Infrared properties of Landau propagators at finite temperature from very large lattices

Attilio Cucchieri (IFSC-São Paulo University)

xQCD2007, Frascati

Collaborators: Tereza Mendes (IFSC-USP), Axel Maas (IF-SAS) and Lucia Mendes Cucchieri (Mundinho Nosso)

Overview

- Introduction
- Various aspects of the topic
- Pros and cons
- Summary
- Discussion

Gribov-Zwanziger confining scenario

- Landau gauge.
- IR-suppressed gluon propagator → D(0)=0 → maximal violation of reflection positivity → gluon confinement.
- IR-enhanced ghost propagator → long-range effect → quark confinement.
- Analytic quantitative predictions for the IR behavior of these propagators.

Gribov-Zwanziger scenario: lattice results

- In quantitative agreement in 2d (A. Maas).
- In 3d (up to L=320, 85 fm): the gluon propagator is IR-suppressed, but D(0)›0, and the ghost propagator is only mildly IR-enhanced.
- In 4d (up to L=128, 27 fm): the gluon propagator shows a plateau in the IR and the ghost propagator is only mildly IR-enhanced.
- Violation of reflection positivity in 2d, 3d and 4d for the gluon propagator.

The finite T case: analytic studies

- Analytic studies at finite T: A.Maas, J.Wambach and R.Alkofer (2005); B. Grűter, R. Alkofer, A.Maas and J.Wambach (2005); A.C., A.Maas and T.Mendes (2007).
- Gluon and ghost propagators change abruptly when T is turned on (different IR exponents).
- For momenta p smaller than (T, Λ) the behavior is the same obtained in the dimensionally-reduced theory and in agreement with the Gribov-Zwanziger scenario.
- Longitudinal gluons acquire a dynamical mass.

The finite T case: lattice studies

- Lattice study at finite T, near Tc: A.C., A.Maas and T.Mendes (2007), using relatively small lattices.
- Transverse gluon decreases as T ↑; stronger IR suppression at high T.
- Longitudinal gluon propagator shows a plateau at $T \neq T_c$.
- Longitudinal gluon propagator blows up at Tc?
- Ghost propagator does not depend on T.
- Smallest non-zero eigenvalue goes to zero in the infinite-volume limit faster than for the Laplacian.

This work

- We consider SU(2) Yang-Mills theory in 4d $\rightarrow$ second-order deconfining transition.
- Problem: what are the effects on the propagators? How do they feel the transition?
- Consider T in the range [Tc/3, 2 Tc].

Simulation parameters

- β = 2.3 (a≈0.838 1/GeV) and 2.511 (a≈0.419 1/GeV)
- Nt = 2 (T≈597MeV), 4 (T≈298MeV ≥Tc), 6 (T≈199MeV), 8 (T≈149MeV) and 10 (T≈119MeV) at β= 2.3
- Ns = 40, 64 and 88 (at β= 2.3)
- # confs › 100

Simulations

- Landau gauge
- Momenta with pt=0
- 3d-transverse gluon (magnetic sector) and 3d-longitudinal gluon (electric sector)
- Ghost propagator and smallest eigenvalue of the FP matrix

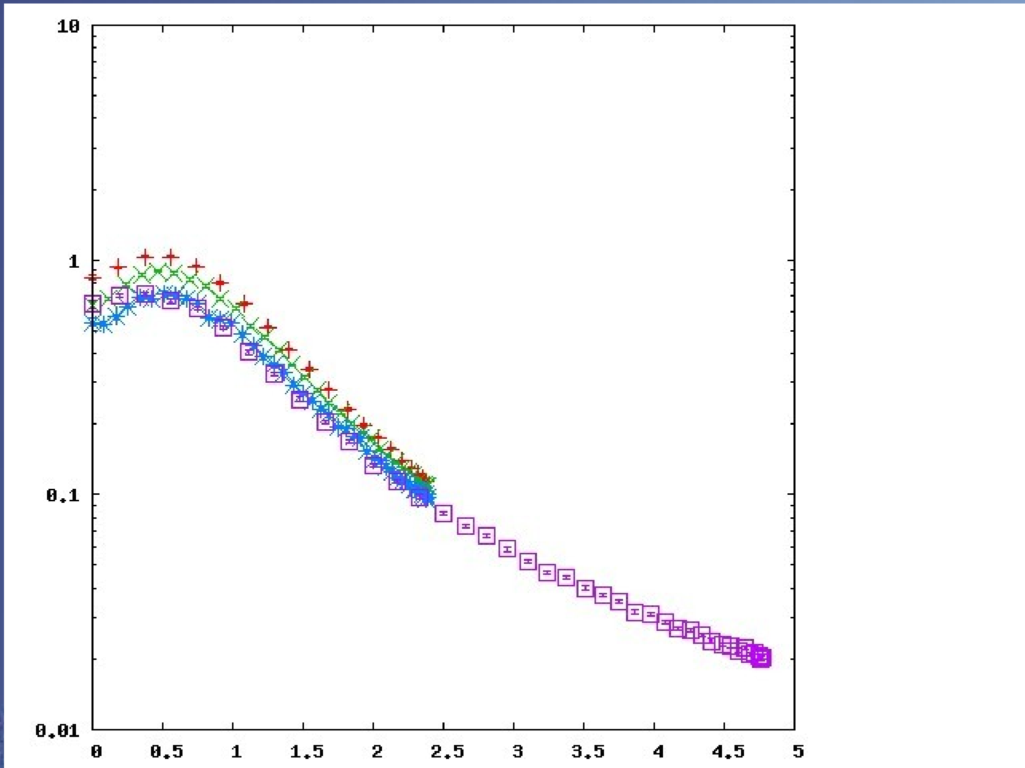
IBM supercomputer at São Paulo University

