HK 38: Heavy-Ion Collisions and QCD Phases VIII

Time: Wednesday 15:45–17:15 Location: SCH/A315

HK 38.1 Wed 15:45 SCH/A315

Critical dynamics in the real-time functional renormalization group — •Johannes Roth[1], Leon Sieke[1], and Lorenz von Smekal[1,2] — [1]Institut für Theoretische Physik, Justus-Liebig-Universität, 35392 Giessen, Germany — [2]Helmholtz Research Academy Hesse for FAIR (HFHF), Campus Giessen, 35392 Giessen, Germany

Real-time quantities such as spectral functions and transport coefficients can serve to examine the real-time evolution of a system close to equilibrium, as they encode the possible excitations in the medium and show universal static and dynamic scaling behavior near a critical point. The functional renormalization group (FRG) formulated on the Schwinger-Keldysh closed-time path provides an excellent calculational tool for such real-time correlations [1]. In this talk I will present a novel approach for the systematic construction of causal regulators for the FRG, which comply with the analytic structure of the propagators, and demonstrate that they can be interpreted as a coupling to a fictitious external heat bath with FRG scale dependent spectral distribution. As particular applications, I will discuss the relaxational Models A, B, and C according to the classification scheme by Halperin and Hohenberg, and show how they can be implemented in the real-time FRG. With this setup, I will then present results which demonstrate the generation of dynamic scaling behavior in spectral functions obtained from one and two-loop self-consistent truncation schemes.

[1] J. V. Roth, D. Schweitzer, L. J. Sieke, L. von Smekal, Phys. Rev. D **105** (2022) 116017.

HK 38.2 Wed 16:00 SCH/A315

A novel saturation-based 3+1D initial state model for Heavy Ion Collisions — •Oscar Garcia-Montero[1], Sören Schlichting[1], and Hannah Elfner[2] — [1]Fakultät für Physik, Universität Bielefeld — [2]GSI Helmholtzzentrum für Schwerionenforschung

We present a new 3+1D resolved model for the initial state of ultrarelativistic Heavy-Ion collisions, based on the $k_\perp$-factorized Color Glass Condensate hybrid approach. This new model responds to the need for a rapidity-resolved initial-state Monte Carlo event generator which can deposit the relevant conserved charges (energy, charge and baryon densities) both in the midrapidity and forward/backward regions of the collision. This event-by-event generator computes the gluon and (anti-) quark phase-space densities using the IP-Sat model, from where the relevant conserved charges can be computed directly. In the present work we have included the leading order contributions to the light flavor parton densities. As a feature, the model can be systematically improved in the future by adding next-to-leading order calculations (in the CGC hybrid framework), and extended to lower energies by including sub-eikonal corrections the channels included. We present relevant observables, such as the eccentricities and flow decorrelation, as tests of this new approach.

HK 38.3 Wed 16:15 SCH/A315

Extending the fluid dynamic description of heavy-ions collisions to times before the collision — •Andreas Kirchner[1], Federica Capellino[2], Alaric Erschfeld[3], Stefan Floerchinger[3], and Eduardo Grossi[4] — [1]ITP Heidelberg — [2]University Heidelberg — [3]TPI Jena — [4]Dipartimento di fisica e astronomia, Universita di Firenze and INFN Sezione di Firenze

It is well established that the late states of a high energy nuclear collision can be described in terms of relativistic fluid dynamics. An open problem in this context is how the actual collision and the early time dynamics directly after it can be described. Phenomenological models are currently employed here and they have several parameters that need to be fitted to experimental data. Using relativistic fluid dynamics of second order we develop a new approach which addresses the entire collision event, and which gets initialized in fact already before the collision. This is based on the droplet model for the incoming nuclei and a state-the-art equation of state including the first-order liquid-gas phase transition. The physics picture we propose assumes that the soft features of a high energy nuclear collision can be fully described through the dynamics of the energy-momentum tensor and other conserved currents.

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HK 38.4 Wed 16:30 SCH/A315

Correlations in a Moat Regime — •Fabian Rennecke — Institut für Theoretische Physik, Justus-Liebig-Universität Giessen

The QCD phase diagram at large chemical potential is largely uncharted territory. Based on model studies, there are various phases that could occur in this regime. Among them are phases related to spatial modulations, such as inhomogeneous/crystalline phases, liquid crystals or a quantum pion liquid. A common feature of all these phases is that particles can have a moat dispersion, where the energy is minimized at nonzero momentum. This can directly affect particle production in the medium created by a heavy-ion collision and leads to characteristic signatures in particle correlations. I will discuss the underlying physics and present a formalism to study particle spectra on general hypersurfaces. Using this formalism, I will show that the correlations generated by the Hanbury-Brown–Twiss effect are promising probes for a moat regime in heavy-ion collisions.

HK 38.5 Wed 16:45 SCH/A315

Search for QCD Instantons with the ATLAS Detector — •Radek Vavricka and Matthias Schott for the ATLAS-Collaboration — Johannes Gutenberg University Mainz

The Standard Model of particle physics predicts the existence of quantum tunnelling processes across topological inequivalent vacua, known as Instantons. In the*electroweak sector, instantons provide a source of baryon asymmetry within the Standard Model. In Quantum Chromodynamics they are linked to chiral symmetry*breaking and confinement. So far, no direct experimental evidence of instanton-induced processes has been found. Recently, new calculations for QCD Instanton processes in proton-proton collisions became public, suggesting promising experimental signatures at the LHC. In this work, we give an update on the ongoing searches for instanton signatures with the ATLAS Detector.

HK 38.6 Wed 17:00 SCH/A315

Fate of critical fluctuations in an interacting hadronic medium — •Jan Hammelmann[1], Marcus Bluhm[2], Marlene Nahrgang[2], and Hannah Elfner[3,1] — [1]Frankfurt Institute for Advanced Studies (FIAS) — [2]SUBATECH UMR 6457 — [3]GSI Helmholtzzentrum für Schwerionenforschung

We study the evolution of critical fluctuations in an expanding system within a hadronic transport approach. The system is initialized with particle number distributions coupled to the critical mode and the hadron gas then evolves in time with realistic hadronic interactions.

The initialization of the system with critical fluctuations is achieved by coupling the ideal hadron resonance gas cumulants to the ones from the 3d Ising model and generating the net and total particle numbers from the maximum entropy probability distribution.

We systematically investigate the evolution of the critical fluctuations initialized at various temperatures and chemical potentials along a freeze-out line and the dependency of the final state cumulants as a function of $\sqrt{s}$ is presented. Additionally, the sets of particles which are coupled to the critical mode are modified such that the strength of the propagation of correlations through interactions can be assessed. We find that in the scaling region of the critical point correlations are propagated through the whole collisional history and are still present after the kinetic freeze-out of the matter.