HK 45: Heavy-Ion Collisions and QCD Phases X

Time: Wednesday 15:45–17:15 Location: HBR 62: EG 05

HK 45.1 Wed 15:45 HBR 62: EG 05

Towards locating the (real) critical end point — •Friederike Ihssen[1] and Jan Martin Pawlowski[1,2] — [1]Institut für Theoretische Physik, Philosophenweg 16, 69120 Heidelberg, Germany — [2]ExtreMe Matter Institute EMMI, GSI, Planckstr. 1, 64291 Darmstadt, Germany

Lattice simulations and functional approaches established that QCD has no phase transition at small baryon chemical potential. However, second order phase transitions are expected at the conjectured critical endpoint at larger chemical potential and in the chiral limit at vanishing chemical potential.

These phase transitions leave an imprint as Lee-Yang edge singularities and can be found at high temperatures $T > T_c$ for complex magnetisation and complex chemical potential. For an increasing real part of the chemical potential, the edge singularity moves towards the real μ_B-axis, potentially allowing for an extrapolation to the critical endpoint.

As a precursor for a quantitative study in QCD we discuss the impact of fluctuations in a low energy effective theory. We show that in this model the location of the phase transition can accurately be determined by tracking the Lee-Yang singularities in the complex plane. We close by discussing the remaining task of extending this computation to full QCD.

HK 45.2 Wed 16:00 HBR 62: EG 05

In-Medium Mixing and the Phase Structure of QCD — •Fabian Rennecke[1], Lorenz von Smekal[1], and Maximilian Haensch[2] — [1]Justus-Liebig-Universität Giessen, Institut für Theoretische Physik — [2]Ludwig-Maximilians-Universität München

Interactions in the hot and dense QCD medium give rise to extensive mixing between hadronic and gluonic degrees of freedom. This modifies the analytic structure of the systems and leads to a non-Hermitian mass matrix, with potential far-reaching consequences for the phase diagram. For example, regimes with spatial modulations and instabilities towards inhomogeneous phases can be induced by such a mixing.

HK 45.3 Wed 16:15 HBR 62: EG 05

The phase diagram of QCD and its critical endpoint — •Franz Richard Sattler[1], Jan Martin Pawlowski[1,2], Friederike Ihssen[1], and Nicolas Wink[3] — [1]Institut für Theoretische Physik, Philosophenweg 16, 69120 Heidelberg, Germany — [2]ExtreMe Matter Institute EMMI, GSI, Planckstr. 1, 64291 Darmstadt, Germany — [3]Institut für Kernphysik, Technische Universität Darmstadt, D-64289 Darmstadt, Germany

We investigate the location of the conjectured critical endpoint of QCD by using the functional renormalization group. This allows to access the high-density region, as this approach does not suffer from the sign problem of lattice QCD.

In this setup, we can systematically identify and include all relevant physical degrees of freedom.

We discuss both quantitative results in the vacuum as well as the extension to the phase diagram up to intermediate densities.

Finally, for calculations at even higher densities, we discuss future extensions of our setup, such as other potentially relevant composite particles.

HK 45.4 Wed 16:30 HBR 62: EG 05

The QCD chiral phase transition with imaginary baryon chemical potential — •Reinhold Kaiser[1,2], Owe Philipsen[1,2], Alfredo D'Ambrosio[1,2], and Michael Fromm[1] — [1]Institut für theoretische Physik, Goethe-Universität Frankfurt — [2]John von Neumann Institute for Computing (NIC) at GSI

In order to constrain the QCD phase diagram with physical quark masses, the QCD chiral phase transition in the massless limit is investigated using lattice QCD with staggered fermions. In 1984, Pisarski and Wilczek predicted a first-order transition for $N_\mathrm{f} \geq 3$, based on RG investigations of a linear sigma model in three dimensions, which was supported by lattice QCD simulations on coarse lattices. However, the order of the thermal chiral transition in lattice QCD depends strongly on the cutoff. Recent lattice QCD results from our group provide strong evidence for a second order chiral phase transition for $N_\mathrm{f} = 2 - 6$ massless quark flavors. It was found that the first-order chiral transitions, observed on coarse lattices, terminate at a tricritical lattice spacing, and are thus not connected to the continuum chiral limit. As a consequence, the chiral transition in the continuum is of second order, unless additional first-order transitions are found on finer lattices or with chiral lattice actions. Adopting the same strategy, we investigate the nature of the chiral phase transition as a function of the number of quark flavors and the lattice spacing for a fixed imaginary baryon chemical potential. The same behavior as at zero chemical potential is observed, which implys a second order chiral phase transition also for imaginary chemical potential in the continuum.

HK 45.5 Wed 16:45 HBR 62: EG 05

QCD Phase Transitions in the Light-Quark Chiral Limit — •Julian Bernhardt[1,2] and Christian S. Fischer[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

In this talk, I report on meson-backcoupling effects in the chiral regions of the Columbia plot. To this end, an extension of a sophisticated combination of Lattice Yang–Mills theory and a (truncated) version of Dyson–Schwinger equations in Landau gauge for $2 + 1$ quark flavours was employed that does not suffer from the sign problem. This analysis encompasses the chiral limit of the light quarks for different strange-quark masses at small (real and imaginary) chemical potentials. I also present a first exploratory study for chiral strange and non-chiral light quarks.

HK 45.6 Wed 17:00 HBR 62: EG 05

The temperature of the QCD chiral phase transition at its tricritical point — •Jan Philipp Klinger and Owe Philipsen — Institut für theoretische Physik, Goethe Universität Frankfurt

The nature of the QCD phase transition in the chiral limit constitutes a challenging problem for lattice QCD as it is not directly simulable. Its study, however, provides constraints on the phase diagram at the physical point. Recently, the thermal transition for massless fermions was shown to be of second order for all numbers of flavours $N_f \lesssim 7$. For this, the lattice chiral limit was approached by mapping out the chiral critical surface separating the first-order region from the crossover region in an enlarged parameter space, which consists of the gauge coupling, a variable number of quark flavours, their masses, and the lattice spacing. Based on simulations of lattice QCD with standard staggered quarks, it was found that for all $N_f \lesssim 7$ there exists a minimal and tricritical lattice spacing a^{tric}, where the chiral transition changes from first order (above) to second order (below). The first-order region thus constitutes a cutoff effect and the transition in the continuum chiral limit is of second order for all $N_f \lesssim 7$. In the current work we determine the associated temperatures $T(N_f^{tric}, a^{tric})$ at those lattice spacings. We confirm an expected decrease in the critical temperature for increasing number of flavours. Running simulations on finer lattices will allow us to determine the location of the tricritical point in the continuum limit and let us resolve the question whether the conformal window is approached by a first or second order phase transition.