Report from A01 group

Tetsuya Onogi (Osaka Univ.)

(Co-) representative

T. Onogi (Osaka) , Y. Kuramashi (Tsukuba), Y. Yamada (KEK)

Main-collaborators

Osaka: H. Fukaya
KEK: T. Kaneko, J. Noaki, S. Hashimoto,
Tsukuba: N . Ishizuka, Y. Taniguchi, N. Ishii
Nagoya: Y. Aoki, M. Hayakawa, T.Yamazaki
Teikyo: Y. Furui
Hiroshima: K.I. Ishikawa

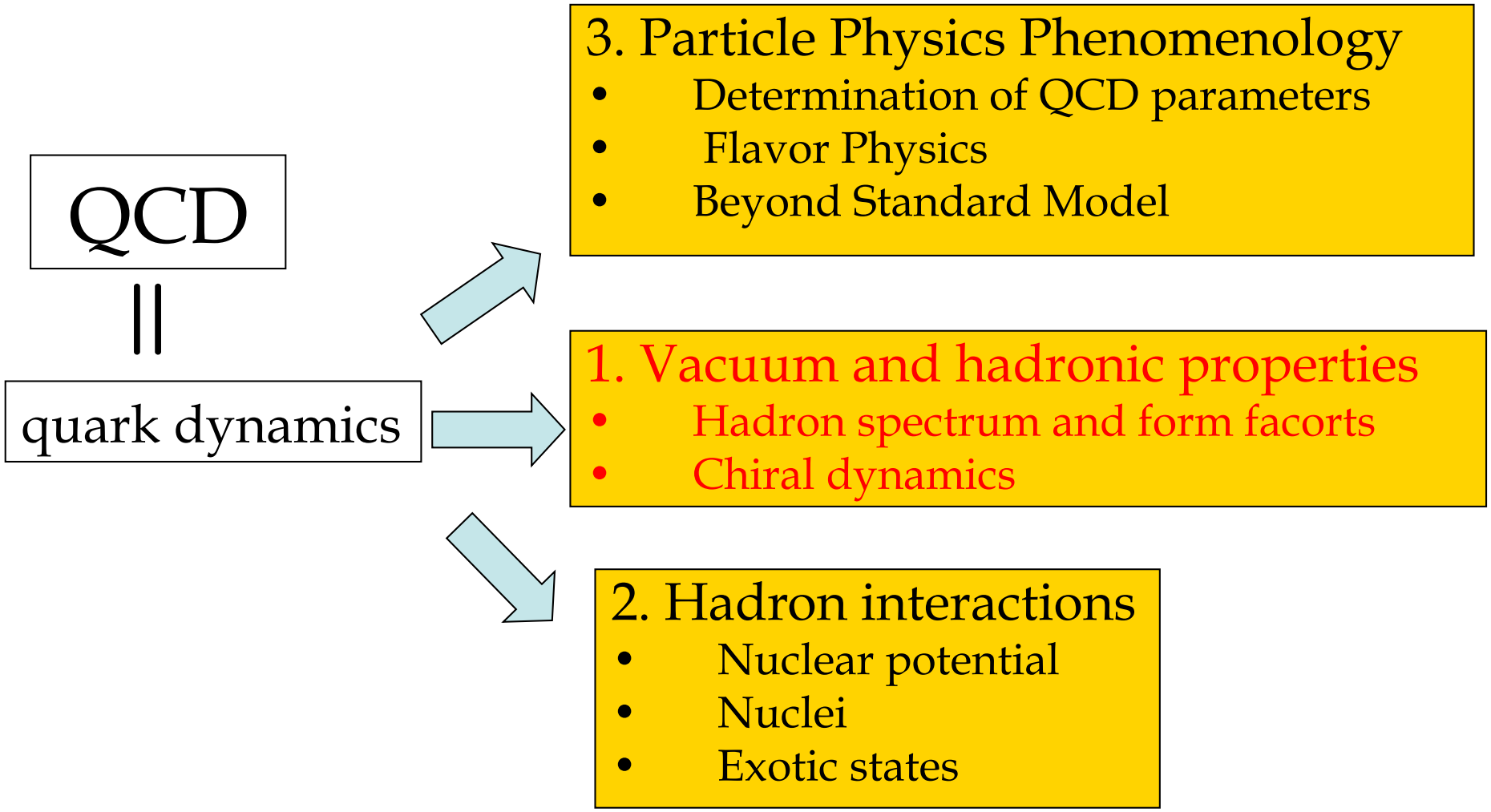
Sub-collaborators

T. Izubuchi, E. Shintani (Riken/BNL)

PD

Sang-Woo Kim (Osaka), Jong-Wan Lee
Namekawa (Tsukuba)

