Highlights of Research 2000-06

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Critical Point of QCD

Strangeness & Quasiquarks

EoS, Specific Heat..

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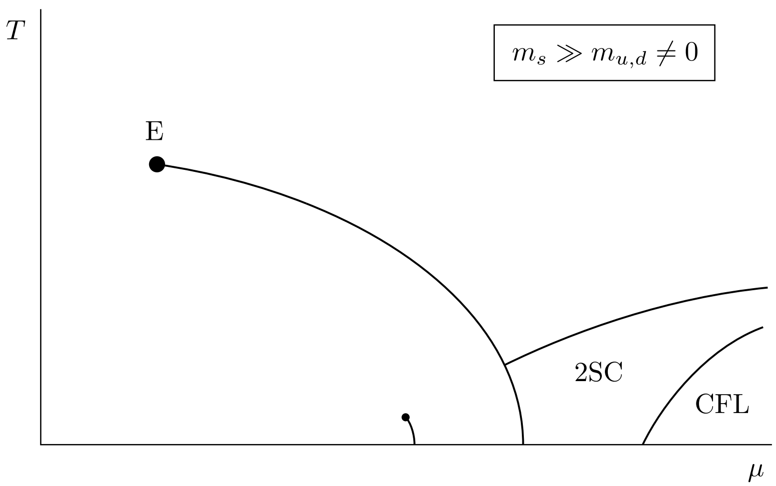
Expected QCD Phase Diagram



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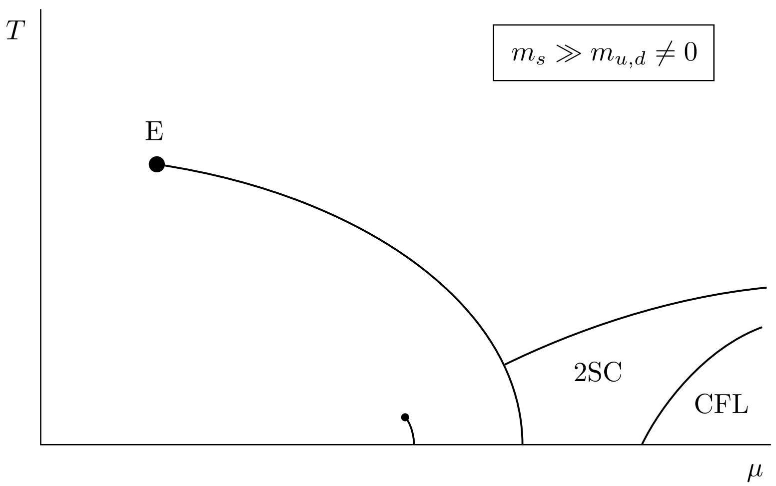

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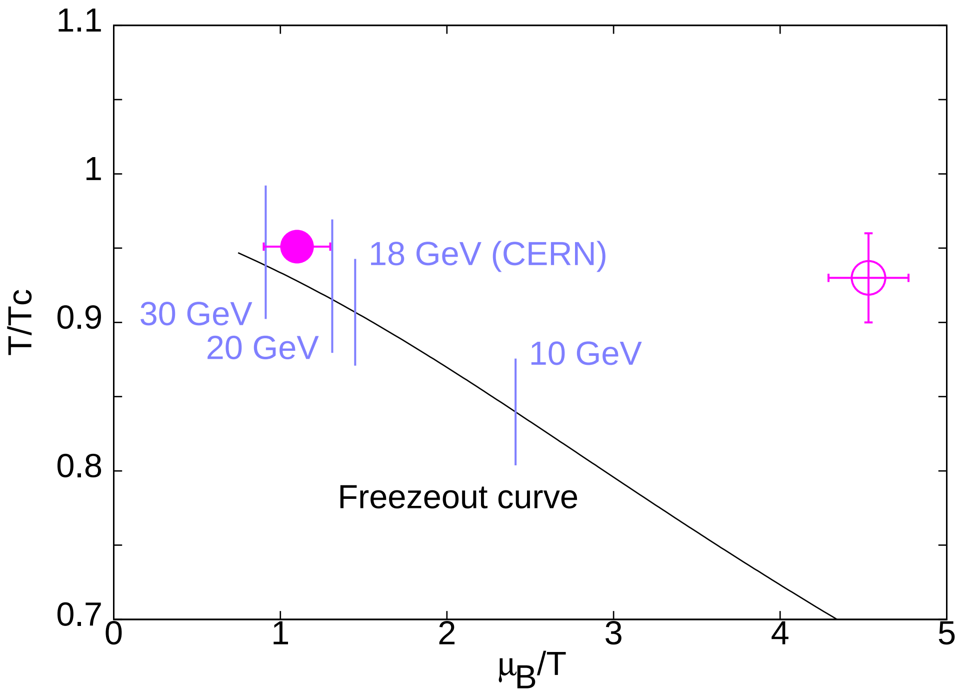

