

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

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# The Group

► **Milano:**

C. Destri  
L. Giusti  
M. Pepe  
M. Pernici  
F. Rapuano

M. Dalla Brida

T. Harris

+ students

► **Ferrara:**

F. Schifano  
R. Tripiccione

E. Calore

+ students

► **Parma & Pavia:**

Francesco Di Renzo  
Marco Guagnelli

+ students

► **Roma I & II:**

M. Papinutto  
A. Vladikas

J. Koponen

+ students



# The physics

## ► Theme 1: QCD and flavour physics

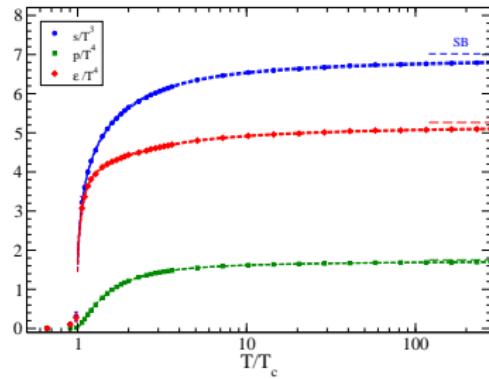
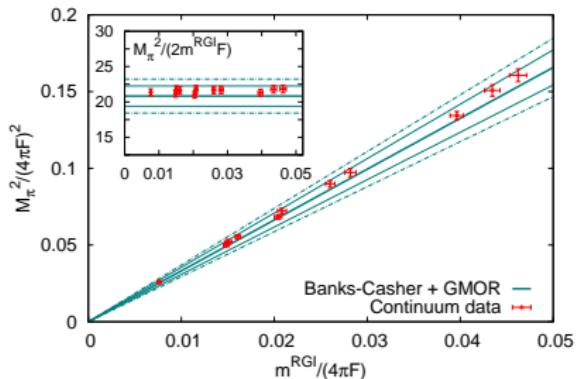
$\alpha_s$ ,  $m_q$ ,  $\chi$ SB,  $\Delta F = 2$  in SM and beyond,  
 $g_A$ , EDM, ...

## ► Theme 2: QCD at high temperature

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

## ► Theme 3: Theoretical developments

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



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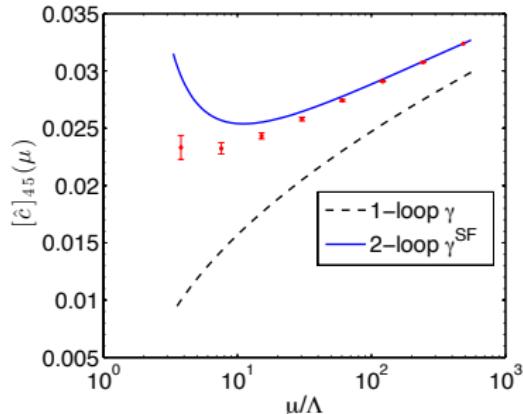
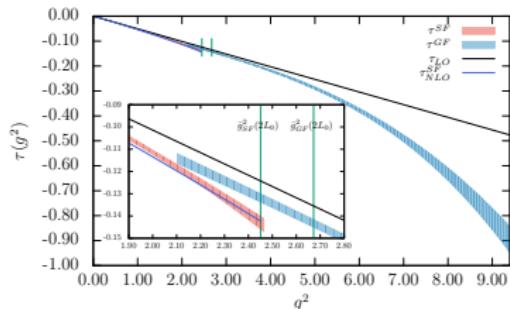
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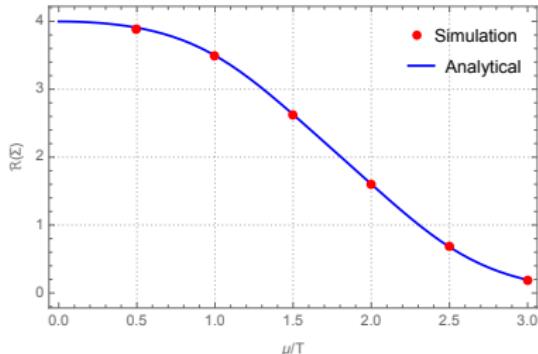
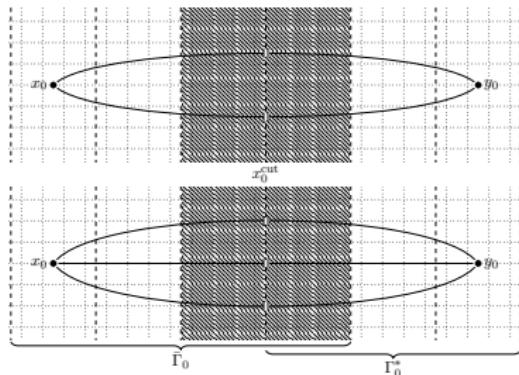


# Computational strategies (theme 4)

- ▶ Local factorization of determinant, multi-level integration with fermions, signal-to-noise ratio, ...

- ▶ Thermal field theories in a moving reference frame

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

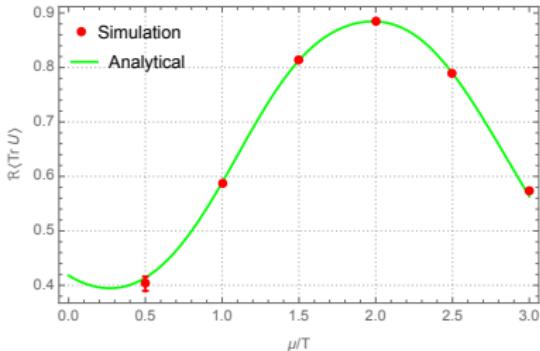
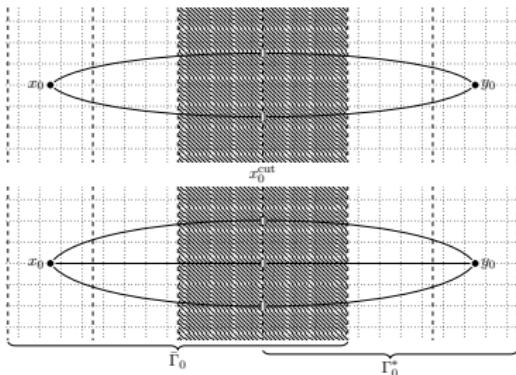


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# Three sizes of HPCs needed



► 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 (QCDOC) 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**

R&D

Physics

## Coordinated Lattice Simulations (CLS)