Goal of A01 group



Activities in 2011

5 Journal papers

1. H.Fukaya et al. [JLQCD and TWQCD Collaboration], ``Determination of the chiral condensate from QCD Dirac spectrum on the lattice,'' Phys. Rev. D 83 (2011) 074501

2. K.Takeda et al. [JLQCD Collaboration], ``Nucleon strange quark content from two-flavor lattice QCD with exact chiral symmetry,'' Phys Rev. D 83 (2011) 114506

3. M.Hayakawa, K.-I.Ishikawa, Y.Osaki, S.Takeda, S.Uno and N.Yamada, ``Running coupling constant of ten-flavor QCD with the Schrodinger functional method,'' Phys. Rev. D 83 (2011) 074509

4. T.Yamazaki, Y.Kuramashi and AUkawa, ``Two-Nucleon Bound States in Quenched Lattice QCD,'' Phys. Rev. D 84 (2011) 054506 → Talk by Yamazaki

5. Y.Namekawa et al. [PACS-CS Collaboration], ``Charm quark system at the physical point of 2+1 flavor lattice QCD,'' Phys. Rev. D 84 (2011) 074505
   → Talk by Namekawa

Activities in 2011

2 preprints

1. T.Aoyama, H.Ikeda, E.Itou, M.Kurachi, C.-J.D.Lin, H.Matsufuru, K.Ogawa, H.Ohki, T. Onogi, E. Shintani, T. Yamazaki , ``Conformal fixed point of SU (3) gauge theory with 12 fundamental fermions,'' arXiv:1109.5806 [hep-lat].

2. S.Aoki et al. [PACS-CS Collaboration], ``rho Meson Decay in 2+1 Flavor Lattice QCD,'' arXiv:1106.5365 [hep-lat].

Activities in 2011

4 proceedings

1. S-W. Kim et al. [The JLQCD Collaboration], ``Lattice study of 4d {\cal N}=1 super Yang-Mills theory with dynamical overlap gluino,'' arXiv:1111.2180 [hep-lat].

2. K.Ogawa, T.Aoyama, H.Ikeda, E.Itou, M.Kurachi, C.J.D.Lin, H.Matsufuru, H.Ohki, T. Onogi, E. Shintani, T. Yamazaki , ``The Infrared behavior of SU(3) Nf=12 gauge theory -about the existence of conformal fixed point-,'' arXiv: 1111.1575 [hep-lat].

3. H. Fukaya et al. [JLQCD Collaboration], ``Chiral interpolation in a finite volume,'' arXiv:1111.0417 [hep-lat]. → Talk by Fukaya

4. T.Yamazaki, Y.Kuramashi and A.Ukawa, ``Calculation of Helium nuclei in quenched lattice QCD,'' AIP Conf. Proc. 1374 (2011) 627.→ Talk by Yamazaki

Renewals of the supercomputer

- KEK supercomputer (SR11000, BlueGene) was shutdown in Dec. 2010.
- YITP supercomputer (SR16000) started in Jan. 2011
- The Earthquake, March 2011.
- KEK supercomputer (SR16000) started in September 2011.
- KEK supercomputer (Blue/Gene) will start in March 2012.

There has been a time that YITP, T2K are the most powerful machines.

We recognized that having independent machine is important.

We also recognized that DataGrid with fast network and large disk is also important.

No group meetings, but closely related one

1. “Future directions of lattice QCD”

   July 27, 2011 @ Univ. of Tokyo

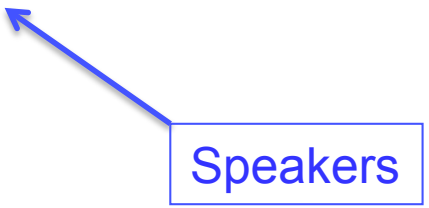
   organized by

   - Joint Institute for Computational Fundamental Science
   - HPCI strategic program, field 5

Appologies

From now on, I pick up only part of the activities, for which
1) possible speaker on the topic is absent,
and/or
2) the topic was not explained last year.

