HK 21: Schwerionenkollisionen und QCD Phasen

Zeit: Dienstag 16:30–19:00 Raum: P 5

Gruppenbericht HK 21.1 Di 16:30 P 5

Quark-meson-diquark model for two-color QCD — •Nils Strodthoff[1], Bernd-Jochen Schaefer[2,3], and Lorenz von Smekal[1] — [1]Institut für Kernphysik, TU Darmstadt, Germany — [2]Institut für Physik, Karl-Franzens-Universität Graz, Austria — [3]Institut für Theoretische Physik, Universität Gießen, Germany

We introduce a two-flavor quark-meson-diquark model for two-color QCD and its extensions to include gauge-field dynamics as described by the Polakov loop. Grand potential and phase structure are being studied both in mean-field approximation and with the functional renormalization group. The model provides an explicit example for the importance of baryonic degrees of freedom: When they are omitted, the phase diagram closely resembles that of the corresponding (Polyakov)-quark-meson models for QCD, in particular including their critical endpoint. In order to reproduce the well established main features based on the symmetries and breaking patterns of two-color QCD, however, they must be included and there is no critical endpoint.

HK 21.2 Di 17:00 P 5

Quark-Meson Model and Functional Renormalization Group — •Matthias Drews, Bertram Klein, and Wolfram Weise — Physikdepartment Technische Universität München, 85747 Garching

By coupling pions and the sigma boson to quarks, the quark-meson model serves to study the chiral phase transition. Our method is the functional renormalization group that interpolates in a non-perturbative way between the theory in the ultraviolet and in the infrared regime.

Quantum fluctuations are taken into account, which allow to treat the chiral phase transition at finite temperature and chemical potential beyond the mean-field approximation. In addition the model can be extended by the Polyakov-loop potential to include a notion of confinement.

Further novel steps towards inclusion of derivative couplings are discussed, with emphasis on an improved treatment of low-energy pion-pion interactions.

Work supported by BMBF, GSI and the Excellence Cluster "Origin and Structure of the Universe".

HK 21.3 Di 17:15 P 5

The QCD deconfinement transition for heavy quarks and all baryon chemical potentials I — •Jens Langelage — Max-von-Laue-Str. 1, 60438 Frankfurt am Main

Using combined strong coupling and hopping parameter expansions, we derive an effective three-dimensional theory from thermal lattice QCD with heavy Wilson quarks. The theory depends on traced Polyakov loops only and correctly reflects the centre symmetry of the pure gauge sector as well as its breaking by finite mass quarks. As an application, we determine the deconfinement transition and its critical end point as a function of quark mass and all chemical potentials.

In this first part, we derive the effective lattice action and present details of the calculation.

HK 21.4 Di 17:30 P 5

The QCD deconfinement transition for heavy quarks and all baryon chemical potentials II — •Stefano Lottini — ITP Goethe Universität, Frankfurt am Main, Deutschland

Using combined strong coupling and hopping parameter expansions, we derive an effective three-dimensional theory from thermal lattice QCD with heavy Wilson quarks. The theory depends on traced Polyakov loops only and correctly reflects the centre symmetry of the pure gauge sector as well as its breaking by finite mass quarks. It is valid up to certain orders in the lattice gauge coupling and hopping parameter, which can be systematically improved. As an application, we determine the deconfinement transition and its critical end point as a function of quark mass and all chemical potentials. In this part we discuss the numerical analysis of the model and draw the conclusions.

HK 21.5 Di 17:45 P 5

Finite-volume effects in the chiral phase diagram — •Ralf-Arno Tripolt[1], Bernd-Jochen Schaefer[2,3], and Lorenz von Smekal[1] — [1]Institut für Kernphysik, Technische Universität Darmstadt, Germany — [2]Institut für Physik, Karl-Franzens-Universität Graz, Austria — [3]Institut für Theoretische Physik, Justus-Liebig-Universität Giessen, Germany

We investigate effects of a finite volume on the phase diagram of a two-flavor quark-meson model. Using a non-perturbative functional renormalization group approach, both quark and meson fluctuation effects are inlcuded. The corresponding flow equation for a finite system is presented and solved numerically with the grid technique.

In particular, we show results for the critical endpoint and thermodynamic observables. Moreover, critical properties of the finite-volume phase structure are studied by calculating the quark number denstiy and quark number susceptibility [1].

[1] Ralf-Arno Tripolt, Jens Braun, Bertram Klein, Bernd-Jochen Schaefer, in preparation.

