On the quark-gluon vertex at non-vanishing temperature

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Der Wissenschaftsfonds.

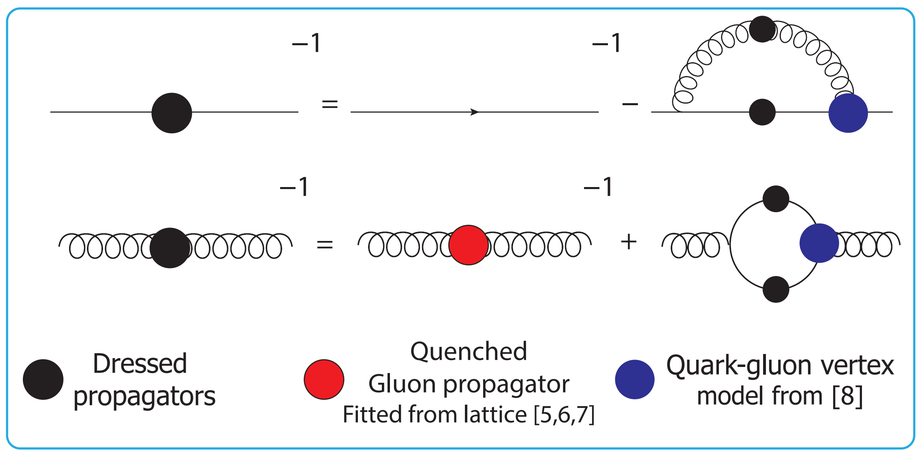
Introduction

Background

QCD with two colors (QC_2D) or with the gauge group G_2 [1] do not suffer from the sign problem at non-vanishing density. This makes these theories interesting candidates for benchmarking functional equations.

Objective

We study [2,3] the medium effects on the chiral condensate and the dressed Polyakov loop [4] for SU(3), SU(2) and G_2 gauge theories using Dyson-Schwinger equations.



Vanishing chemical potential

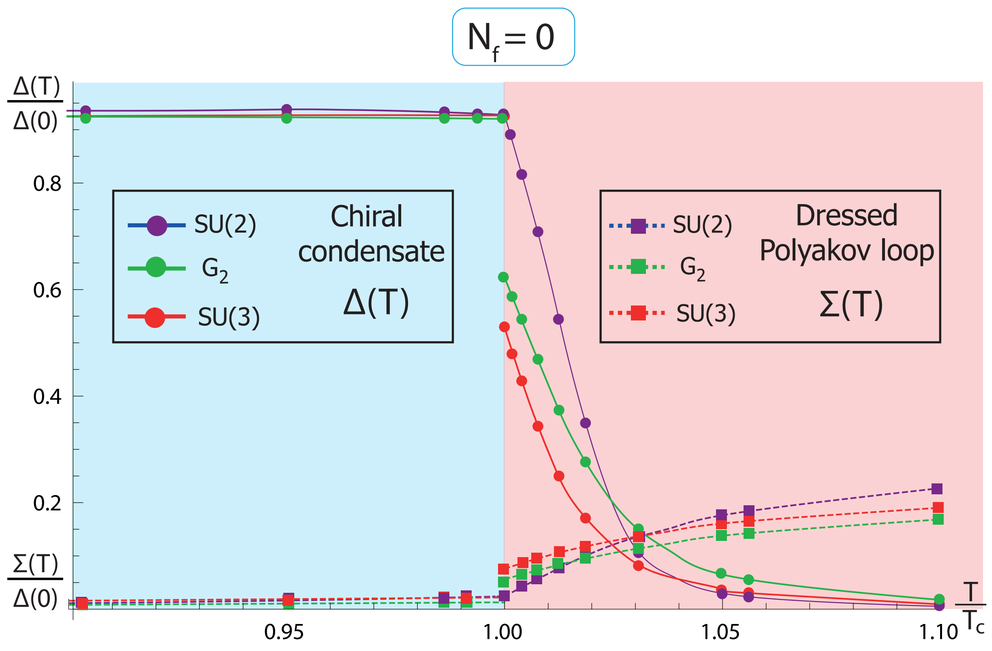


Fig. 1 : Temperature dependence of the dressed Polyakov loops and regularized quark condensates for the quenched cases of the three gauge groups considered