There are many interesting topics which should be explained.
I feel very sorry for
Cossu-san, Ejiri-san, Iida-san, Ishii-san, Fukaya-san,
Kouhei Takeda-san, Kaneko-san, Ishizuka-san. ,



2. Hadron Physics

QCD with finite density,

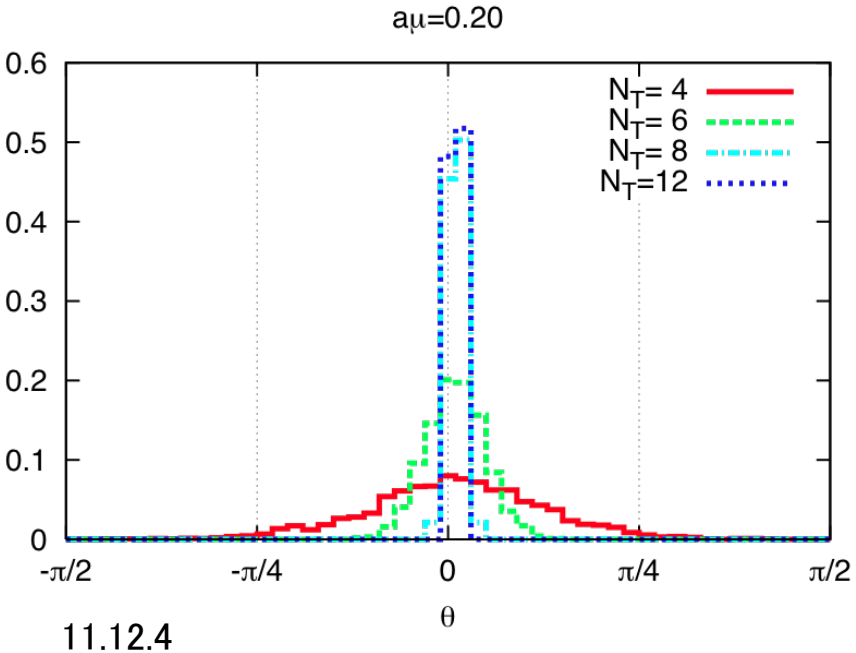
S. Takeda, Y. Kuramashi, A. Ukawa , arXiv:1111.6363

Upper bound for the phase of quark determinant
quark winding number & 1/m expansion

$$\theta(m,\mu) \leq \left(\frac{L}{a}\right)^3 \left(\frac{1}{am}\right)^{\frac{1}{aT}} \exp(\frac{\mu}{T})$$

