HK 49: Schwerionenkollisionen und QCD Phasen VI

Time: Thursday 14:00–16:00 Location: HS AP

Group Report HK 49.1 Thu 14:00 HS AP

Quark Hadron Matter in a Unified Approach — •Philip Rau[1], Jan Steinheimer[1], Stefan Schramm[1,2], and Horst Stoecker[1,2,3] — [1]Institut für Theoretische Physik, Goethe-Universität Frankfurt — [2]Frankfurt Institute for Advanced Studies (FIAS), Frankfurt — [3]GSI Helmholtzzentrum für Schwerionenforschung, Darmstadt

We present an effective model for the QCD EoS, taking into account chiral symmetry restoration as well as the deconfinement phase transition. For the hadronic part we apply a $SU_f(3)$ parity doublet model with quarks introduced in anology to the PNJL model. The correct asymptotic degrees of freedom at the high and low temperature limits are included (quarks $\leftrightarrow$ hadrons). As expected from lattice calculations, the model shows a rapid crossover for both order parameters at $\mu_B = 0$. We compare thermodynamic properties of the model at $\mu_B = 0$ which are in qualitative agreement with lattice data, while apparent quantitative differences can be attributed to hadronic contributions. Our model reproduces a first-order liquid gas phase transition as expected, and exhibits another first order chiral phase transition at high densities terminated by a critical endpoint. The deconfinement transition appears as a very wide crossover in which heavily medium modified hadrons coexist with free quarks.
Furthermore,the full baryonic resonance spectrum is implemented and we study the impact of a varying vector coupling strength on the phase diagram, i.e. the location of the phase transition and the existence of a critical point. We present quark number susceptibilities and compare them to lattice results.

Group Report HK 49.2 Thu 14:30 HS AP

Quark degrees of freedom in a hybrid approach to heavy ion collisions — •Jan Steinheimer[1,2], Elvira Santini[1,2], Björn Bäuchle[1,2], George Moschelli[1,2], Thomas Lang[1,2], Gunnar Gräf[1,2], Marlene Nahrgang[1,2], Christoph Herold[1,2], and Marcus Bleicher[1,2] — [1]Institut für theoretische Physik, Goethe Universität Frankfurt am Main — [2]Frankfurt Institute for Advanced Studies

We will present recent results obtained with the UrQMD hybrid model for heavy ion collisions. In this approach an intermediate hydrodynamic stage is used to model the hot and dense phase of heavy ion collisions. An equation of state that incorporates a chiral as well as a deconfinement phase transition in accordance with lattice results is implemented and its effects on different bulk observables is studied. While hadron multiplicities and bulk flow observables seem independent on the underlying degrees of freedom we observe a dependence of di-lepton and photon production.
Furthermore we will show how the model can be used to separate the system, created in a heavy ion collision, into an equilibrated core and a dilute corona. In such a scenario we use the hydrodynamic approach only for the dense core of the system while the dilute outer region is described by the transport model. Within our model, such a separation is able to explain observables like the position and with of the horn in the K^+/π^+ ratio as a transition from systems out of equilibrium to systems that are in chemical and thermal equilibrium.

HK 49.3 Thu 15:00 HS AP

Transport properties of the Quark-Gluon Plasma from a virial expansion — •Stefano Mattiello and Wolfgang Cassing — Institut für Theoretische Physik, Universität Giessen, Ger many

One of the most striking results coming from RHIC heavy-ion collisions is the observation that the quark-gluon plasma (QGP) created in ultrarelativistic Au + Au collisions behaves like an almost ideal liquid rather than a gas of quarks and gluons. Therefore a dynamic calculation of the transport properties as the shear viscosity η and the bulk viscosity ζ is desirable. In the quark-gluon plasma phase we calculate the shear and the bulk viscosity within a virial expansion approach. We focus on the ratio of η to the entropy density s, i.e. η/s and in the competition between shear and bulk viscosity near the critical temperature T_c. We derive a realistic equation of state using a virial expansion approach which allows to include the interactions between the partons in the deconfined phase and to evaluate the corrections to a single-particle partition function. Our numerical results give a ratio $\eta/s \approx 0.1$ at the critical temperature T_c, which is very close to the theoretical bound of $1/(4\pi)$. Furthermore, for temperatures $T \leq 1.8T_c$ the ratio η/s is in the range of the present experimental estimates $0.1 - 0.3$ at RHIC and we observe a pronounced minimum of η/s close to the critical temperature T_c. Additionally, the systematic calculation of the bulk viscosity shows that its contribution is negligible in comparison to η. Finally, we discuss their application to dissipative hydrodynamical calculations.
This work is supported by DFG.

HK 49.4 Thu 15:15 HS AP

Finite lifetime effects on the photon production from a quark-gluon plasma — •Frank Michler[1], Björn Schenke[2], and Carsten Greiner[1] — [1]Institut für theoretische Physik, Goethe Universität Frankfurt am Main, Max von Laue Straße 1, 60438 Frankfurt am Main, Germany — [2]Physics Department, Brookhaven National Laboratory, Upton, NY, 11973, USA

Direct photons play an important role as electromagnetic probes from a quark-gluon plasma (QGP) created in heavy ion collisions. After being once produced, they leave the medium undisturbed an thus provide direct insight into the early stage of the collision. We use the real time Keldysh formalism to investigate how non-equilibrium effects such as a finite lifetime modify the resulting photon spectra. We provide an ansatz which eliminates the divergent contribution from the vacuum polarization and renders the photon spectrum UV-finite if the time evolution of the QGP is described in a suitable manner.

HK 49.5 Thu 15:30 HS AP

Soft-Collinear Effective Theory — •Sabine Bönig — TU Darmstadt

The soft-collinear effective theory is a useful tool to describe the interaction between energetic and non-energetic particles in the final state of a hadronic process. For a particular process, the cross section can be factorised into hard, jet and soft functions, which need to be calculated. I will state the main underlying ideas of the soft-collinear effective theory and explain the importance of its application.

HK 49.6 Thu 15:45 HS AP

The Chiral Magnetic Effect — •Harmen Warringa — Institut für Theoretische Physik, Goethe Universität, Max-von-Laue-Str. 1, Frankfurt am Main

In quantum chromodynamics (QCD) an imbalance in the number of right- and left-handed quarks will be induced by fluctuations of topological charge. This is a P- and CP-odd effect, and can potentially be relevant during heavy ion collisions. The question then is how one could investigate this imbalance in experiment. In this talk I will show that enormous magnetic fields are created in heavy ion collisions in the direction of angular momentum of the collision. I will explain that such imbalance naturally leads to generation of an electric current in the direction of the magnetic field. This is the chiral magnetic effect, which I will review in this talk. I will discuss quantitative calculations of the magnitude of this induced current. In heavy ion collisions, the chiral magnetic effect is expected to lead to separation of charge which in principle can be addressed experimentally by measuring specific charge correlations.