HK 28: Theorie

Zeit: Dienstag 11:00–13:30 Raum: 2F

Gruppenbericht HK 28.1 Di 11:00 2F

Phase transitions in the 2+1 flavor quark-meson model — Bernd-Jochen Schaefer[1], •Mathias Wagner[2], and Jochen Wambach[2,3] — [1]Institut für Physik, — [2]Institut für Kernphysik, TU Darmstadt, D-64289 — [3]Gesellschaft für

The phase structure of quantum chromodynamics (QCD) at finite temperature and density is still an open question. At finite chemical potentials QCD lattice calculations suffer from the fermion sign problem. By means of the imaginary chemical potential technique lattice results at finite density become available. These results put the existence of the chiral critical point in the phase diagram into question. In this talk a new analysis of the the 2+1 flavor quark-meson model is presented. The chiral critical surface in the $m_\pi - m_K$ plane with and without $U(1)_A$ anomaly is discussed. The in-medium scalar and pseudoscalar meson masses are presented in view of the restoration of the chiral and $U(1)_A$ symmetry. The obtained results are compared with other model and lattice calculations.

HK 28.2 Di 11:30 2F

Comparison of O(4) scaling behavior and lattice QCD results — •Bertram Klein[1] and Jens Braun[2] — [1]Technische Universität München, Garching — [2]TRIUMF, Vancouver, Canada

QCD lattice simulations have established the phase transition order for three quark flavors with a high degree of confidence, but there are still questions for two light quark flavors. While there is a lot of evidence for a second-order transition, some lattice results appear to be incompatible with the expected O(4) scaling behavior.

An analysis of the scaling behavior is necessary to determine the order of a phase transition in a finite-volume system in the presence of symmetry-breaking quark masses. Such an analysis requires knowledge about critical exponents and scaling functions.

We use non-perturbative Renormalization Group methods to calculate scaling functions and finite-size scaling behavior for an O(4) model in 3 dimensions, including a symmetry-breaking external field.

We obtain results for scaling functions for the order parameter and the chiral susceptibility over a wide range of volumes and pion masses and establish infinite-volume as well as finite-size scaling behavior. We find that corrections to the leading-order scaling behavior are already quite large at pion masses comparable to those in current lattice calculations. In addition, corrections to the finite-size scaling behavior also become large at volume sizes comparable to those in current lattice simulations. We compare scaling behavior of QCD lattice results for the phase transition with two flavors to the scaling functions obtained from our non-perturbative RG calculations.

HK 28.3 Di 11:45 2F

The QCD phase diagram from effective models — •Bernd-Jochen Schaefer[1] and Jochen Wambach[2,3] — [1]Institut für Physik, KFU Graz, Austria — [2]Institut für Kernphysik, TU Darmstadt, Germany — [3]GSI, Darmstadt, Germany

Chiral symmetry breaking and confinement are two important non-perturbative feature of low-energy QCD. At finite temperature and density QCD predicts a phase transition and a new deconfined phase of matter emerges.

In this talk the phase structure of different effective quark-meson models are presented. In pure Yang-Mills theory the expectation value of the Polyakov loop serves as an order parameter for confinement. The impact of the Polyakov loop dynamics on the phase diagram is also addressed.

All used models exhibit a critical endpoint in the phase diagram where fluctuations become important. The influence of fluctuations around criticality is demonstrated by an comparison of the mean-field approximation with a renormalization group analysis.

HK 28.4 Di 12:00 2F

Eigenvalue repulsion in an effective theory of SU(2) Wilson lines in three dimensions — Adrian Dumitru and •Dominik Smith — Institut für Theoretische Physik, Universität Frankfurt

We perform simulations of an effective theory of SU(2) Wilson lines in three dimensions. We include a non-perturbative "fuzzy-bag" contribution which is added to the one-loop perturbative potential for the Wilson line. We confirm that, at moderately weak coupling, this leads to eigenvalue repulsion in a finite region above the deconfining phase transition which shrinks in the extreme weak-coupling limit. A non-trivial Z(N) symmetric vacuum arises in the confined phase.

