HK 46: Heavy-Ion Collisions and QCD Phases X

Time: Wednesday 16:00–17:15 Location: HK-H2

Group Report HK 46.1 Wed 16:00 HK-H2

Regulator dependence of the chiral phase transition at high densitities — Konstantin Otto[1], •Christopher Busch[1,2], and Bernd-Jochen Schaefer[1,2] — [1]Institut für Theoretische Physik, Justus-Liebig-Universität Gießen — [2]Helmholtz Forschungsakademie Hessen für FAIR (HFHF)

Functional methods like the functional renormalization group (FRG) provide a powerful tool for the study of non-perturbative phenomena such as the spontaneous breaking of chiral symmetry in QCD. Recent FRG investigations of the QCD phase diagram at low temperature and high densities show a strange back-bending of the chiral phase transition line combined with the appearance of a negative entropy density in the chirally symmetric phase. Among possible physical reasons for these observations technical artifacts caused by common FRG truncation schemes are part of ongoing discussions. In this talk we will focus on this issue and will elucidate the role played by different FRG regulator choices. First results of the regulator effects in this regime of the phase diagram will be given.

HK 46.2 Wed 16:30 HK-H2

Critical endpoint of QCD in a finite volume — •Julian Bernhardt[1,2], Christian S. Fischer[1,2], Philipp Isserstedt[1,2], and Bernd-Jochen Schaefer[1,2] — [1]Institut für Theoretische Physik, Justus-Liebig-Universität Gießen, 35392 Gießen, Germany — [2]Helmholtz Forschungsakademie Hessen für FAIR (HFHF), GSI Helmholtzzentrum für Schwerionenforschung, Campus Gießen, 35392 Gießen, Germany

We summarize recent results on the volume dependence of the location of the critical endpoint in the QCD phase diagram. To this end, we employ a sophisticated combination of Lattice Yang-Mills theory and a (truncated) version of Dyson-Schwinger equations in Landau gauge for $2+1$ quark flavors. We study this system at small and intermediate volumes and determine the dependence of the location of the critical endpoint on the boundary conditions and the volume of a three-dimensional cube with edge length L. Additionally, we report on the chiral limit of the light quarks for different strange quark masses at vanishing chemical potential.

HK 46.3 Wed 16:45 HK-H2

Phase structure and thermodynamics of QCD from Dyson–Schwinger equations — •Philipp Isserstedt[1,3], Michael Buballa[2,3], Christian S. Fischer[1,3], Pascal J. Gunkel[1,3], and Thorsten Steinert[1] — [1]Institut für Theoretische Physik, Justus-Liebig-Universität Gießen, 35392 Gießen, Germany — [2]Technische Universität Darmstadt, Department of Physics, Institut für Kernphysik, Theoriezentrum, 64289 Darmstadt, Germany — [3]Helmholtz Forschungsakademie Hessen für FAIR (HFHF), Germany

We summarize our recent results on the phase structure and thermodynamics of QCD obtained within the nonperturbative framework of Dyson–Schwinger equations. Our results are based on solutions to a truncated set of these equations for the quark and gluon propagators of $(2+1)$-flavor QCD in Landau gauge. First, we present baryon number fluctuations and ratios thereof, ranging from vanishing chemical potential up to the critical endpoint. In comparison with experimental data, our results are compatible with the scenario of a critical endpoint at large chemical potential and a freeze-out line that bends below the endpoint [1]. Second, we discuss a truncation-independent method to obtain thermodynamic quantities like the pressure, entropy density, energy density, and interaction measure across the QCD phase diagram from Dyson–Schwinger equations [2], which has been accomplished so far only within simple truncations of the rainbow-ladder type.

[1] Phys. Rev. D 100, 074011 (2019), arXiv:1906.11644 [hep-ph].
[2] Phys. Rev. D 103, 054012 (2021), arXiv:2012.04991 [hep-ph].

HK 46.4 Wed 17:00 HK-H2

Fluctuations and phases in baryonic matter — •Len Brandes — Technical University of Munich

The phase structure of baryonic matter is investigated with focus on the role of fluctuations beyond the mean-field approximation. The prototype test case studied is the chiral nucleon-meson model, with added comments on the chiral quark-meson model. Applications to nuclear matter include the liquid-gas phase transition. Extensions to high baryon densities are performed for both nuclear and neutron matter. The role of vacuum fluctuations is systematically explored. It is pointed out that such fluctuations tend to stabilize the hadronic phase characterized by spontaneously broken chiral symmetry, shifting the chiral restoration transition to very high densities. This stabilization effect is shown to be further enhanced by additional dynamical fluctuations treated with functional renormalisation group methods.

This work has been supported in part by DFG (Project-ID 196253076 - TRR 110) and NSFC as well as the DFG Excellence Cluster ORIGINS.