- IBM supercomputer
- 112 blades with 2 dual-core PowerPc 970 2.5 Ghz CPU's
- Myrinet network
- About 4.5 Tflops peak
- Position 363 in the TOP500 (until a few weeks ago)
- Thanks to FAPESP

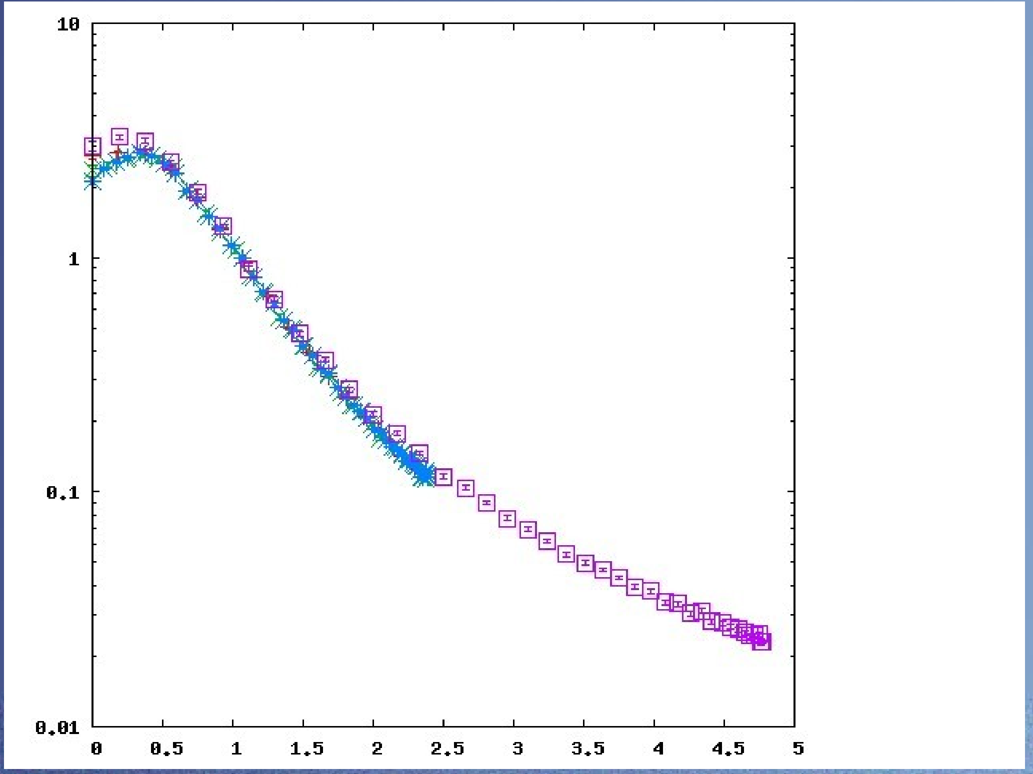
RESULTS

- Preliminary analysis.
- Finite-volume and discretization effects.
- Temperature dependence.

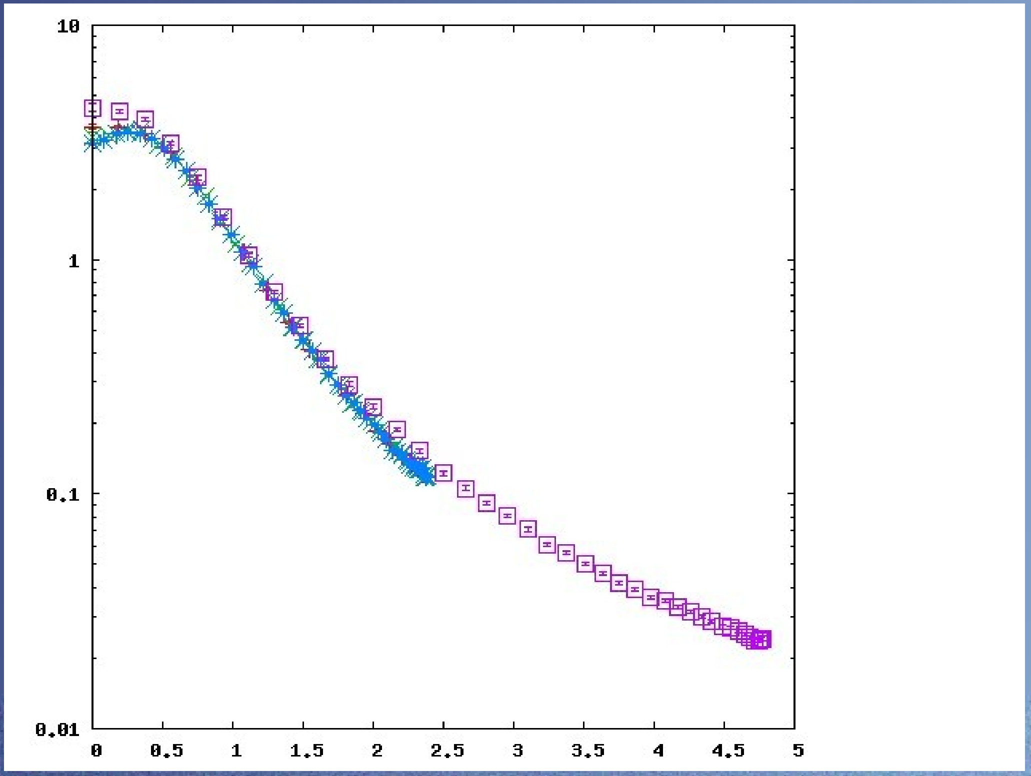
Transverse Gluon (T≈597MeV, V increases ↓)