HK 21.6 Di 18:00 P 5

Event-by-event mean p_T fluctuations in pp and Pb–Pb collisions measured by the ALICE experiment at the LHC — •Stefan Heckel for the ALICE-Collaboration — Goethe-Universität Frankfurt, Institut für Kernphysik, Max-von-Laue-Str. 1, 60438 Frankfurt am Main

Non-statistical event-by-event fluctuations of the mean transverse momentum of charged particles in pp and Pb–Pb collisions are studied using the ALICE experiment at the LHC. The analysis is performed at $|\eta| < 0.8$ and $0.15 < p_T < 2$ GeV/c. Multiplicity dependent results are obtained for pp collisions at $\sqrt{s} = 0.9$, 2.76 and 7 TeV. Pb–Pb collisions at $\sqrt{s_{NN}} = 2.76$ TeV are analysed in intervals of multiplicity and centrality, the latter in bins of 5%. Little collision energy dependence is observed in pp collisions. The data indicate a common scaling behaviour with event multiplicity from pp to semi-central Pb–Pb collisions. In central Pb–Pb collisions, the results deviate from this trend, exhibiting a significant reduction of the fluctuation strength. The results are compared to measurements in Au–Au collisions at lower collision energies and to Monte Carlo simulations with PYTHIA and HIJING.

HK 21.7 Di 18:15 P 5

The role of fluctuations in the phase diagram of QC_2D — •Naseemuddin Khan[1,2], Lisa M. Haas[1,2], Jan M. Pawlowski[1,2], Michael M. Scherer[3], and Fabian Rennecke[1,2] — [1]Institut für Theoretische Physik, Universität Heidelberg, Philosophenweg 16, 62910 Heidelberg, Germany — [2]ExtreMe Matter Institute EMMI, GSI Helmholtzzentrum für Schwerionenforschung, Planckstr. 1, 64291 Darmstadt, Germany — [3]Institut für Theoretische Festkörperphysik, RWTH Aachen, Otto-Blumenthal-Straße, 52074 Aachen, Germany

We apply the Functional Renormalization Group equation to Quantum Choromodynamics with two colours and two quark flavours. Diquark states can form colour singlets and hence a vacuum state with non-zero baryon number can be realized. We explore the phase diagram for various regions of temperature and chemical potential, and evaluate the behavior of the chiral condensate, the diquark condensate and the mass spectrum by including bosonic and fermionic fluctuations.

HK 21.8 Di 18:30 P 5

Critical point in the QCD phase diagram: effects of vector interaction and axial U(1) anomaly at finite chemical potential — •Nino Bratovic[1,2], Wolfram Weise[1], and Tetsuo Hatsuda[2] — [1]Institut für Theoretische Physik T39, Physik-Department der TU München, James-Franck-Straße 1, 85747 Garching, Deutschland — [2]Quantum Hadron Physics Laboratory, RIKEN, Wako-shi, Saitamaken, Japan

The Nambu-Jona-Lasinio model extended by Polyakov-loop dynamics (PNJL model) for 2 + 1 flavors is used in order to study the QCD phase diagram and associated thermodynamic quantities. In this approach, spontaneous chiral symmetry breaking as well as color singlet suppression in the hadronic phase are realized dynamically in terms of the respective order parameters. We investigate in detail the effects of a vector-type interaction in this model, particularly in combination with the U(1)A symmetry breaking Kobayashi-Maskawa-*t Hooft interaction. We show phase diagrams in the temperature-density plane and discuss possible constraints on the model from our knowledge of nuclear physics. The question of the existence and possible locations of the critical point within our framework is discussed as well.

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Cluster "Origin and Structure of the Universe".

HK 21.9 Di 18:45 P 5

Thermalized or not thermalized? The SHM at SIS energies. —
•Manuel Lorenz[1], Romain Holzmann[2], and Joachim Stroth[1,2] for the HADES-Collaboration — [1]Goethe -Universität, Frankfurt — [2]GSI Helmholtzzentrum für Schwerionenforschung, Darmstadt

With the HADES detector we have investigated in great detail the collision system Ar+KCl at 1.76 AGeV. From the data, the up to now most complete set of particle species in the 1-2A GeV energy regime could be reconstructed. This allows for a stringent test of various phenomenological models, in particular statistical hadronization models. SHM have indeed been successful in extracting the freeze-out line in the $T - \mu_b$ plane of the nuclear phase diagram by fitting particle yields from relativistic and ultrarelativistic heavy ion collisions [1]. At energies of a few GeV, however, the validity of these models is not so well established, since it remains unclear whether chemical equilibrium can be reached, and therefore the question arises whether a statistical treatment of particle production is at all meaningful. The situation is further complicated by the need for strangeness suppression, which is handled differently in the various implementations of the SHM. In this contribution, we compare the measured particle yields to an SHM fit and discuss the results critically with respect to the various signatures of thermalization of the collision system, in particular the strong deviation observed for double strange particles. This work has been supported by BMBF (06 FY 9100 I), HIC for FAIR, EMMI and GSI.
[1] A. Andronic, P. Braun-Munzinger and J. Stachel, Nucl. Phys. **A 772**, (2006) 167.