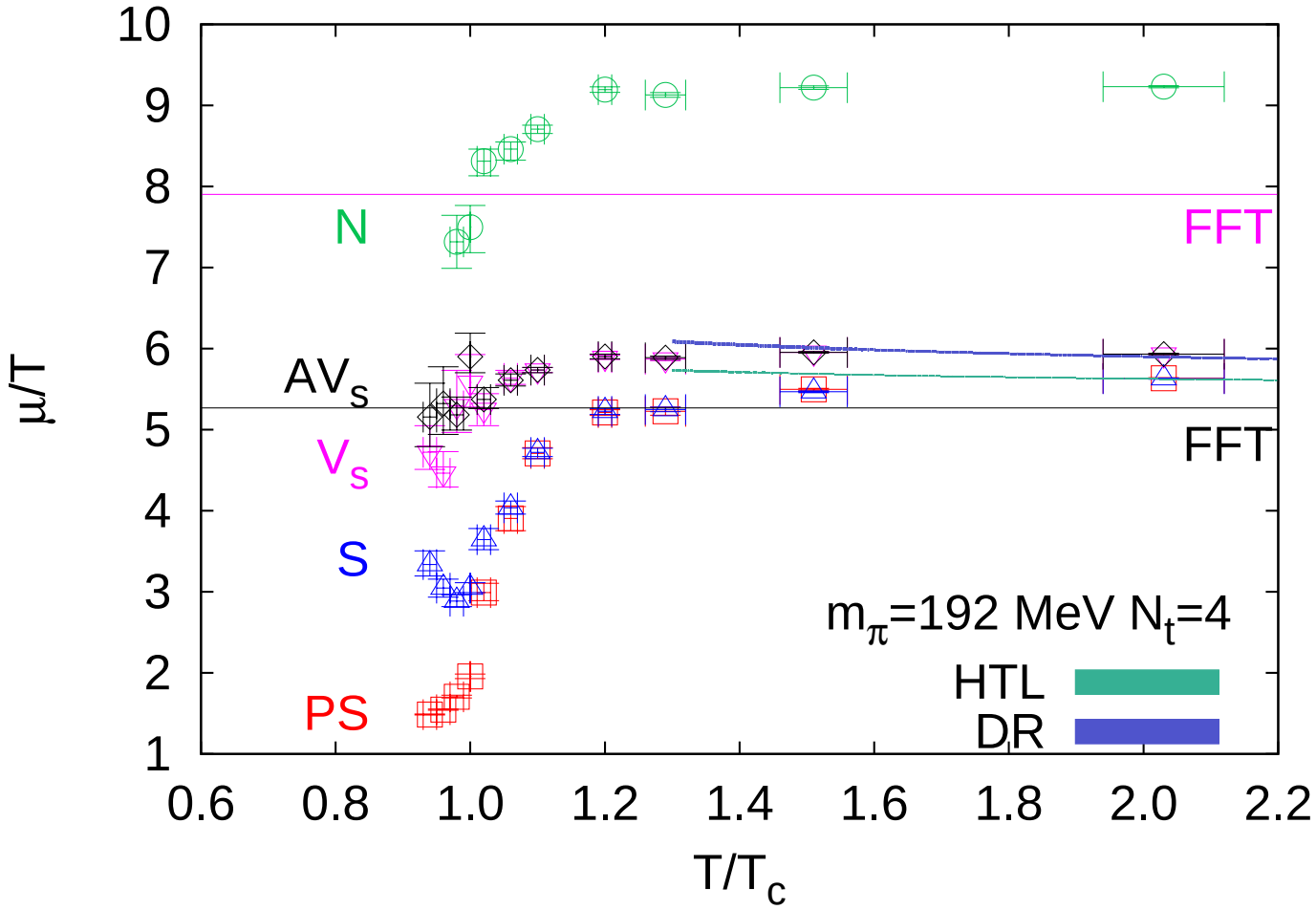


Screening with improved taste

M. Laine *et al.* 2004, W. M. Alberico *et al.* 2007

$$\mu_I = \mu_{FFT} + \Delta(T) \quad \Delta(T) > 0$$

Improving taste: mesons closer to FFT and also approach FFT from above.



Conclusions

- We showed that smearing suppresses UV modes in both gluonic and quark sectors.
- Improving taste symmetry at $T = 0$ causes super-linear improvement at high T. Optimize smearing at $T = 0$ and apply it to finite temperature as well.
- Using optimal HYP smeared valence quark, we measured the hadronic screening masses. For $T > 1.5T_c$, screening masses of all the mesons approach ideal gas value from above in concordance with weak-coupling prediction.