Transverse Gluon (T≈199MeV)

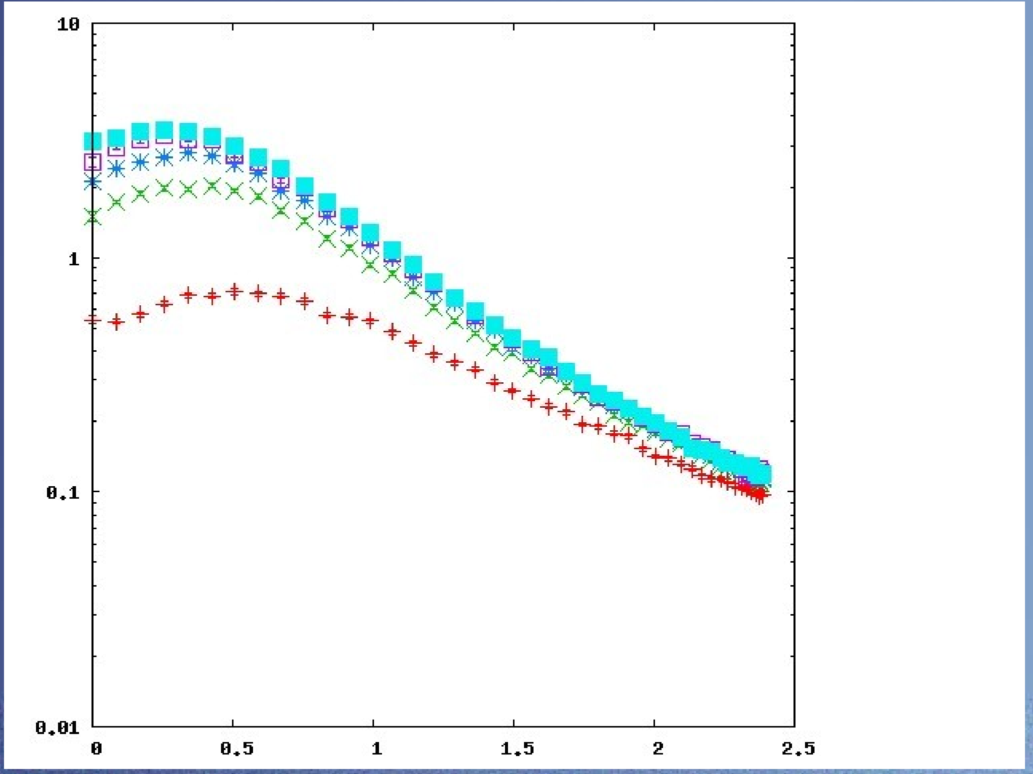


Transverse Gluon (T≈119MeV)