R.V. Gavai and S. Gupta, PR D71 (2005) 114014

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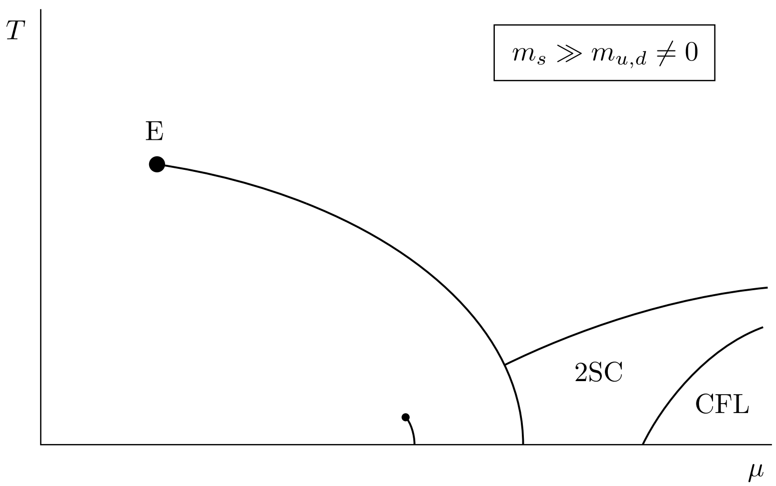

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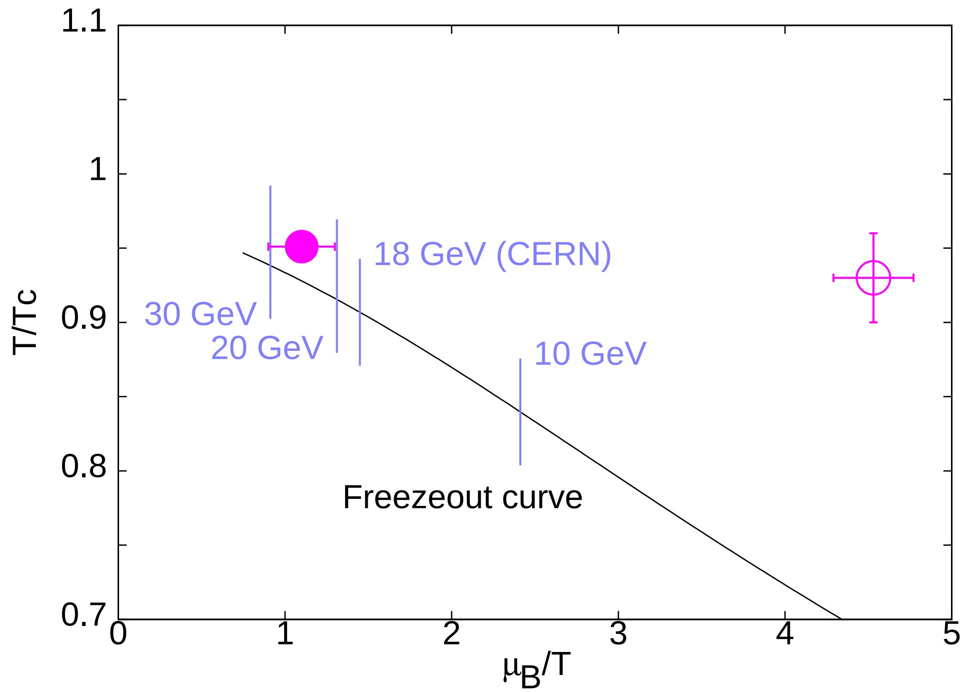

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♣ Proposed *new* method, using Taylor Expansion (R.V. Gavai and S. Gupta, PR D68 (2003) 034506) and used it up to 8th order to get results.

Strangeness & Quasiquarks

♠ Showed that Quark Number Susceptibilities, $\chi_{ij} \sim \partial \ln Z / \partial \mu_i \partial \mu_j$, can provide an estimate of "Wróblewski Parameter", a measure of strangeness produced in Heavy Ion Collisions. (RVG & Sourendu Gupta, PRD 2002, PRD 2003 and PRD 2006)

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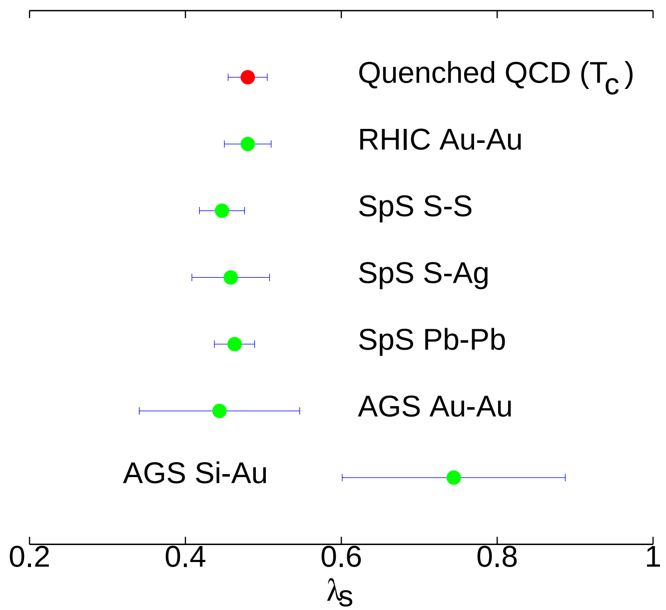

