QCD finite T transition with Wilson fermions

(Comparison between Wilson and staggered results)

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Outline

- Motivation and aims
- Action parameters
- Setting the scale
  - scale for staggered calculations
  - scale for Wilson calculations
- Results for quark number susceptibility
- Conclusions
Motivation and aims

Motivation:
- Debate whether staggered is good or not
- There are many ”insensitive” tests (eg. spectrum)

Aim:
- Do a sensitive test
- Sensitive quantity: $\chi_s$
  - quenched: 1st order $\rightarrow$ derivative is infinite
  - unquenched: cross-over $\rightarrow$ derivative is finite (but unknown)
  - $m_q = 0$: derivative is infinite
Action parameters

- tree-level Symanzik improved gauge action
- stout smearing
  - Wilson: 3 steps, $\varrho = 0.1$
  - staggered: 2 steps, $\varrho = 0.15$
- clover improved Wilson fermions, $c = 1.0$
- staggered fermions
- $n_f = 3$, $m \approx m_s/3$
- Wilson: $\beta = 3.2 - 3.7$
  - staggered: $\beta = 3.5 - 4.0$
- Lattice sizes: $32^3 \times 8$ and $32^3 \times 10$
- algorithm: RHMC
Setting the scale

- \( n_f = 3 \)

- \( \frac{m_{PS}}{m_V} = 0.5 \quad \rightarrow \quad m \approx m_s/3 \)

- scale is defined via \( m_V \) for comparison between staggered and Wilson results
Scale for staggered calculations
Scale for Wilson calculations

\[ \kappa = \frac{1}{8r + 2am_{\text{bare}}} \]
Quark number susceptibility

- quantity to measure: quark number susceptibility

\[
\frac{\chi_s}{T^2} = \frac{1}{TV} \frac{\partial^2 \log Z}{\partial \mu_s^2} \bigg|_{\mu_s=0}
\]

- no renormalization needed
  \[\implies\] results of different actions can be easily compared

- maximum of derivative: one definition for \(T_c\)

- derivative gives a sensitive test
Quark number susceptibility

\[ \chi_s \]

\[ T/m_v \]

- \( N_t=8 \) Wilson
- \( N_t=10 \) Wilson
- \( N_t=8 \) staggered
- \( N_t=10 \) staggered
Quark number susceptibility

\[ \frac{d\chi_s}{d(T/m_v)} \]

- \( N_t=8 \) W.
- \( N_t=10 \) W.
- \( N_t=8 \) st.
- \( N_t=10 \) st.

\( T/m_v \)
Conclusions

- $N_t = 8$: staggered and Wilson results differ

- $N_t = 10$: staggered and Wilson results get closer to each other

- to be conclusive: $N_t = 12$ needed