HK 63: Schwerionenkollisionen und QCD Phasen

Zeit: Donnerstag 14:00–16:15 Raum: HSZ-204

Gruppenbericht HK 63.1 Do 14:00 HSZ-204

Das Compressed Baryonic Matter Experiment - Status und Ausblick* — •Christian Pauly für die CBM-Kollaboration — Bergische Universität Wuppertal

Die Erforschung des QCD-Phasendiagramms im Bereich hoher baryonischer Dichten und moderater Temperaturen ist das Kernziel des Compressed Baryonic Matter Experiments (CBM), welches eine der vier wissenschaftlichen Säulen der neuen Facility for Antiproton and Ion Research (FAIR) darstellt. In Kern-Kern-Kollisionen am geplanten SIS100 Synchrotron bei Energien von bis zu 14 GeV/Nukleon (später am SIS300 bis 45 GeV/Nukleon) sollen Materiezustände höchster Dichte (bis zu 10-fache Kerndichte) untersucht werden. Das Experiment ist auf die Erzielung höchster Ereignisraten (bis zu 10 MHz) ausgelegt und erlaubt somit die Erforschung sehr seltener Prozesse. Ein Beispiel sind leptonische Zerfälle von Vektormesonen oder Charm. Diese Proben wechselwirken nicht stark mit dem dichten, hadronischen Medium und erlauben daher einen Einblick in die frühe, hochdichte Phase des Kollisionsprozesses. Inzwischen ist die Planung und Entwicklung des CBM-Detektorsystems weit fortgeschritten und für verschiedene Komponenten des Experiments wurden bereits Technical Design Reports fertiggestellt. Im Rahmen diverser Teststrahlzeiten am CERN, COSY und an der GSI konnte die Leistungsfähigkeit von Prototyp-Detektoren inklusive (ungetriggerter) Auslese-Elektronik getestet und weiterentwickelt werden. Der Vortrag gibt einen Überblick über das CBM-Projekt sowie den Entwicklungsstand der verschiedenen Subdetektorsysteme.
*Gefördert durch BMBF, EU-FP7-HP3 und HIC-for-FAIR

HK 63.2 Do 14:30 HSZ-204

Detector Independent Cellular Automaton Algorithm for Track Reconstruction — Ivan Kisel[1,2,3], •Igor Kulakov[1,2,3], and Maksym Zyzak[1,2,3] for the CBM-Collaboration — [1]Goethe-Universitat Frankfurt am Main — [2]Frankfurt Institute for Advanced Studies — [3]GSI Helmholtzzentrum fur Schwerionenforschung GmbH

Track reconstruction is one of the most challenging problems of data analysis in modern high energy physics (HEP) experiments, which have to process per second of the order of 10^7 events with high track multiplicity and density, registered by detectors of different types and, in many cases, located in non-homogeneous magnetic field. Creation of reconstruction package common for all experiments is considered to be important in order to consolidate efforts.

The cellular automaton (CA) track reconstruction approach has been used successfully in many HEP experiments. It is very simple, efficient, local and parallel. Meanwhile it is intrinsically independent of detector geometry and good candidate for common track reconstruction.

The CA implementation for the CBM experiment has been generalized and applied to the ALICE ITS and STAR HFT detectors. Tests with simulated collisions have been performed. The track reconstruction efficiencies are at the level of 95% for majority of the signal tracks for all detectors.

Supported by EU-FP7 HadronPhysics3, HIC for FAIR, HGS-HIRe for FAIR and Hessischen Ministerium fuer Wissenschaft und Kunst gefoerdert.

HK 63.3 Do 14:45 HSZ-204

The Cellular Automaton track finder at high track multiplicities — •Valentina Akishina[1,3,4], Ivan Kisel[1,2,3], Igor Kulakov[1,2,3], and Maksym Zyzak[1,3,4] — [1]Goethe-Universität Frankfurt am Main, Frankfurt am Main, Germany — [2]Frankfurt Institute for Advanced Studies, Frankfurt am Main, Germany — [3]GSI Helmholtzzentrum für Schwerionenforschung GmbH, Darmstadt, Germany — [4]JINR Joint Institute for Nuclear Research, Dubna, Russia

The CBM experiment at FAIR is being designed to study heavy-ion collisions at extremely high interaction rates. The event selection has to be done online, therefore fast and efficient reconstruction algorithms are required. The Cellular Automaton (CA) track finder is fast and robust and thereby is used both for the online and offline track reconstruction in CBM. Since the CBM beam will have no bunch structure, but continuous, the reconstruction of time slices rather than events is needed. Measurements in this case will be 4D (x, y, z, t). In order to study the worst case scenario with no time measurment taken into account a number of minimum bias events (up to 100) was grouped into one, which was treated by the track finder as one event. The study has showed that CA track finder is stable with respect to track multiplicity: the efficiency of the algorithm decreases only by 4% for 100 minimum bias events in one group. The speed of the algorithm behaves as a second order polynomial with the number of track. Supported by FIAS, HICforFAIR and HGS-HIRe for FAIR. Das Projekt wird vom Hessischen Ministerium für Wissenschaft und Kunst gefördert.