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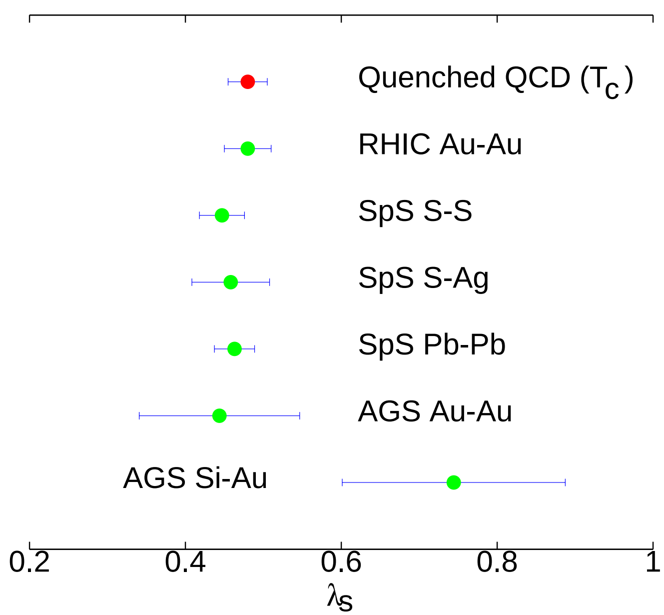

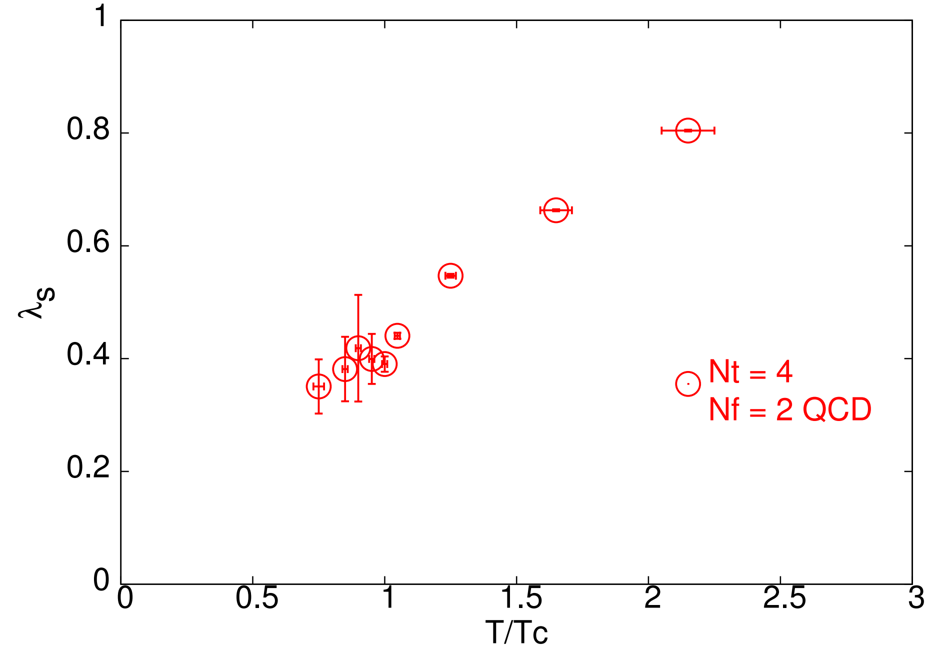

Baryon-Strangeness Correlation

♣Correlation between quantum numbers K and L can be studied through the ratio $C_{(KL)/L} = \frac{\langle KL \rangle - \langle K \rangle \langle L \rangle}{\langle L^2 \rangle - \langle L \rangle^2}$, i.e. ratios of QNS : Shown Theoretically Robust

