HK 26: Schwerionenkollisionen und QCD Phasen

Zeit: Dienstag 16:30–19:00 Raum: HZ 6

Gruppenbericht HK 26.1 Di 16:30 HZ 6

Shear viscosity from a large-Nc NJL model — •Robert Lang[1,3], Tetsuo Hatsuda[3], Norbert Kaiser[1], and Wolfram Weise[2,1] — [1]TUM Physik Department, Garching, Germany — [2]ECT* Villa Tambosi, Villazzano (TN), Italy — [3]RIKEN Nishina Center, Wakoshi, Japan

We investigate the shear viscosity to entropy ratio within the vicinity of the chiral phase transition/crossover using the NJL model in a large-Nc expansion. As heavy-ion collisions at RHIC and LHC in combination with hydrodynamic simulations suggest, this ratio is close to the AdS/CFT benchmark. This indicates a strongly correlated state of matter produced in such collisions. We study in detail the non-perturbative structure of the NJL model and the question if resummation techniques are required. In the large-Nc expansion next-to-leading-order contributions to the shear viscosity are derived.

HK 26.2 Di 17:00 HZ 6

Equation of State and Viscosities from a Gravity Dual of the Gluon Plasma — •Roman Yaresko[1,2] and Burkhard Kaempfer[1,2] — [1]Helmholtz-Zentrum Dresden-Rossendorf — [2]TU Dresden

Employing new precision data of the equation of state of the SU(3) Yang-Mills theory (gluon plasma) several dilaton potentials are adjusted in a holographic gravity-scalar set-up in the temperature range $(1-10)T_c$. The relation between the potentials is investigated. The results suggest that the shape of the potentials in the region corresponding to the above temperature interval (parameterized by the horizon position of a black brane embedded in an asymptotically AdS Riemann space) is the same in each case and, in particular, independent of any assumed UV or IR asymptotics. We further observe that the holographically calculated bulk viscosity, based on the AdS/CFT duality, is determined entirely by the equation of state, i.e. is the same for different potentials which fit the lattice data equally well. We find the ratio of bulk viscosity to shear viscosity to be $\zeta/\eta \approx \pi\Delta v_s^2$ for $\Delta v_s^2 < 0.2$, where $\Delta v_s^2 \equiv 1/3 - v_s^2$ is the non-conformality measure and v_s^2 is the squared velocity of sound. The inclusion of quark degrees of freedom is discussed to arrive at a dual description (equation of state and transport coefficients) of the quark-gluon plasma in the strong-coupling regime, as relevant for heavy-ion collisions at LHC and RHIC.

HK 26.3 Di 17:15 HZ 6

On- and off-shell heavy quark transport properties in the quark gluon plasma (QGP) — •Hamza Berrehrah[1], Elena Bratkovskaya[1], Wolfgang Cassing[2], Pol-Bernard Gossiaux[3], and Jörg Aichelin[3] — [1]FIAS, Frankfurt, Germany — [2]ITP, Giessen, Germany — [3]Subatech, Nantes, France

Within the aim of a dynamical study of on- and off-shell heavy quarks Q in the quark gluon plasma (QGP) [1] - as produced in relativistic nucleus-nucleus collisions - we study the heavy quark collisional scattering on partons of the QGP and the underlying transport properties. The elastic cross sections are evaluated for perturbative partons (massless on-shell particles) and for dynamical quasi-particles (massive off-shell particles as described by the dynamical quasi-particles model DQPM) using the leading order Born diagrams [2]. Correspondingly, the on- and off-shell heavy quark dynamical collisional energy loss and transport coefficients are computed [3]. Within our study, we demonstrate the influence of the finite width of the quasi-particles on heavy quarks scattering. We, furthermore, provide a comprehensive comparison between perturbative and non-perturbative QCD based models on the determination of the heavy quark transport coefficients (drag and diffusion, longitudinal and transverse Q momentum fluctuations, etc.).

[1] W. Cassing, and E. L. Bratkovskaya, Nucl.Phys. A831 (2009) 215-242. [2] H. Berrehrah, E. Bratkovskaya, W. Cassing, P.B. Gossiaux, J. Aichelin, and M. Bleicher, arXiv:1308.5148. [3] H. Berrehrah, E. Bratkovskaya, W. Cassing, P.B. Gossiaux and J. Aichelin, to be submitted.

HK 26.4 Di 17:30 HZ 6

The second order hydrodynamic transport coefficient κ for the gluon plasma from the lattice — •Christian Schäfer and Owe Philipsen — Goethe-Universität, Frankfurt am Main, Germany

The quark gluon plasma produced in heavy ion collisions behaves like an almost ideal fluid described by viscous hydrodynamics with a number of transport coefficients. These are difficult to calculate in lattice QCD because of their real time nature. The second order coefficient κ is related to a Euclidean correlator of the energy-momentum tensor at vanishing frequency and low momentum. This allows for a lattice determination without maximum entropy methods or modelling, but the required lattice sizes represent a formidable challenge. We calculate κ in leading order lattice perturbation theory and simulations on $120^3 \times 6,8$ lattices with $a < 0.1$ fm. In the temperature range $2T_c - 10T_c$ we find $\kappa = 0.36(15)T^2$. Remarkably, this result is smaller than predicted by the AdS/CFT correspondence, but consistent with perturbation theory.