$$\det(D(m,\mu)) \equiv |\det(D(m,\mu)|\exp(i\theta(m,\mu))$$

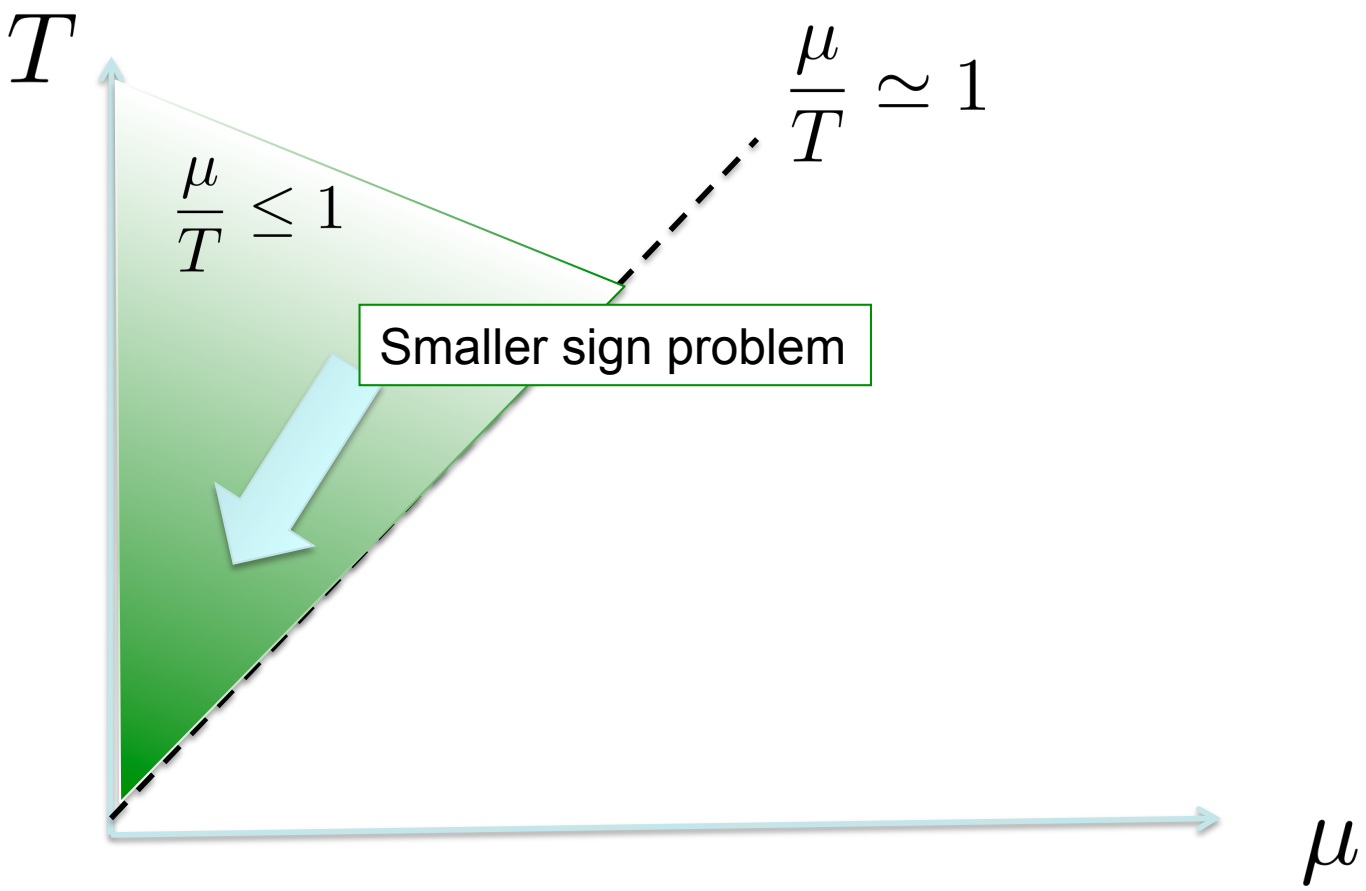
At lower temperature and heavier quark mass and for $\frac{\mu}{T} \leq 1$, Sign problem is less severe.