HK 63.4 Do 15:00 HSZ-204

Lattice QCD based equation of state at finite baryon density — •Pasi Huovinen — Frankfurt Institute for Advanced Studies (FIAS), Ruth-Moufang-Straße 1, D-60438 Frankfurt, Germany

We employ the lattice QCD data on Taylor expansion coefficients to extend the parametrization of the equation of state to finite baryon density. When we take into account lattice spacing and quark mass dependence of the hadron masses, the Taylor coefficients at low temperature are equal to those of hadron resonance gas. Thus we require that the equation of state is smoothly connected to the hadron resonance gas equation of state at low temperatures. We also show how the hydrodynamical evolution is affected by this equation of state in the energy range relevant for SPS and the RHIC energy scan.
This work is funded by BMBF.

HK 63.5 Do 15:15 HSZ-204

Dense Matter and Renormalization Group — •Matthias Drews[1,2], Bertram Klein[1], and Wolfram Weise[1,2] — [1]Technische Universität München — [2]ECT* Trento, Italien

As a contribution to the ongoing discussion on the question of a critical endpoint of a chiral phase transition, a nucleon-meson model was studied recently [1]. There was no evidence of a critical phase transition in the region of chemical freeze-out for larger chemical potential. We try to extend and solidify the calculations that were done at the mean field level by including mesonic fluctuations with help of the functional renormalization group equations.

[1] S. Floerchinger and C. Wetterich, Nucl.Phys.A 890-891 (2012)

Supported in part by BMBF and by the DFG cluster "Origin and Structure of the Universe"

HK 63.6 Do 15:30 HSZ-204

Domain formation and density fluctuations as a signal for the QCD first order phase transition — •Christoph Herold[1,2] and Marcus Bleicher[1,2] — [1]Institut für Theoretische Physik, Goethe-Universität, Max-von-Laue-Str. 1, D-60438 Frankfurt — [2]Frankfurt Institute for Advanced Studies (FIAS), Ruth-Moufang-Str. 1, D-60438 Frankfurt

We develop a nonequilibrium Polyakov-chiral fluid dynamics model in order to understand dynamical symmetry breaking and to give realistic estimates for experimental observables connected to the QCD phase transition. The expansion of the hot fireball after a heavy ion collision is simulated by a fluid-dynamically propagated quark medium. On this background the order parameters for the chiral and deconfinement transition are explicitly propagated by Langevin equations. Large nonequilibrium fluctuations at the first order transition influence the trajectories in the phase diagram. Here the transition proceeds through the formation of domains where high- and low-temperature phases coexist until finally all chirally symmetric and deconfined domains have decayed. These inhomogeneous structures produce large pressure gradients leading to the formation of high density clusters, an effect that is not observed if the system evolves through the crossover or the critical end point. These clusters might constitute excellent experimental probes for a first order phase transition, e. g. non-monotonic hadron multiplicity fluctuations.
Supported by the Hessian LOEWE initiative through the Helmholtz International Center for FAIR (HIC for FAIR), GSI, and HGS-HIRe.

HK 63.7 Do 15:45 HSZ-204

The thermal transition from twisted mass lattice QCD — •Christopher Pinke and Owe Philipsen — Goethe Universität Frankfurt am Main

The phase diagram of QCD is subject to ongoing investigations, and lattice QCD provides a tool to study it from first principles. We report on our results for the thermal transition of QCD in the chiral limit with two flavours of twisted-mass fermions by means of universal scaling behaviour and analysis of screening masses.

HK 63.8 Do 16:00 HSZ-204

Finite-volume effects in O(N)-models — •Paul Springer and Bertram Klein — Physik Department, Technische Universität München, 85747 Garching

The investigation of QCD phases is currently a much discussed topic in particle physics. In the context of this discussion the knowledge about the nature of chiral phase transition is significant. A powerful tool for this purpose are lattice simulations. They are, however, still carried out at quark masses far from the chiral limit and in small volumes, which could strongly influence the critical behavior.

Since continuous phase transitions are controlled by the long range fluctuations only the dimensionality and symmetries dictate the universal behavior near the critical point. Therefore, more simple systems from the same universality class can be used to analyze QCD at chiral phase transition.

We investigate 3-dimensional O(2)- and O(4)-models in finite volumes using non-perturbative Renormalization Group methods. We provide scaling functions in infinite and finite volume that are universal for O(2)- and O(4)-universality classes in d=3 dimensions and applicable to the chiral phase transition. We also investigate the effects of the finite volume on the critical behavior and determine the finite-size scaling region for both models in order to provide a tool, which assists in analysis of lattice QCD data.