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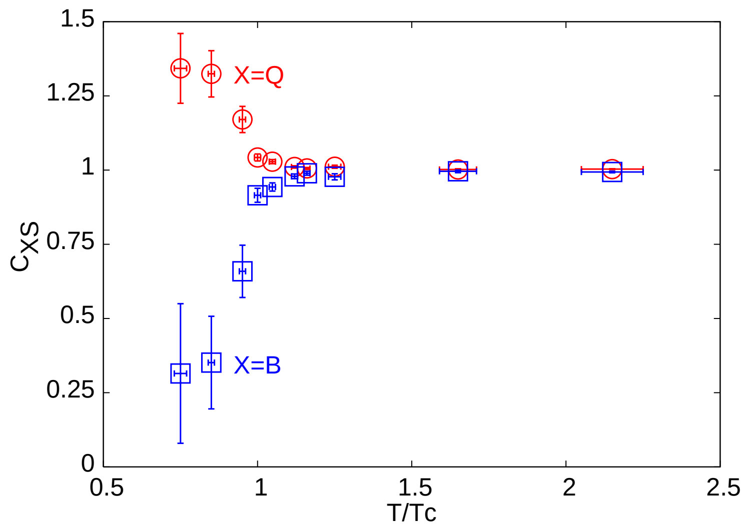

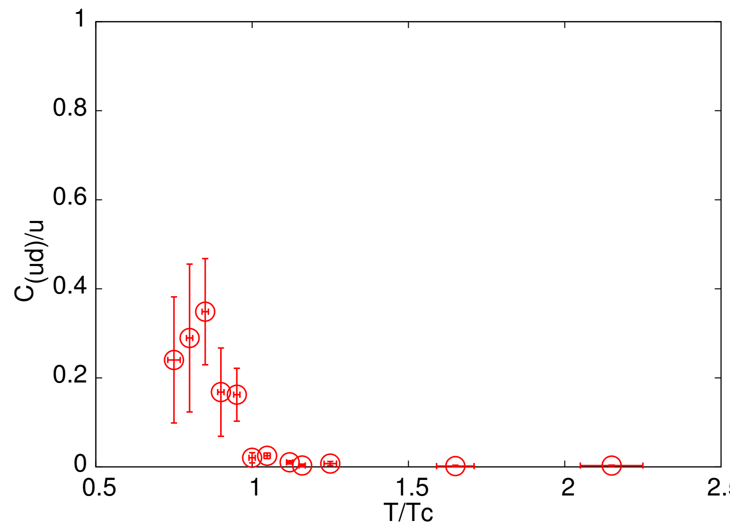

♣ Baryon Number(Charge)–Strangeness correlation suggest strangeness -1 carried by objects with baryon number 1/3 and charge -1/3. Similarly for u and d quarks. $\Longrightarrow$ quasiquarks. (RVG & Sourendu Gupta, PR D 2006).

QGP in Bulk : EoS, Speed of Sound...

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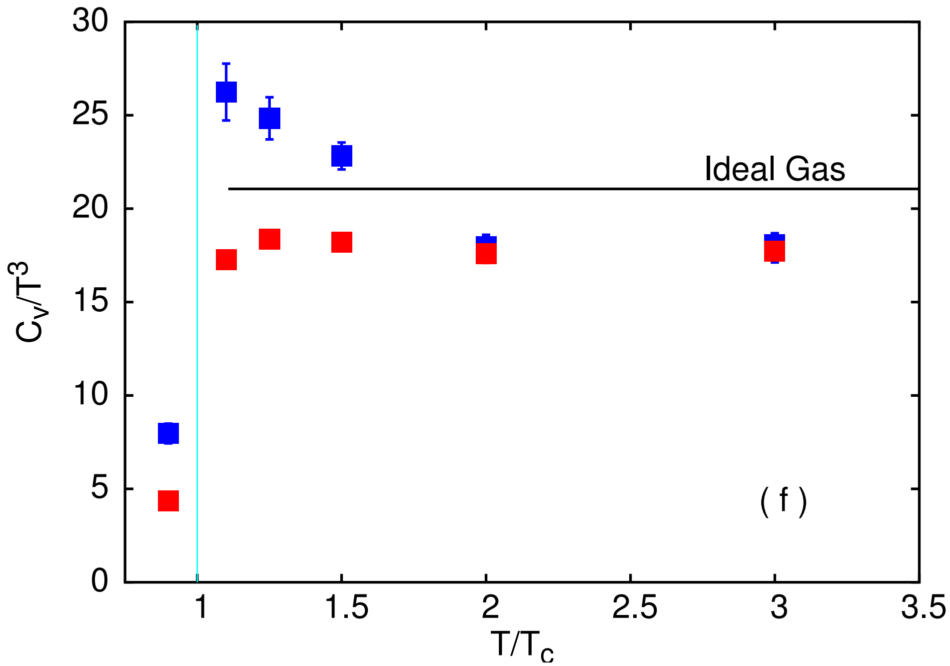
- C_v – Event-by-event temperature/p_T fluctuations.

- Obtained these by relating them to the temperature derivative of anomaly measure Δ/ϵ and showed them to have correct high T limit.

