Update of $N_f=3$ finite temperature QCD phase structure with Wilson-Clover fermions

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**Phase structure of 3-flavor QCD at finite temperature**

1st order region in chiral region has been reported to be so small! in KS fermion study

We study the location of critical point with $N_f=3$ by Wilson-type fermions

**Strategy**

Set up & Simulate parameters

- NP O(a) improved Wilson fermions & Iwasaki gauge
- BQCD code
- RHMC, accept. rate is around 0.8
- measured naive chiral condensate (order parameter)
- 10-20 noises ($Z$ noise) are used for estimating $\text{tr}[D^{1,2,3,4}]$ needed for calculating cumulants

**Results**

$K = K_E + AN_L^{1/\nu} (\beta - \beta_{CEP})$

Kurtosis intersection

Consistent with $Z_2$ universality class

Chiral condensate tends to largely overlap with energy-like obs. for $N_f=8$ & 10?

**Summary**

- We derive a new fitting form of kurtosis intersection method including the effect of the energy-like observable
- New fitting result is consistent with $Z_2$ for larger $N_f=8$, 10
- We shall try the mixed observable analysis
- Continuum limit ($N_f=6,8,10$)
- $N_f=2+1$ and study the shape of critical line

**Kurtosis intersection**

$kurtosis \ K = \kappa_4 \kappa_2$

cumulants of order parameter

- $Kt-xh \approx -1$ for $Z_2$, O(2), O(4) in 3D

$B \propto c_E$

One additional parameter in the fitting form reduces the tension in large $N_f=8, 10$

Consistent with $Z_2$