HK 26.5 Di 17:45 HZ 6

Event-by-Event Particle Multiplicity Fluctuations in Pb-Pb collisions with ALICE — •Mesut Arslandok for the ALICE-Collaboration — Institut für Kernphysik, Goethe-Universität Frankfurt

The study of event-by-event fluctuations of identified hadrons may reveal the degrees of freedom of the strongly interacting mater created in heavy-ion collisions. Particle identification that is based on the measurement of the specific ionization energy loss dE/dx works well on a statistical basis, however, suffers from ambiguities when applied on the event-by-event level. A novel experimental technique called the "Identity Method" was recently proposed to overcome such limitations. The method follows a probabilistic approach using the inclusive dE/dx distributions measured in the ALICE TPC, and determines the moments of the multiplicity distributions by an unfolding procedure. In this contribution, the status of an event-by-event fluctuation analysis that applies the Identity Method to Pb-Pb data from ALICE will be presented.

Supported by BMBF and the Helmholtz Association.

HK 26.6 Di 18:00 HZ 6

Probing the QCD matter close to the phase transition with net-particle fluctuations measured by ALICE at the LHC — •Jochen Thäder for the ALICE-Collaboration — Research Division and ExtreMe Matter Institute, GSI Helmholtzzentrum für Schwerionenforschung, Planckstr. 1, 64291 Darmstadt — Institut für Kernphysik, Technische Universität Darmstadt, Schlossgrabenstr. 9, 64289 Darmstadt

An event-by-event asymmetry in the number of particles and antiparticles produced at mid-rapidity in heavy-ion collisions can be related to fluctuations of the conserved quantities such as baryon number or charge in the strongly coupled quark-gluon plasma. Lattice calculations suggest that higher moments of the net-proton and the net-charge distributions are sensitive to the thermodynamic susceptibilities of the system.

The status of the event-by-event net-proton distribution and its higher moments measurement, taking the reconstruction efficiency into account, will be presented for Pb-Pb collisions at $\sqrt{s_{NN}} = 2.76$ TeV using the tracking and particle identification of the Time Projection Chamber of the ALICE apparatus at the LHC. Different methods will be compared and limits arising for the experimental data will be shown. Furthermore, results from net-charge fluctuations measured by the ALICE collaboration, their higher moments, and a comparison to the theoretical predictions will be presented.

HK 26.7 Di 18:15 HZ 6

Longitudinal thermalization via the Chromo-Weibel instability — •Maximilian Attems — Frankfurt Institute for Advanced Studies

Non-Abelian instabilities play a crucial role in the non-equilibrium dynamics of a weakly coupled Quark-Gluon Plasma. In particular, it has been proposed that this collective phenomenon may be the mechanism behind the fast thermalization of the plasma in ultra-relativistic heavy ion collisions. In this context, I will discuss recent advances in the understanding of the exponential growth and isotropization of soft unstable chromo-magnetic fields at short times which are produced by the Chromo-Weibel instabilities. The necessary momentum-space anisotropy that drives the instabilities is produced by the color-glass-

condensate initial state. Using the discretized hard loop framework we simulate the 3D+3V realtime evolution of the soft gluonic fields in a longitudinally free streaming expanding background.

HK 26.8 Di 18:30 HZ 6

Spinodal amplification of density fluctuations in fluid-dynamical simulations of relativistic nuclear collisions — •Jan Steinheimer[1], Jorgen Randrup[2], and Volker Koch[2] — [1]Frankfurt Institute for Advanced Studies, Frankfurt am Main, Germany — [2]Lawrence Berkeley National Laboratory, Berkeley, USA

I will present work based on extending a previously developed two-phase equation of state, which for the first time allows simulating head-on relativistic lead-lead collisions, in the presence of a mechanically unstable phase region due to the first order deconfinement phase transition. For collision energies that bring the bulk of the system into the mechanically unstable spinodal region of the phase diagram, the density irregularities are being amplified significantly. The resulting density clumping may be exploited as a signal of the phase transition. I will discuss several observables, like nuclei production, radial correlations and di-lepton production, and their sensitivity on the observed density clumping.

HK 26.9 Di 18:45 HZ 6

Nonequilibrium dynamics and transport in a quark-meson model — •Alex Meistrenko[1], Christian Wesp[1], Hendrik van Hees[2], and Carsten Greiner[1] — [1]Institut für Theoretische Physik, Goethe-Universität Frankfurt, Max-von-Laue-Straße 1, D-60438 Frankfurt, Germany — [2]Frankfurt Institute for Advanced Studies (FIAS), Ruth-Moufang-Straße 1, D-60438 Frankfurt, Germany

Based on the 2PI quantum effective action of the linear sigma model with constituent quarks, we develop a transport approach to study systems out of equilibrium. In particular, we focus on the chiral phase transition as well as the critical point, where nonequilibrium effects near the phase transition give rise to critical behavior such as the fluctuation of the baryon number density. Predictions for long-range correlations and fluctuations of observables in our model could be used to study fundamental properties of the QCD phase transition.
Supported by HGS-HIRe.