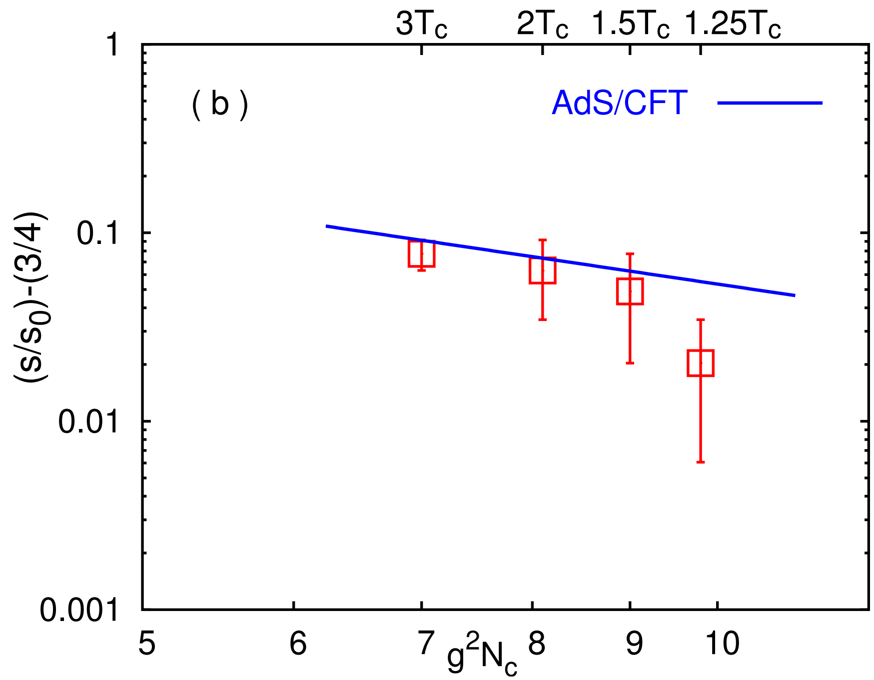
  (RVG, S. Gupta and S. Mukherjee, PR D71 (2005))

- New method to obtain these & EoS differentially without getting negative pressure. Introduced an improved operator than used in earlier Bielefeld studies.

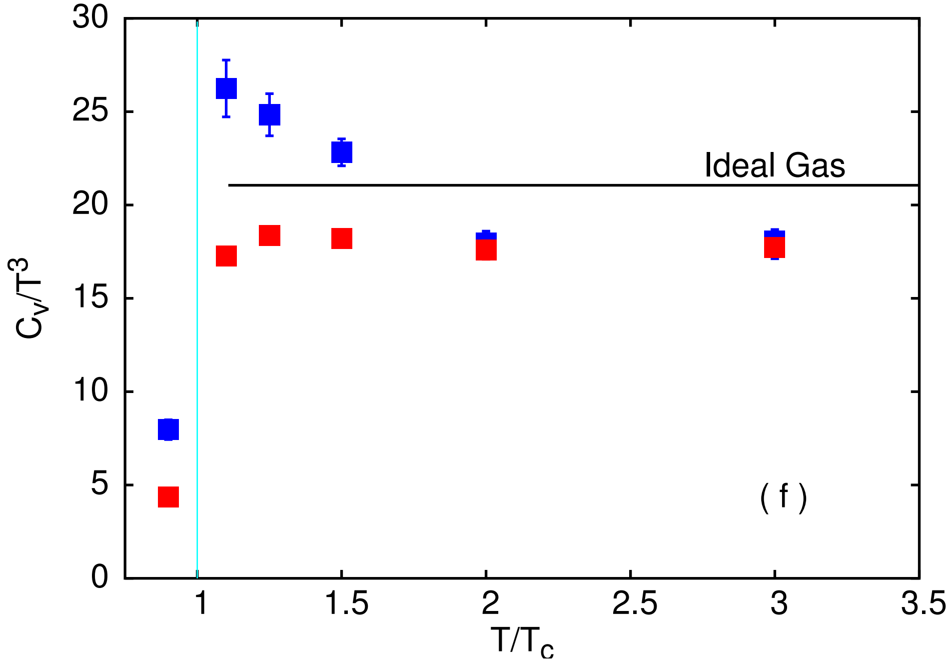
  (RVG, S. Gupta and S. Mukherjee, hep-lat/0506015)