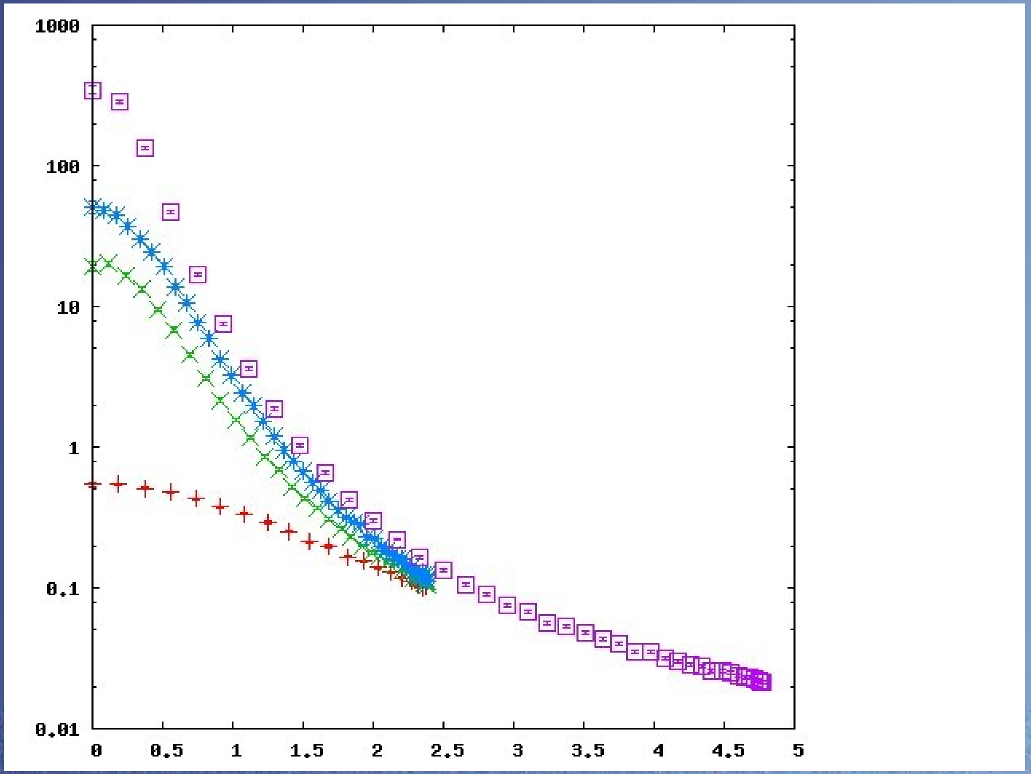


Transverse Gluon vs. T

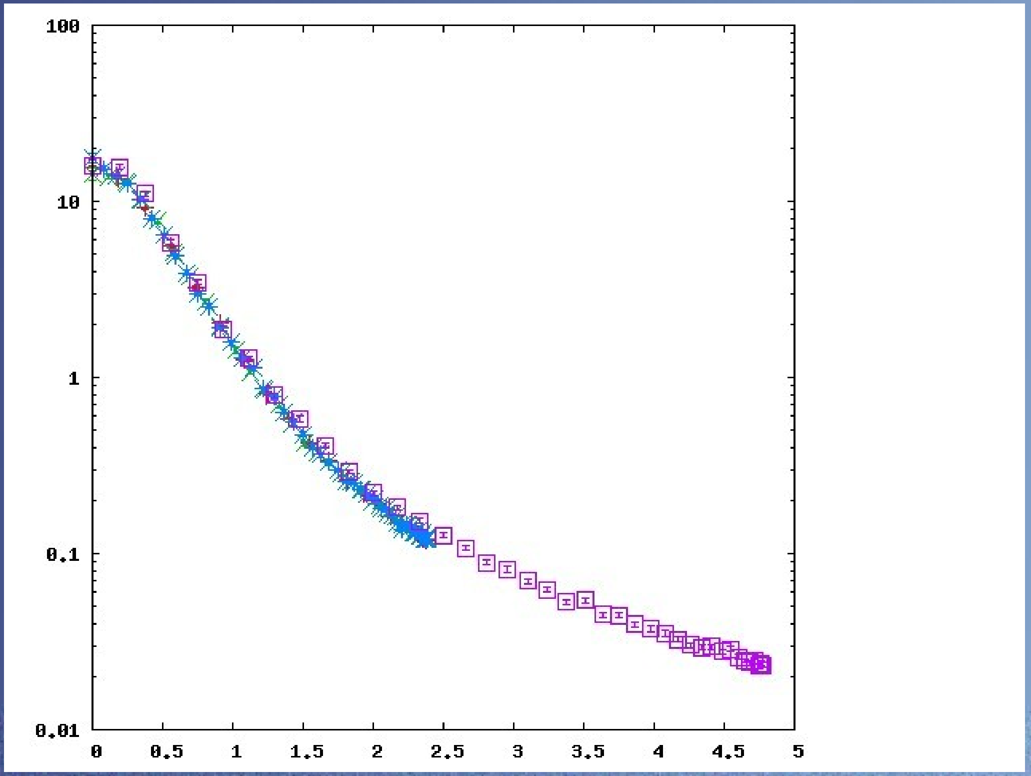
(T increases ↓)



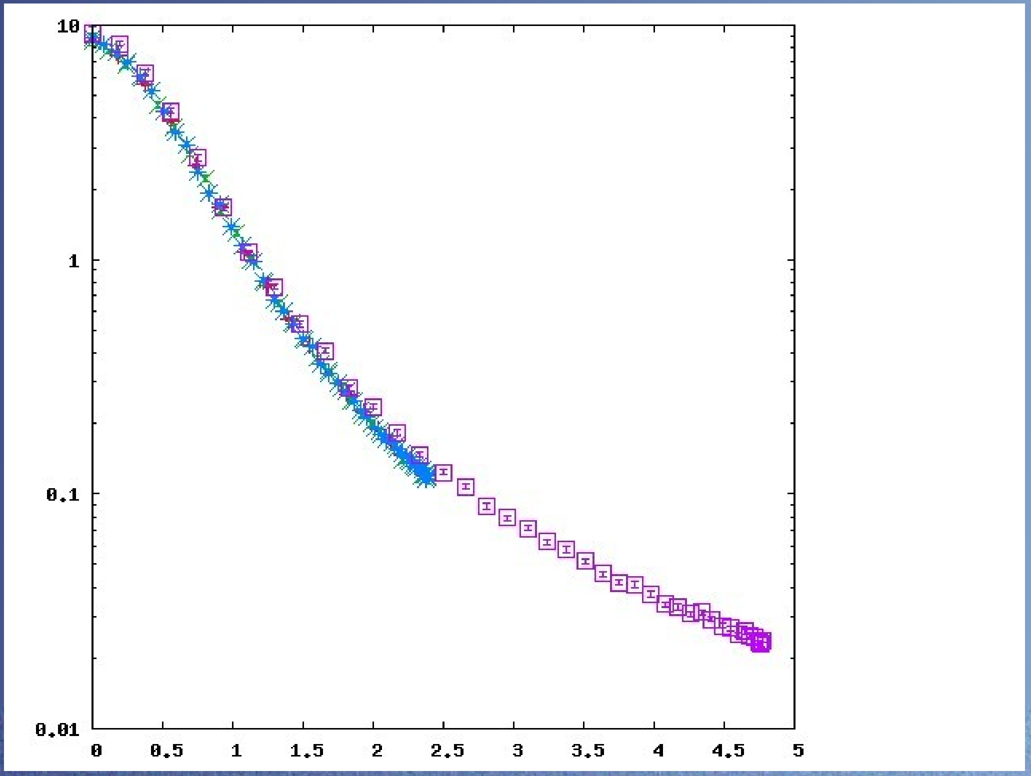
Longitudinal Gluon (T≈597MeV, V increases ↑)