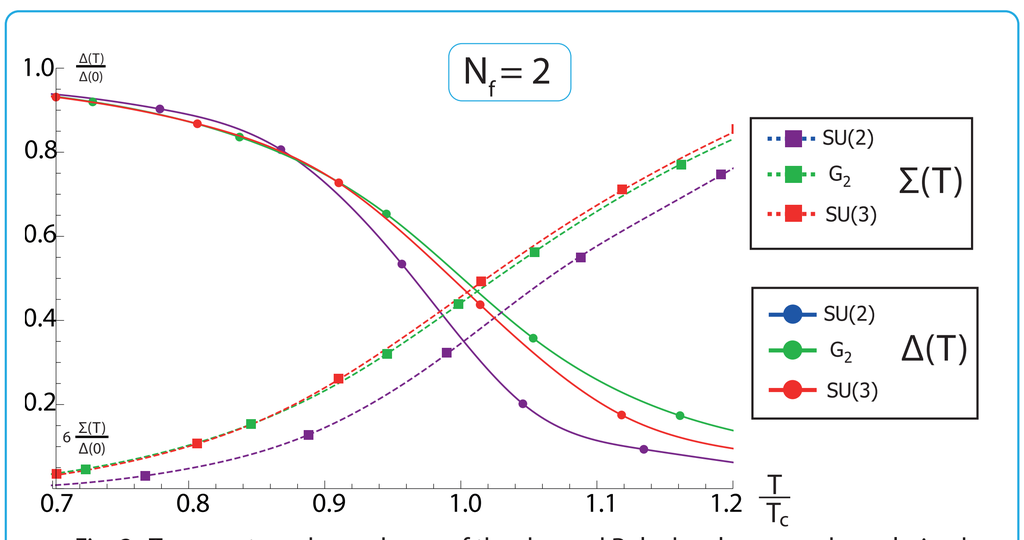


Fig. 2 : Temperature dependence of the dressed Polyakov loops and regularized quark condensates for $N_f = 2$ in QCD and QCD-like theories

- In the quenched case, we observe for the chiral and deconfinement order parameter a first order transition for SU(3) and G_2 and a second order transition for SU(2).
- In the unquenched case, the phase transitions become crossovers.
- For $N_f = 2+1$, a direct comparison with lattice is possible and both calculations agree remarkably well.

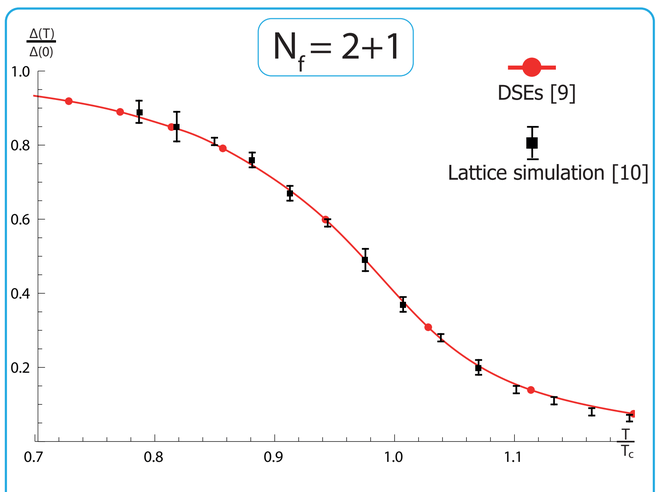


Fig. 3 : Temperature dependence of the regularized quark condensate for $N_f = 2+1$ in SU(3) gauge theory