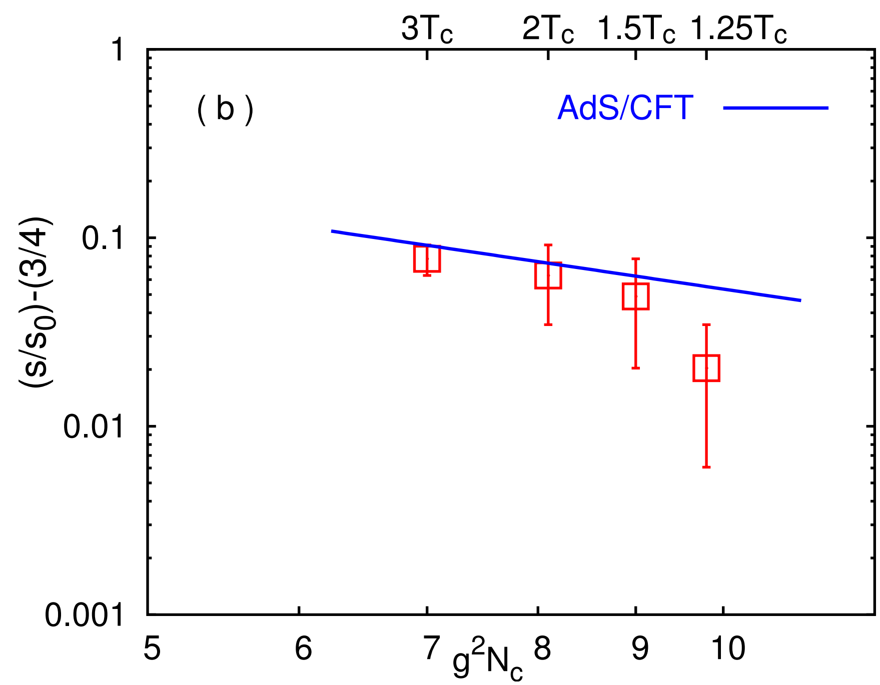


30
25
20
15
10
5
0
1
1.5
2
2.5
3
3.5
C_V/T^3
T/T_c
Ideal Gas
(f)

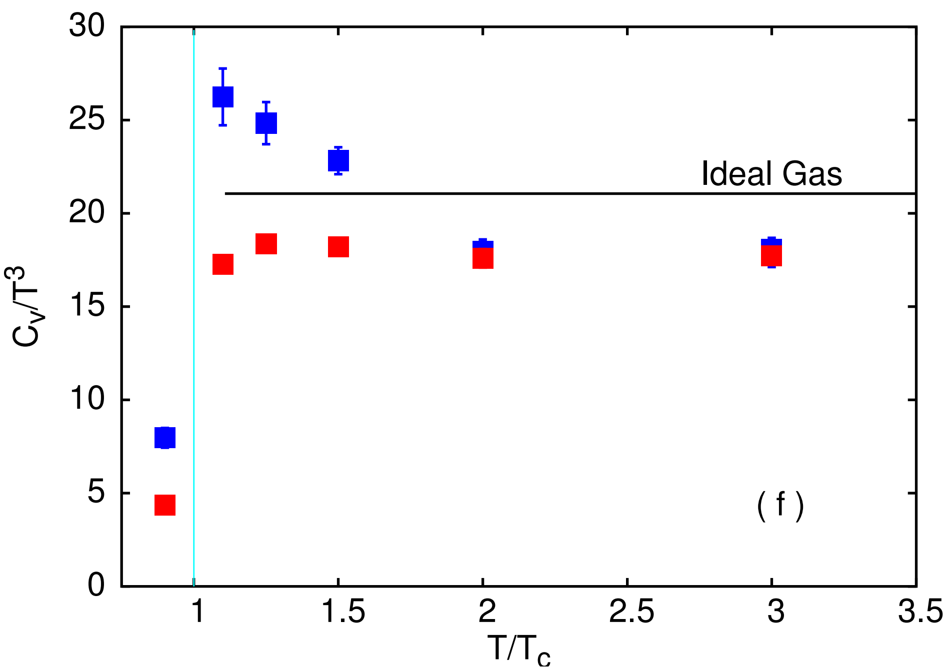


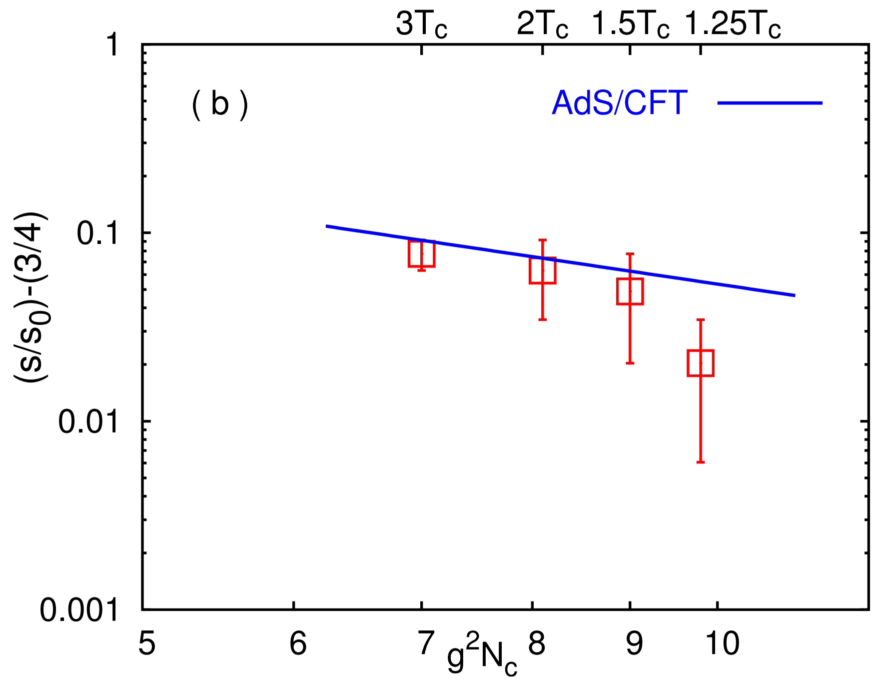
$3T_c$ $2T_c$ $1.5T_c$ $1.25T_c$
1
0.1
0.01
0.001
5
6
7
8
9
10
(s/s_0)-(3/4)
g^2N_c
(b)
AdS/CFT





