

QCDSLAT: new frontiers in lattice field theory for the Standard Model and beyond

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The Group

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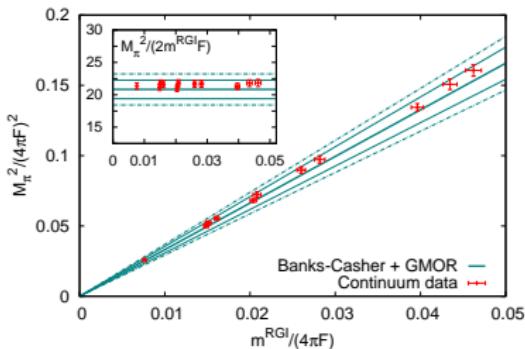
+ students



The physics

► Theme 1: QCD and flavour physics

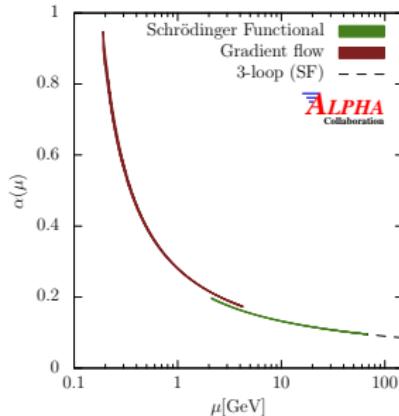
α_s , m_q , χ SB, $\Delta F = 2$ in SM and beyond,
 g_A , EDM, . . .



► Theme 2: QCD at high temperature

EoS for $N_f = 2 + 1$, transport coefficients,
topology (axions), . . .

$$[\Sigma^{\text{RGI}}]^{1/3}/F = 2.77(2)(4) \quad (N_f = 2)$$



► Theme 3: Theoretical developments

NP renormalization (SF), $T_{\mu\nu}$, NSPT,
improvement, . . .

$$\alpha_{\text{MS}}^{(5)}(M_Z) = 0.11852(84)$$

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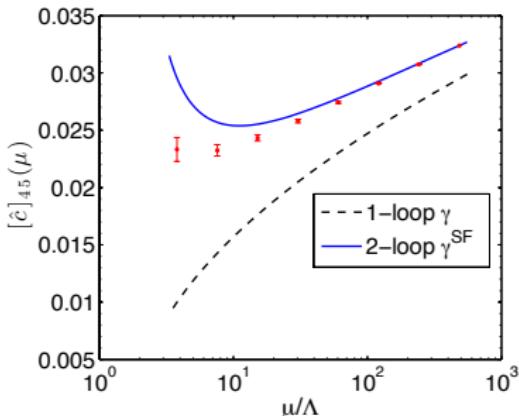
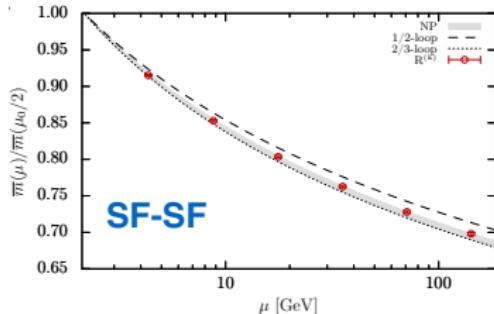
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The physics