Numerical test on

$$6^3 \times 4, 6, 8, 12 \text{ lattices}$$

For 4-flavor QCD with Wilson fermion

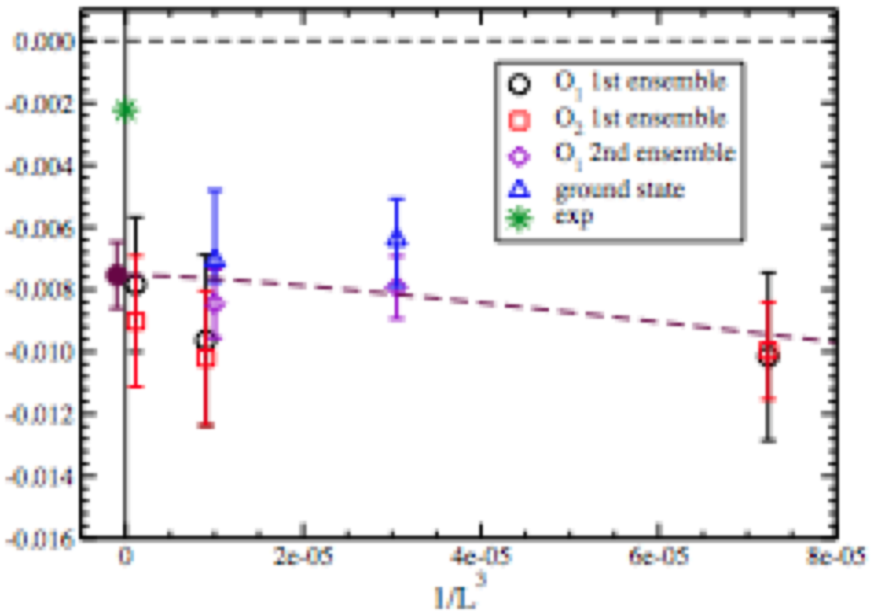

T
$\frac{\mu}{T} \simeq 1$
$\frac{\mu}{T} \leq 1$
Smaller sign problem
μ

Two nucleon bound state,

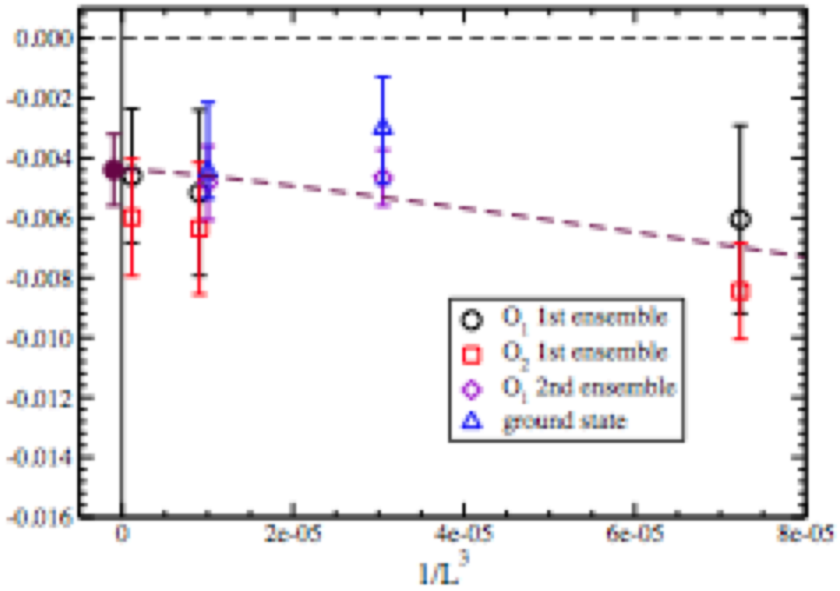
T. Yamazaki et al, ariXiv:1105.1418

Quenched lattice QCD study with $a = 0.128$ fm, $m_\pi = 0.8$ GeV

$^3S_1$ channel



$^1S_0$ channel



Bound state for deuteron.

- The reason for larger bound state in triplet channel and the existence of bound state in singlet channel are unclear.

  → Further studies on various systematic error are needed.

- Personally, a study of nuclear potential with exactly the same parameter ((quenched QCD with a=0.128fm, mpi=0.8 GeV) seems to be very important.

  → It would help to understand the sys. error of Yamazaki-Kuramashi-Ukawa calculation.

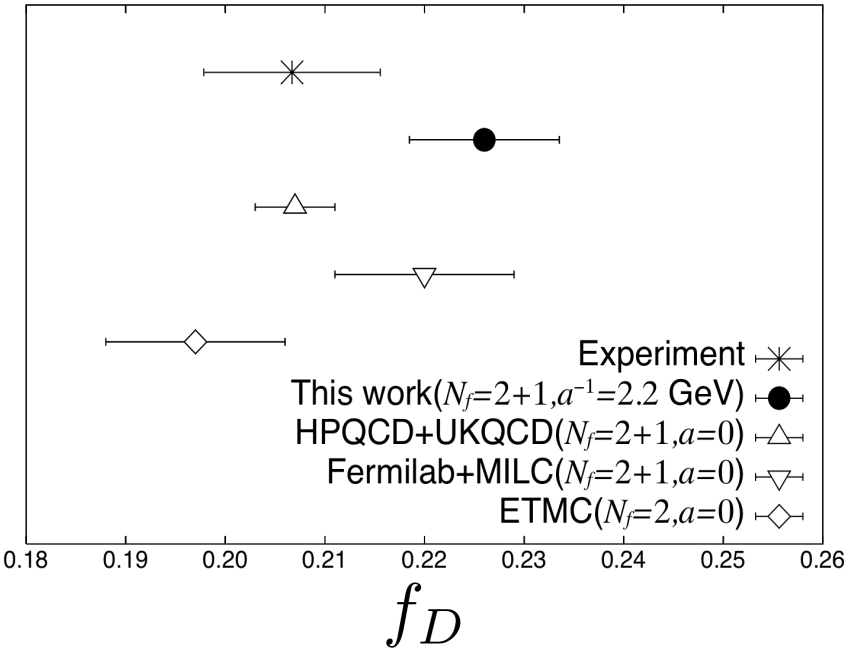
  → It would also give a good test of the method by HAL collaboration.