♠ Specific heat $\Longleftrightarrow$ fluctuations in p_T. Possible to extract from RHIC data?





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- Entropy agrees with strong coupling SYM prediction (Gubser, Klebanov & Tseytlin, NPB '98, 202) for $T = 1.5 - 3T_c$ but fails at lower T, as do various weak coupling schemes: $\frac{s}{s_0} = f(g^2 N_c)$, where $f(x) = \frac{3}{4} + \frac{45}{32}\zeta(3)x^{-3/2} + \cdots$ and $s_0 = \frac{2}{3}\pi^2 N_c^2 T^3$.

- Screening Correlators & Overlap fermions

  $\rightsquigarrow$ Sourendu's talk.

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- Deconfinement in $SU(4)$ Gauge Theory: Showed Latent Heat $\uparrow$, as $N_c \uparrow$.

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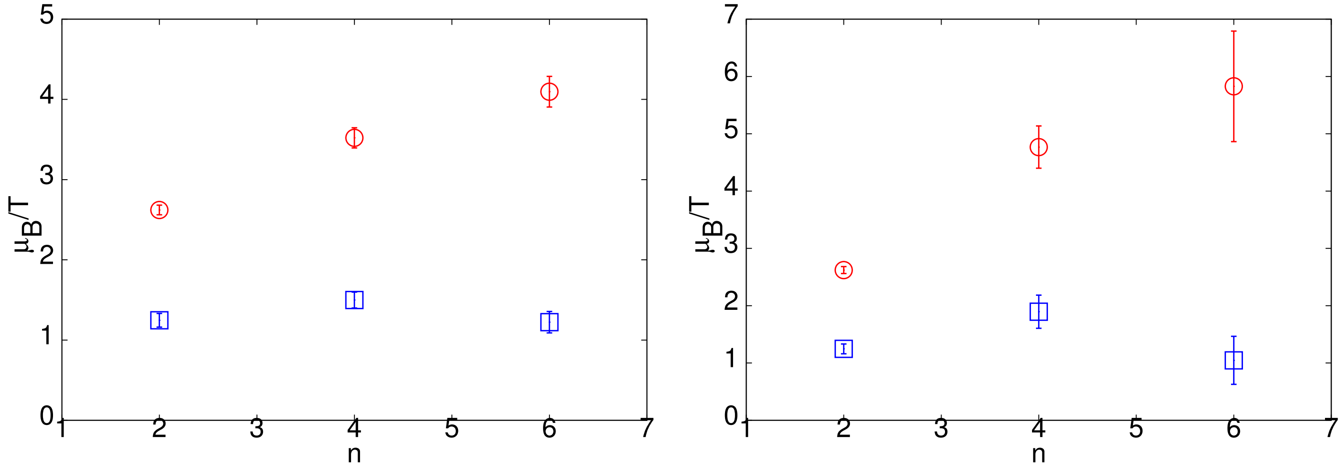
- Future Plans :
  - Continuum limit & Realistic Pion Mass.
  - Better Algorithms
  - LHC Physics : Υ family

Back-Up : Critical Point Estimate

RVG & S. Gupta, PR D 71 2005.