Longitudinal Gluon (T≈199MeV)

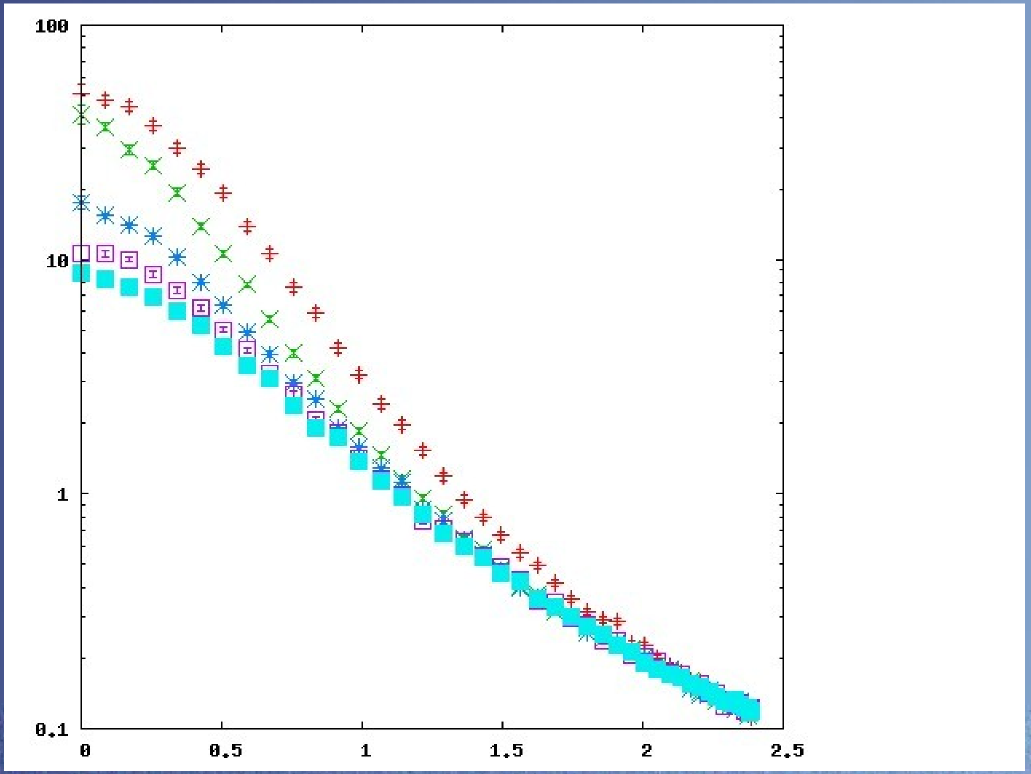


Longitudinal Gluon (T≈119MeV)



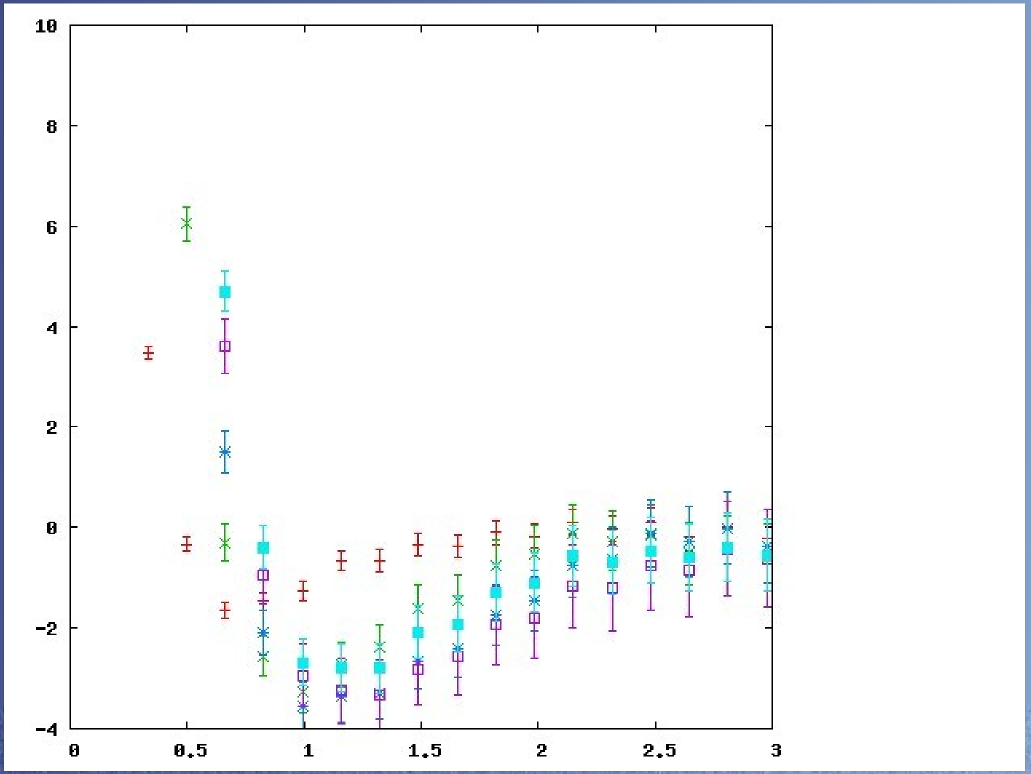
Longitudinal Gluon vs. T

(T increases ↑)