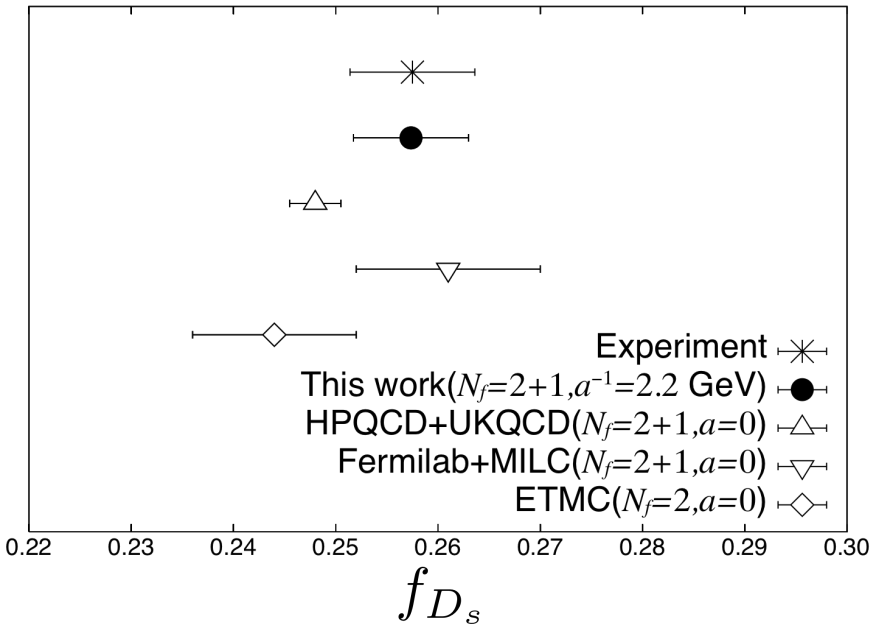
3. Particle Physics Phenomenology

Charm quark physics (D meson),

Y.Namekawa et al. [PACS-CS Collaboration],
Phys. Rev. D 84 (2011) 074505

2+1 flavor QCD with relativisitc heavy quark action



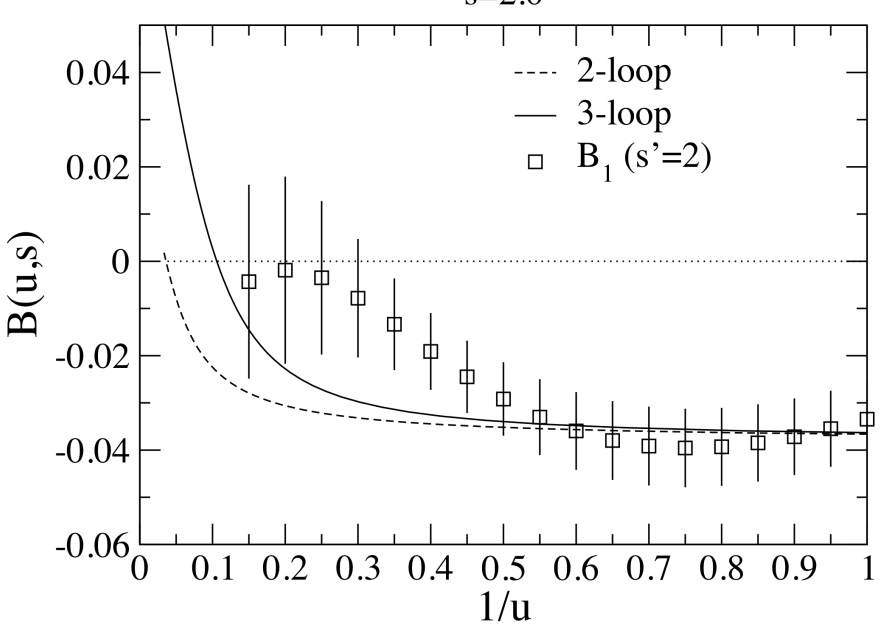


"fD puzzle" is solved.
Application to flavor physics is promising.