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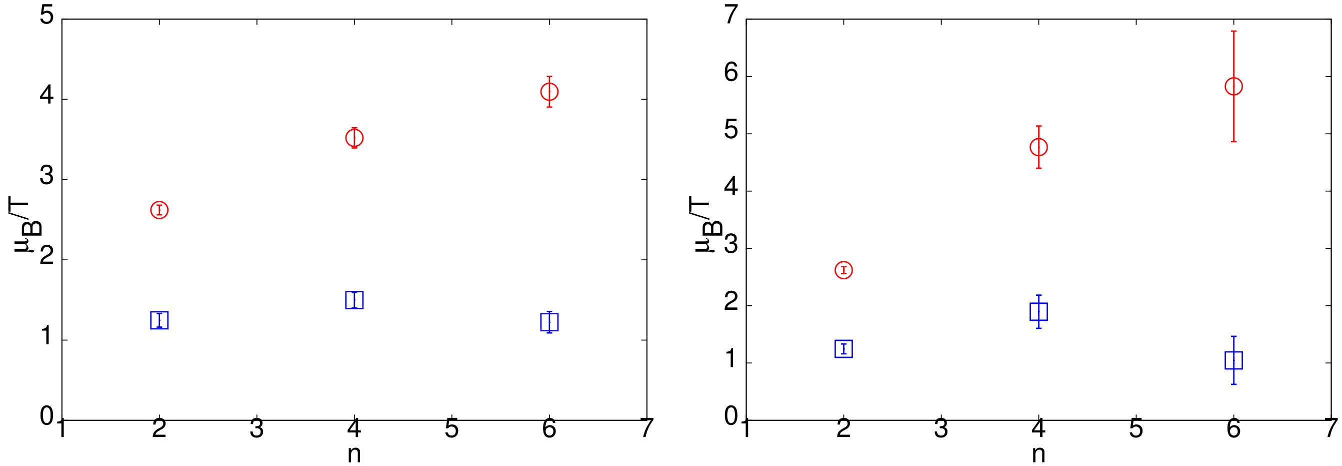

♠ Radii of convergence as a function of the order of expansion at $T = 0.95T_c$ on $N_s = 8$ (circles) and 24 (boxes). Left panel for ρ_n and right one for r_n.

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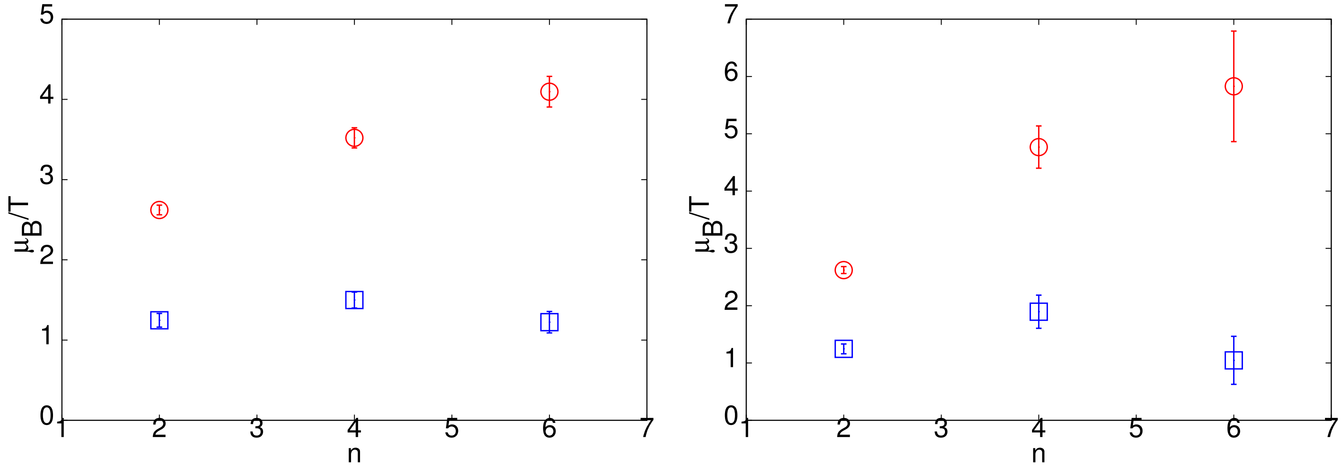

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♠ Extrapolation in $n \rightsquigarrow \mu^E/T^E = 1.1 \pm 0.2$ at $T^E = 0.95T_c$. Finite volume shift consistent with Ising Universality class.

m_ρ/T_c	m_π/m_ρ	m_N/m_ρ	$N_s m_\pi$	flavours	T^E/T_c	μ_B^E/T^E
5.372 (5)	0.185 (2)	—	1.9–3.0	2+1	0.99 (2)	2.2 (2)
5.12 (8)	0.307 (6)	—	3.1–3.9	2+1	0.93 (3)	4.5 (2)
5.4 (2)	0.31 (1)	1.8 (2)	3.3–10.0	2	0.95 (2)	1.1 (2)
5.4 (2)	0.31 (1)	1.8 (2)	3.3	2	—	—
5.5 (1)	0.70 (1)	—	15.4	2	—	—

Table 1: Summary of critical end point estimates— the lattice spacing is $a = 1/4T$. N_s is the spatial size of the lattice and $N_s m_\pi$ is the size in units of the pion Compton wavelength, evaluated for $T = \mu = 0$. The ratio m_π/m_K sets the scale of the strange quark mass.

Results are sequentially from Fodor-Katz '04, Fodor-Katz '02, Gavai-Gupta, de Forcrand- Philipsen and Bielefeld-Swansea.