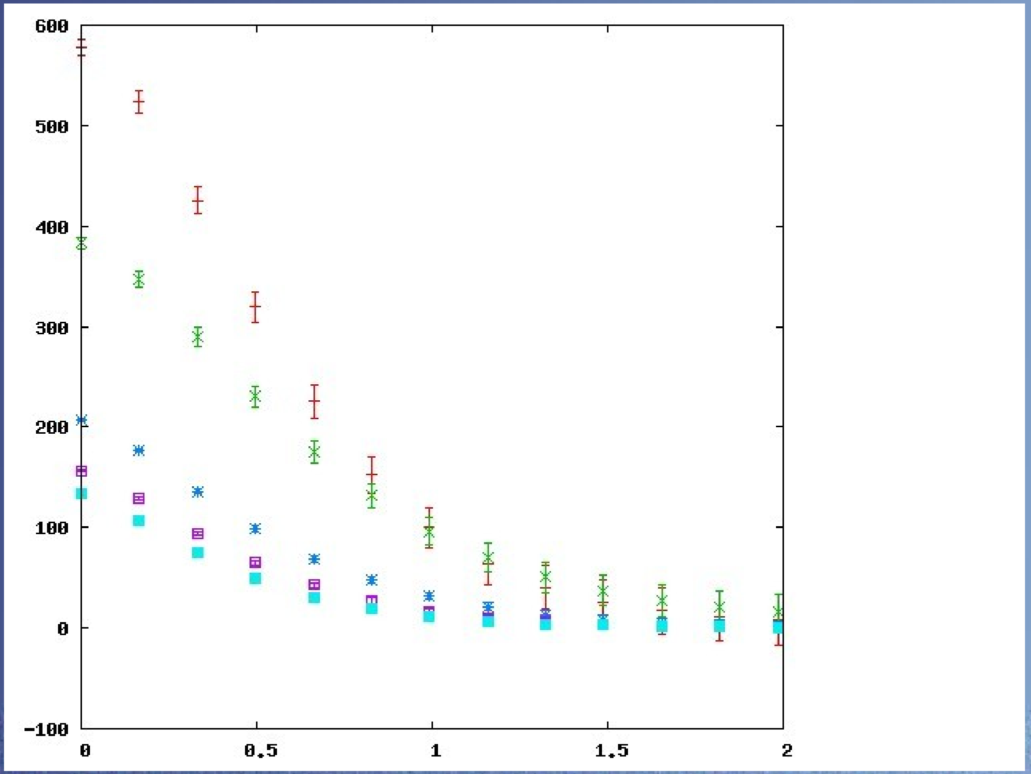
Transverse Gluon

(as a function of space-separation d)