Conformal window

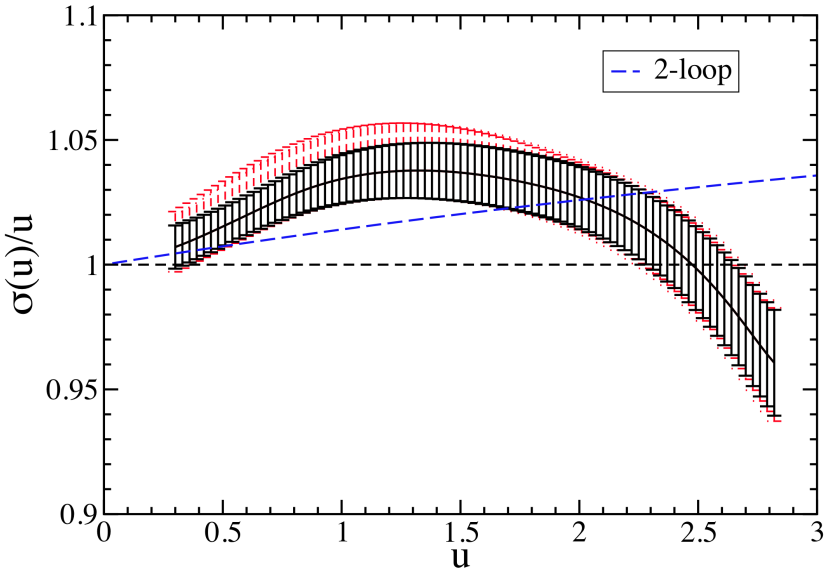
Search for conformal phase in many flavor QCD

10-flavors



M.Hayakawa,, S.Takeda, N.Yamada, et al
Phys. Rev. D 83 (2011) 074509

12-flavors



T.Aoyama, E.Itou, et al. arXiv:1109.5806

RG evolution of the running coupling is studied.
Evidence for IR fixed point → Useful for Walking technicolor theory?

Gluino condensate in N=1 SUSY Yang-Mills theory

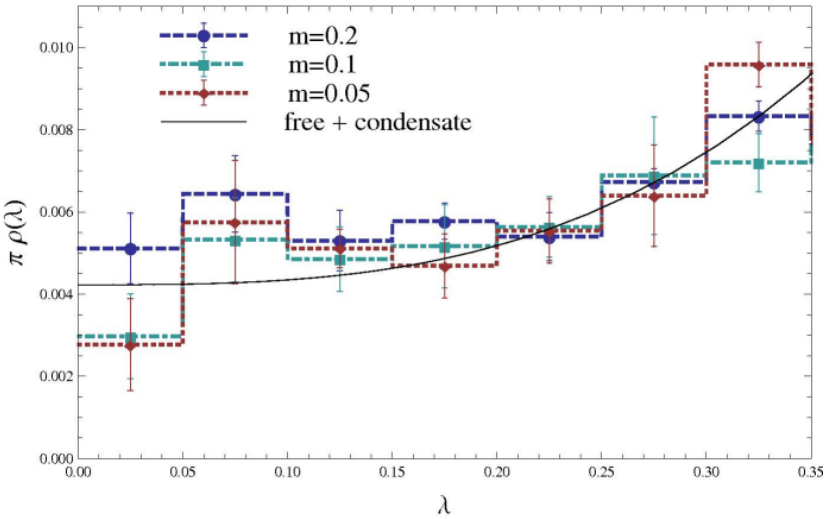
First step

S-W. Kim et al. [The JLQCD Collaboration], arXiv:1111.2180 [hep-lat].

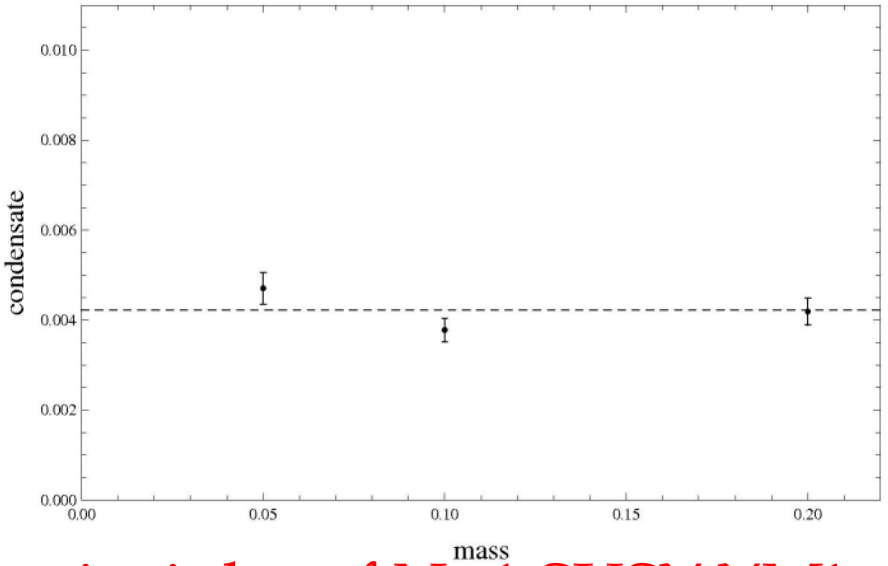
Nonperturbative study of SUSY QCD vacuum is needed!