Phase diagram

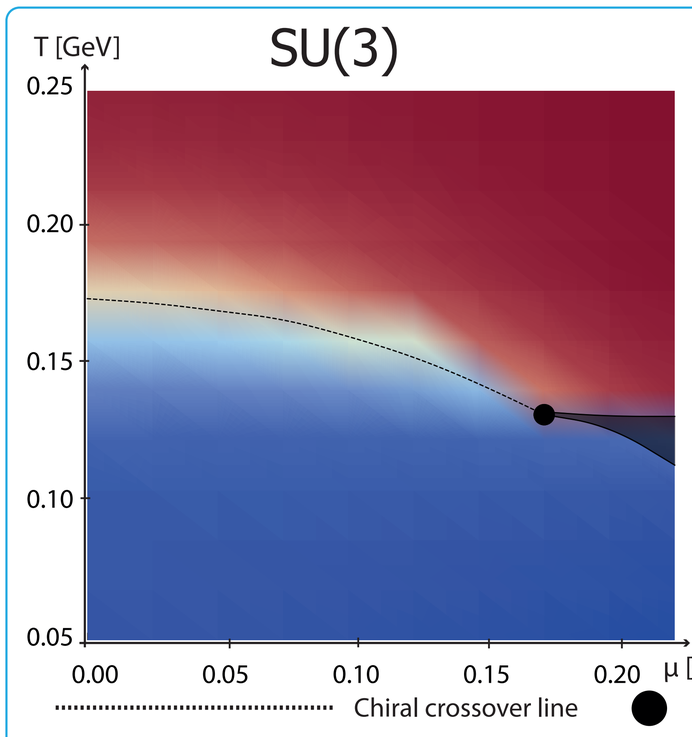


Fig. 4 : Phase diagram of chiral transition in QCD with two flavors

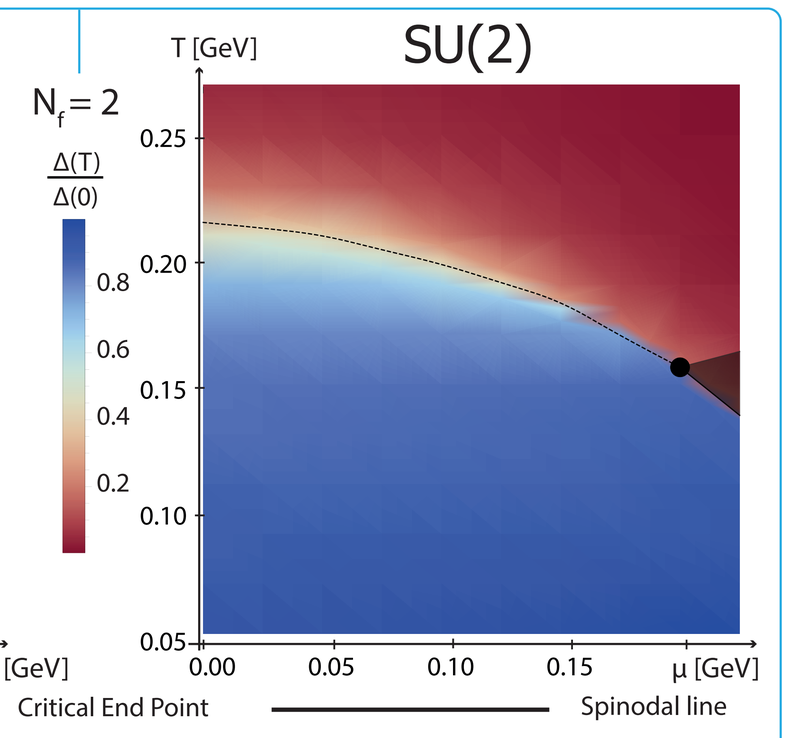


Fig. 5 : Phase diagram of chiral transition in QC_2D (SU(2)) with two flavors

- QCD and QCD-like theories show qualitatively the same behavior within this truncation
- Universality beyond this truncation needs to be tested

Quark-gluon interaction

Fig. 6 : Truncated equation of motion for our semi-perturbative calculation of the quark-gluon vertex from the 3PI effective action. The Abelian diagram is neglected due to color and dynamical suppression

- For functional equations, the next step to describe the matter sector consists in the implementation of a dynamical quark-gluon vertex.
- Little is know about this quantity beyond the vacuum (e.g. [13,14]). As the first step in this study at finite temperature, we performed a semi-perturbative [12] calculation in order to explore the importance of the quantities involved.