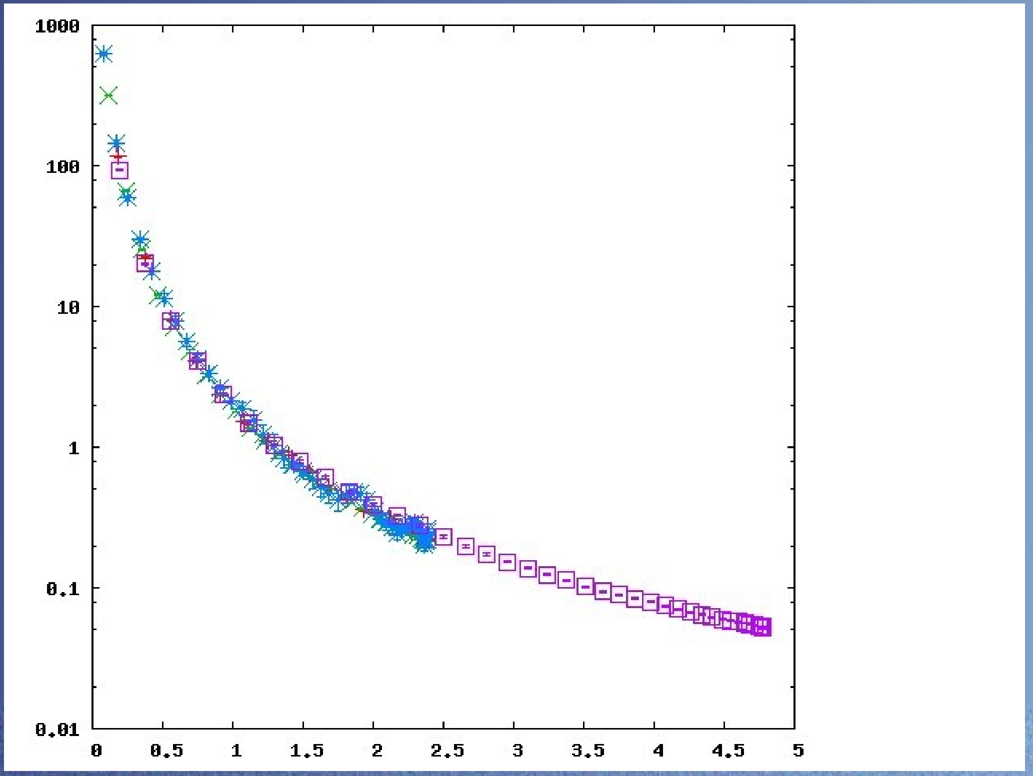


Longitudinal Gluon

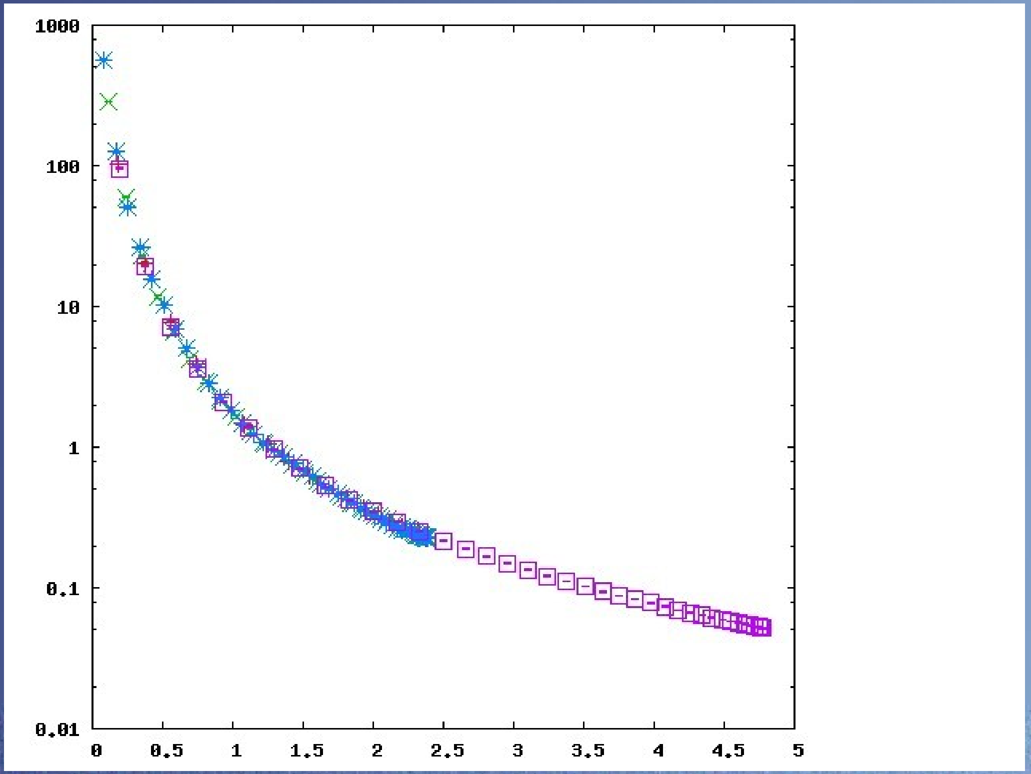
(as a function of space-separation d, T increases ↑)



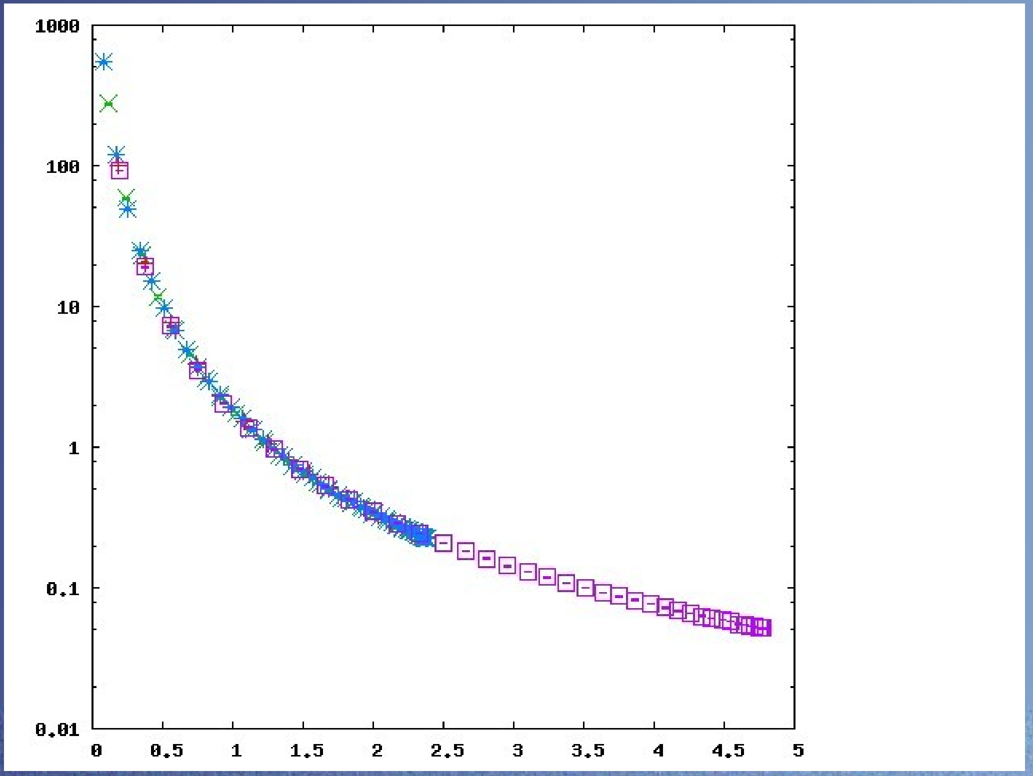
Ghost (T≈597MeV)



