HK 3: Heavy Ion Collisions and QCD phases

Time: Monday 14:00–16:00 Location: H-ZO 10

Invited Group Report HK 3.1 Mo 14:00 H-ZO 10

Exploring hot and dense QCD matter with heavy-flavour probes at RHIC — •Andre Mischke — Institute for Subatomic Physics, Faculty of Science, Utrecht University, the Netherlands

Calculations from Lattice-QCD predict that at high energy densities a phase transition between hadronic matter and a deconfined state formed by quarks and gluons, the Quark-Gluon Plasma, occurs. The Relativistic Heavy-Ion Collider (RHIC) at Brookhaven National Laboratory (Upton, US) has yielded compelling evidence for the formation of this novel state of matter in high energy nuclear collisions. Measurements of the momentum distribution of emitted particles and comparison with hydrodynamic model calculations have shown that the matter behaves almost like an ideal fluid.

The investigation of heavy-flavour production in nuclear collisions provides key tests of parton energy-loss models and, thus, yields profound insight into the properties of the produced highly-dense QCD matter. Theoretical models based on perturbative QCD predict that heavy quarks should experience smaller energy loss than light quarks when propagating through the extremely dense medium due to the mass-dependent suppression (so-called dead-cone effect). Moreover, heavy quarks allow testing predictions from AdS/CFT, a formalism which provides a conjectured connection between strongly interacting gauge theories and string theory.

In this talk, recent results on charm and bottom production at RHIC and perspectives at CERN's Large Hadron Collider are reviewed.

Group Report HK 3.2 Mo 14:30 H-ZO 10

Equation of state of the QGP in a virial expansion — •Stefano Mattiello and Wolfgang Cassing — Institut für Theoretische Physik, Universität Giessen, Germany

Recent observations at the Relativistic Heavy-Ion Collider indicate that the quark gluon plasma (QGP) created in ultrarelativistic Au + Au collisions is interacting more strongly than hadronic matter. To relax the approximation of the QGP as an ideal gas we use a generalised version of the classical virial expansion for $\mu_{\mathrm{q}} = 0$ to calculate the partition function with a potential extracted from lattice calculations. We can describe three-flavour QCD lattice data with almost physical masses for the pressure, speed of sound and interaction measure at nonzero temperature and vanishing chemical potential. For the deconfined phase we use a phenomenological model which includes non-perturbative effects from dimension two gluon condensates that describe the free energy of quenched QCD very well. The hadronic phase is parametrised by a generalised resonance-gas model. Therefore, we extend this approach to finite densities introducing an explicit μ-dependence of the interaction. We calculate pressure, quark-number density, entropy and energy density and compare the results with lattice calculations. We, furthermore, investigate the structure of the phase diagram by calculating the isobaric and isentropic lines.
Work supported by DFG.

HK 3.3 Mo 15:00 H-ZO 10

Series expansions in lattice QCD at finite temperature — •Jens Langelage and Owe Philipsen — Institut für Theoretische Physik, Westfälische Wilhelms-Universität Münster

We calculate several observables in finite temperature lattice QCD in strong coupling expansions. Among these observables are the equation of state and the Polyakov loop susceptibility.

We use these series to get estimates for the critical parameters of the corresponding phase transition. For the pure gauge case our results are in good agreement with results from Monte Carlo simulations.

HK 3.4 Mo 15:15 H-ZO 10

Critical point in the QCD phase diagram: role of axial U(1) anomaly and strange quark mass — •Nino Bratovic, Thomas Hell, Simon Rössner, and Wolfram Weise — Physik Department, TU München, 85748 Garching, Germany

We use the Nambu-Jona-Lasinio model extended by Polyakov-loop dynamics (PNJL model) for $2 + 1$ flavours in order to study the QCD phase diagram and associated thermodynamic quantities. In this approach, spontaneous chiral symmetry breaking as well as confinement are realized dynamically in terms of the respective order parameters. In particular, we investigate the existence and location of the critical endpoint in the phase diagram. The dependence on the strength of the $\mathrm{U}(1)_A$ symmetry-breaking 't Hooft interaction and on the strange quark mass m_s is examined. Our findings are compared to related results from other groups.

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

HK 3.5 Mo 15:30 H-ZO 10

Conical Correlations, Bragg Peaks, and Transverse Flow Deflections in Jet Tomography — •Barbara Betz[1,2], Miklos Gyulassy[3], Jorge Noronha[3], Dirk Rischke[1,4], and Giorgio Torrieri[1,4] — [1]Institut für Theoretische Physik, Goethe-Universität Frankfurt — [2]Helmholtz Research School, Universität Frankfurt, GSI and FIAS — [3]Department of Physics, Columbia University — [4]Frankfurt Institute for Advance Studies, FIAS, Frankfurt

New results are presented on away side jet correlations [1] computed in a variety of (3+1)d hydrodynamic scenarios extending our work in Ref. [2] to include stopped jets, the effects of possible Bragg peak deposition and transverse background expansion. We contrast pQCD and AdS string drag plasma-jet coupling dynamics [3] and discuss strategies for experimental falsification of models using tagged heavy quark jet tomography.

[1] H. Stöcker, Nucl. Phys. A **750** (2005) 121; F. Antinori and E. V. Shuryak, J. Phys. G **31**, L19 (2005); A. Adare *et al.* [PHENIX Collaboration], Phys. Rev. C **78**, 014901 (2008); J. G. Ulery [STAR Collaboration], Nucl. Phys. A **783**, 511 (2007). [2] B. Betz, M. Gyulassy, J. Noronha and G. Torrieri, arXiv:0807.4526 [hep-ph]. [3] J. Noronha, M. Gyulassy and G. Torrieri, arXiv:0807.1038 [hep-ph]; R. B. Neufeld, B. Muller and J. Ruppert, Phys. Rev. C **78**, 041901 (2008).

HK 3.6 Mo 15:45 H-ZO 10

Investigation of jet-quenching and elliptic flow within a pQCD partonic transport model — •Oliver Fochler, Zhe Xu, and Carsten Greiner — Institut für Theoretische Physik, Goethe Universität Frankfurt

We investigate the gluonic contribution to the nuclear modification factor, R_{AA}, for central Au+Au collisions at the RHIC-energy of $\sqrt{s} = 200\,\mathrm{AGeV}$ employing the perturbative QCD-based parton cascade BAMPS including radiative processes. A flat quenching pattern is obtained up to transverse momenta of 30 GeV. When compared to results from the GLV formalism, the suppression is found to be slightly stronger. We demonstrate that the present microscopic transport description provides excellent means of investigating both jet-quenching and a strong build-up of elliptic flow in terms of the same standard perturbative QCD interactions.