HK 28.5 Di 12:15 2F

Thermodynamische Eigenschaften des Quark-Gluon-Plasmas in relativistischer Molekulardynamik — •Stefano Mattiello und Wolfgang Cassing — Institut für Theoretische Physik, Universität Gießen

Das Phasendiagramm der Quantenchromodynamik ist extrem reichhaltig und seine Erforschung gehört zu den aktuellen Fragen der modernen Hadronen- und Kernphysik. Relativistische Schwerionenstösse ermöglichen die experimentelle Untersuchung des Quark-Gluon-Plasmas. Als sehr nützlicher theoretischer Zugang zur Untersuchung der Eigenschaften des Quark-Gluon-Plasmas erweist sich die relativistische Molekulardynamik. Dabei ist es möglich, der dynamischen Entwicklung des Systems zu folgen und seine thermodynamischen Eigenschaften zu bestimmen. Dazu verwenden wir durch Gitter-Rechnungen motivierte langreichweitige Potentiale, die die effektive Wechselwirkung zwischen den Partonen beschreiben. Dadurch kann die Zustandsgleichung für das Quark-Gluon-Plasma bestimmt werden. Ausserdem wird die Abhängigkeit der Ergebnisse von der Wahl der Wechselwirkung gezeigt und diskutiert.
Diese Arbeit wurde von der DFG unterstützt.

HK 28.6 Di 12:30 2F

Plasma instabilities in non-abelian gauge theories — Juergen Berges, •Sebastian Scheffler, and Denes Sexty — Institut fuer Kernphysik, Technische Universitaet Darmstadt, Darmstadt, Germany

We study the time evolution of SU(2)- gauge theory in the classical statistical approximation on the lattice. This is essential for understanding the formation of an equilibrated quark-gluon plasma whose properties are studied in experiments at RHIC and in the future also at LHC and FAIR.

Using anisotropic initial conditions we investigate the role of plasma instabilities in the isotropization process. We find that instabilities affect the isotropization of low-momentum degrees of freedom. Establishing contact to experiments, we obtain growth rates of order 1 c/fm. This means that the instabilities are probably too slow to explain the experimental findings at RHIC which suggest rapid isotropization within 0.6 fm/c. We discuss implications for experiments and discuss possible extensions of our approach.

HK 28.7 Di 12:45 2F

Bremsstrahlung from a fermion jet in a non equilibrated hot plasma — •Frank Michler, Björn Schenke, and Carsten Greiner — Institut für theoretische Physik, Johann Wolfgang Goethe Universität Frankfurt am Main, Max von Laue Straße 1, 60438 Frankfurt am Main, Germany

Radiative processes have been found to be one main reason for energy loss of hard probes in a quark gluon plasma. Since the quark gluon plasma created in heavy ion collisions expands and cools down before it hadronizes, the density of scattering centers is decreasing in time, which makes the radiative behavior of the jet time dependent. We use the real time formalism to describe such a non equilibrium phenomenon including the Laundau Pomeranschuk Migdal effect. As a first step we restrict our calculations to QED-like interactions, i.e., to ordinary photon emission. A comparision of our results to a quasistatic calculation reveals that the radiative behavior follows the changes in the medium almost instantaneously.

HK 28.8 Di 13:00 2F

Diagonal and Off-Diagonal Susceptibilities in a Quasiparticle Model of the Quark-Gluon Plasma — •Marcus Bluhm[1] and Burkhard Kämpfer[1,2] — [1]Forschungszentrum Dresden-Rossendorf, Institut für Strahlenphysik, PF 510119, 01314 Dresden, Germany — [2]TU Dresden, Institut für Theoretische Physik, 01062 Dresden, Germany

We extend our quasiparticle model, which is linked to QCD via the two-loop Φ-functional approach [1], to two independent chemical potentials by generalizing Peshier's flow equation which transports information from zero to non-zero net baryon densities. In this way, we have access

to diagonal and off-diagonal susceptibilities as well as quark number, isovector and electric charge susceptibilities. The model compares fairly well with the available lattice QCD data for two degenerate quark flavors. Testing the self-consistent extrapolation to large baryon densities within our quasiparticle model is important for a firm knowledge of the QCD equation of state relevant for the hydrodynamic description of the expansion stage of heavy-ion collision experiments [2] as needed, for instance, for SPS and future FAIR experiments.

References

[1] M. Bluhm, B. Kämpfer, R. Schulze and D. Seipt, *Eur. Phys. J. C* **49** (2007) 205.
[2] M. Bluhm, B. Kämpfer, R. Schulze, D. Seipt and U. Heinz, *Phys. Rev. C* **76** (2007) 034901.

HK 28.9 Di 13:15 2F

Pseudoscalar condensates in color superconductors — •Hannes Basler and Michael Buballa — Institut für Kernphysik, TU Darmstadt

At sufficiently high densities and low temperatures quark matter forms a color superconductor. In addition to the well-investigated scalar condensates the formation of pseudoscalar condensates has a relevant effect on the structure of a color superconductor. In particular in the color-flavor locked (CFL) phase these pseudoscalar condensates have a significant effect related to the breaking of chiral symmetry and the appearance of Goldstone modes.

We examine such a color superconductor using an NJL model with a self-consistent treatment of the dynamic quark masses. In this framework we calculate the phase diagram for color and electrically neutral quark matter in weak equilibrium.