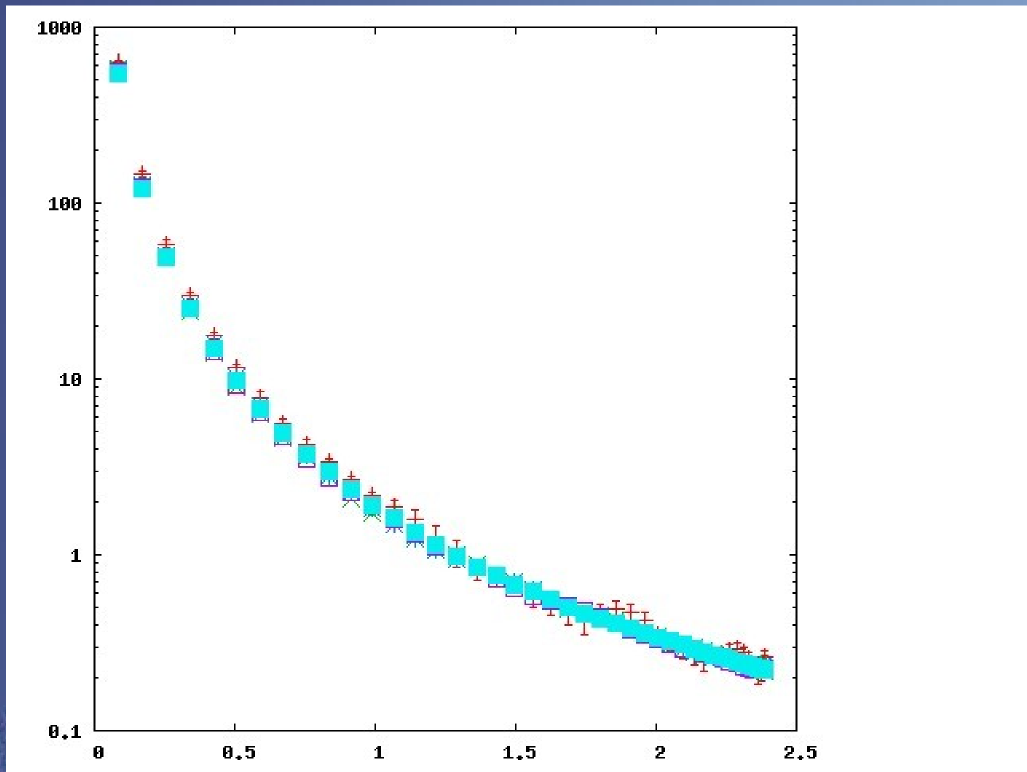
Ghost (T≈199MeV)



Ghost (T≈119MeV)

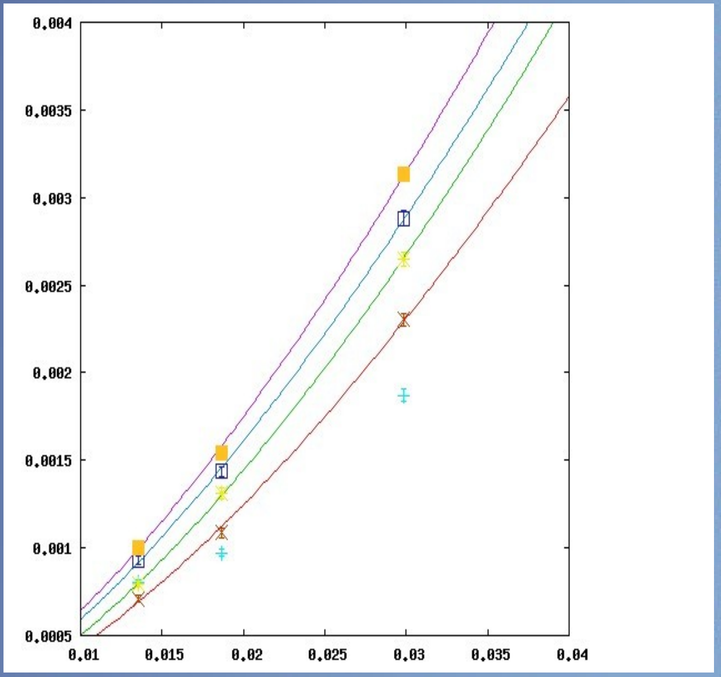


Ghost vs. T



Infinite-volume limit

- Smallest nonzero eigenvalue of the FP matrix as a function of 1/L.
- Goes to zero slower than in the Laplacian case.



Summary and conclusions

- Finite-size and discretization effects essentially under control.
- Mass scale for the gluon propagators with different origin in the electric and in the magnetic sector.
- Ghost propagator insensitive to the temperature.

In the near future

- T-dependence of screening masses.
- Behavior at very small momenta.
- Temperatures up to 4 Tc, keeping discretization effects under control.