- A lot of mysteries: N=1 Seiberg-duality, metastable vacua, …
- SUSY breaking mechanism is also important.

Eigenvalue distribution for Gluino Dirac operator



Chiral extrapolation of Gluino condensation.

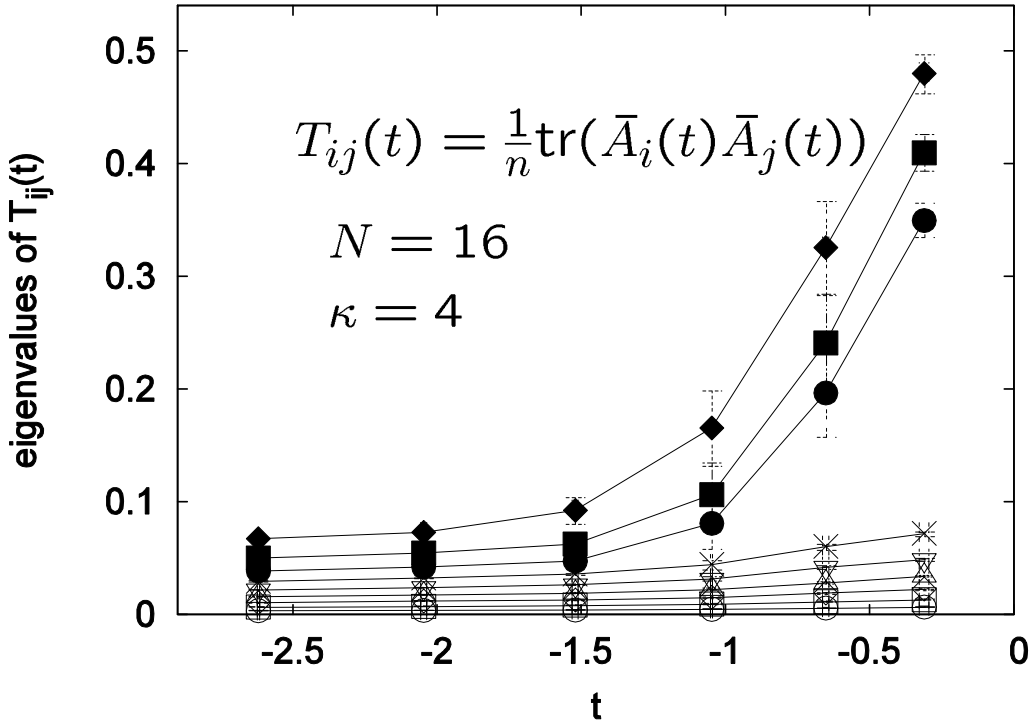


Gluino condensation from 1st principles of N=1 SUSY YM!

Expansion of 3-dim space in superstring theory

S.-W. Kim, J Nishimura, A. Tsuchiya, Arxiv:1108. 1540, 1110. 4803

New simulation method
for IKKT matrix model
In Lorentzian signature



- After some critical time, SSB occurs and SO(9) breaks down to SO(3)
- Inflation from string theory??

Summary

- Many activities in vacuum structure, hadron physics and particle physics phenomenology.

- I hope there will be intensive discussion on these topics during this workshop. For people outside A01 group, the talk by S. Takeda-san and T. Yamazaki-san may be of particular interest.

- New machine is installed at KEK and more is coming.
  → Next phase of lattice QCD simulation.

Backup

Rho meson decay in 2+1 Flavor QCD