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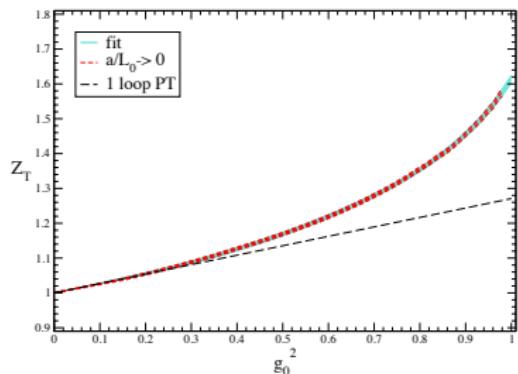
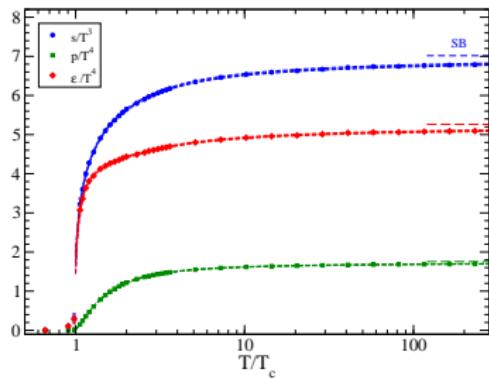
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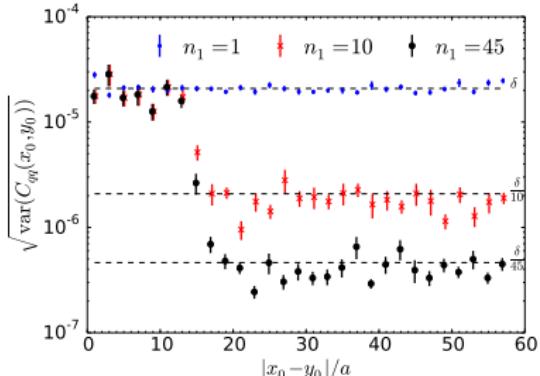
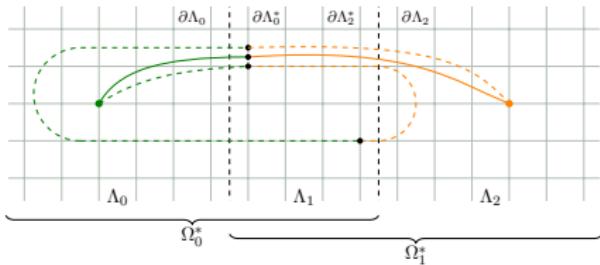
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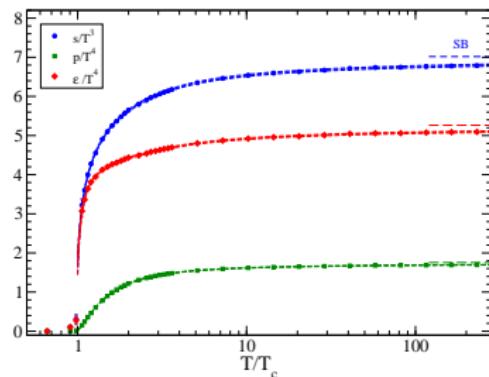
Computational strategies (theme 4)

- ▶ Local factorization of determinant, multi-level integration with fermions, signal-to-noise ratio, ...
- ▶ Various topologies of quark paths simulated differently:
 - * No loops with pseudofermions
 - * Up to N loops with multibosons
 - * More loops with reweighting
- ▶ Turning point for computing many interesting quantities sensitive to SM and hopefully to BSM physics:
 - * HVP and HLbL contributions to $g - 2$
 - * Semi-leptonic B decays
 - * Baryon masses and matrix elements
 - * ρ , η' ,

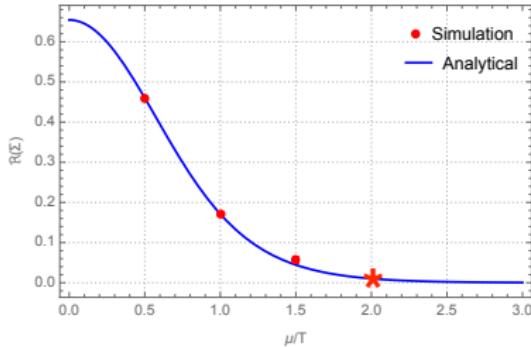


Computational strategies (theme 4)

- Thermal field theories in a moving reference frame extended now to QCD (fermions). New results in the incoming months



- Lefschetz thimble formulation of field theories at $\mu \neq 0$



(a) Chiral condensate at $T = 0.5$, $N_f = 1$, $m = 0.1$.

Three sizes of HPCs needed



- ▶ Small HPC: algorithmic R&D
Funded (too irregularly) by Universities
 $O(0.1 \text{ M}\mathbb{E})$

- ▶ Medium HPC: feasibility studies
Funded by INFN $O(1 \text{ M}\mathbb{E})$
In 2014-2016 **6.5 MHours** in total

- ▶ Large HPC: production
INFN & PRACE calls, $O(10 \text{ M}\mathbb{E})$

In 2014-2016 2 PRACE and 3 ISCRA projects: **160 MHours(BG/Q)** total
INFN: **60 MHours(BG/Q)** in total



Resources needed

- ▶ Generation of gauge ensembles:

2014-2016: **700 MHours (BG/Q)**

Italian (QCDSLAT) contribution: **30%**

- ▶ Expected:

Charm 2-3x

Multilevel 5-10x

Thermo & Thimble : hundreds MHours

2018-2020: 10x to remain competitive

- ▶ **Regular funding of a small HPC by INFN badly needed**

- ▶ **Regular funding of postdoc positions**

Physics

R&D

Coordinated Lattice Simulations (CLS)