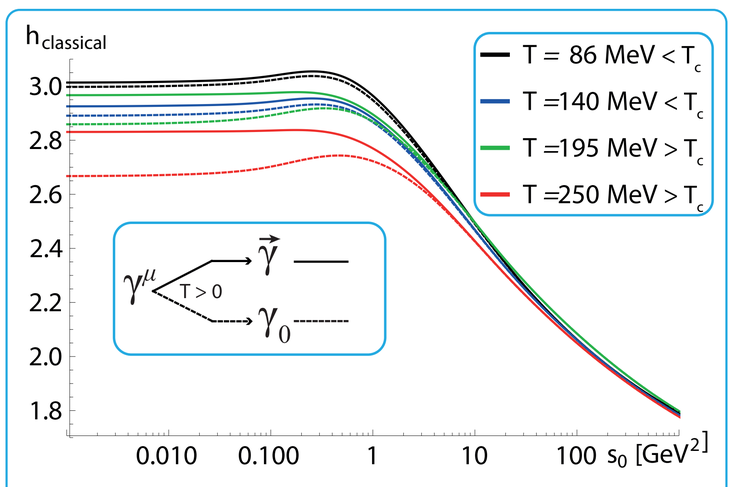


Fig. 7 : Temperature dependence of the classical dressing functions of the quark-gluon vertex at the symmetric point.

l : relative quark momentum k : gluon momentum

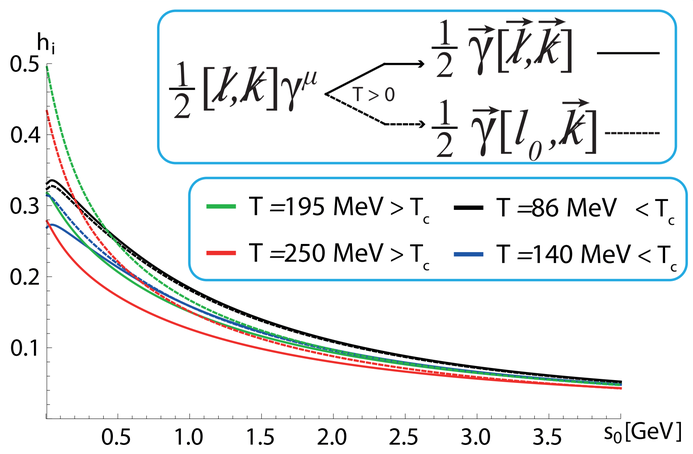


Fig. 8 : Temperature dependence of selected chirally symmetric dressings of the quark-gluon vertex at the symmetric point.

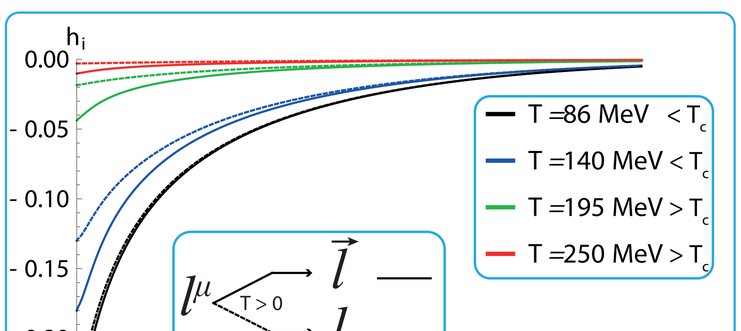


Fig. 9 : Signal of chiral restoration in selected chirally forbidden dressings at the symmetric point.

Conclusion/Outlook

We extended the QCD analysis by studying the chiral transition at a non-vanishing chemical potential for QCD-like theories and saw a universal behavior within the given truncation.

Furthermore, we presented a semi-perturbative calculation of the quark-gluon vertex at finite temperature. We saw the suppression of chirally forbidden dressings beyond the chiral crossover.

References

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