HK 16: Heavy-Ion Collisions and QCD Phases III

Time: Tuesday 14:00–15:30 Location: HS 3 Chemie

HK 16.1 Tue 14:00 HS 3 Chemie

Low-mass, low-momentum virtual photon measurement with HADES — •Iuliana Carina Udrea for the HADES-Collaboration — TU Darmstadt

Collisions of heavy nuclei at relativistic energies create a hot and dense medium, offering a unique environment to explore its microscopic properties using electromagnetic probes.

Dileptons are particularly advantageous for this purpose, as they do not interact strongly with the surrounding matter, allowing them to carry undisturbed information about the QCD matter produced during the reaction. In particular, the study of low-mass and low-momentum dileptons provides valuable insights into transport properties such as electrical conductivity.

In this contribution, we outline the key steps towards investigating soft dileptons. For this purpose data from Ag+Ag collisions at $1.23A$ GeV with a nominal magnetic field strength are compared with a reduced magnetic field (5% of $B_{\max}$), the latter increasing the acceptance for low-momentum pairs.

Furthermore, we will present simulations at reduced magnetic field strength, which provide optimal parameters for the upcoming run in 2024/2025 with Au+Au collisions at $0.8A$ GeV, conducted with the HADES experiment.

This work is supported by: GSI F&E and HGS-HIRe.

HK 16.2 Tue 14:15 HS 3 Chemie

Dielectron Analysis for the CBM Experiment in Au+Au Collisions at $\sqrt{s_{NN}} = 3.19\,\mathrm{GeV}$ — •Luisa Faber for the CBM-Collaboration — Institut für Kernphysik Universität Münster

The Compressed Baryonic Matter (CBM) experiment is currently under construction in Darmstadt and designed to explore the QCD phase diagram at high net-baryon densities using heavy ion collisions with energies ranging from $\sqrt{s_{NN}} = 2.86\,\mathrm{GeV}$ to $\sqrt{s_{NN}} = 4.93\,\mathrm{GeV}$ and high interaction rates up to 10 MHz.

In different stages of the fireball evolution virtual photons are produced and able to leave the medium since they do not interact strongly, making them an important measurement tool. They carry the information with their invariant mass, which can be accessed by their decay into dileptons. The invariant mass spectrum allows for example to determine the temperature of the medium. By extracting this temperature at different collision energies one can access the caloric curve and possibly determine the order of the phase transition between the QGP and confined matter in this region of the phase diagram.

In this talk simulations with a kinetic energy of 3.56 AGeV for Au+Au collisions are used to extract the dielectron mass spectrum. Since dileptons are rare probes it is of utmost importance in this analysis to ensure a high electron efficiency and a high pion suppression. Prior work was carried out for the maximum energy of 11 AGeV. The used cuts on detector parameters are adapted for the lower energy. First results of the analysis are shown in this talk.

HK 16.3 Tue 14:30 HS 3 Chemie

Dielectron Identification with Machine Learning in Ag+Ag collisions at 1.58A GeV at HADES — •Henrik Flörsheimer for the HADES-Collaboration — Technische Universität Darmstadt

The High-Acceptance-Di-Electron-Spectromet (HADES) is a fix target experiment capable of measuring heavy-ion as well as elementary collisions. With beam energies around a few GeV nuclear matter at high densities and moderate temperature can be observed. One way to gain information about these collisions is to study electro- magnetic probes, such as the virtual photon decaying into electron positron pairs. They can be used to characterize the evolution of the fireball or to gain further information using their invariant mass spectrum to determine a fireball temperature or potential in medium modifications.

At HADES, the main components for reconstruction of dileptons are the ring imaging Cherenkov (RICH) detector, two Multi-wire drift chambers (MDCs) before and after the magnet for tracking and momentum determination, an electromagnetic calorimeter (ECAL) measuring the energy loss, and a forward wall for determining the centrality of the collisions.

In this contribution, we discuss new methods to utilize all these detector observables in a multivariate analysis in order to optimally identify leptons. We demonstrate how the performance in the dilepton analysis can be increased using Machine Learning. We also show how to deal with challenges in the efficiency correction and the need for additional checks for unwanted biases.

HK 16.4 Tue 14:45 HS 3 Chemie

Dielectron production and topological separation of dielectron sources with ALICE in Run 3 — •Jerome Jung for the ALICE Germany-Collaboration — Goethe University, Frankfurt, Germany

Dielectrons are an exceptional tool to study the properties of hadronic and nuclear collisions as they can leave the strongly interacting system at any stage of its evolution. However, the interpretation of their spectra relies on a precise understanding of all contributing sources. To single out potential medium contributions in nucleus*nucleus collisions on top of those from hadron decays, studies in hadronic collisions are instrumental to obtain a reference measurement.

To measure prompt sources at invariant masses above 1.2 GeV/c^2, such as Drell-Yan or thermal dielectrons, it is necessary to disentangle these contributions from the large physics background from correlated semi-leptonic decays of heavy-flavor hadrons. The upgraded ALICE detector with its increased pointing resolution and higher data acquisition rates allows disentangling these contributions based on their topology using the distance-of-closest approach (DCA) to the primary vertex with high precision.

This talk presents the status of the analysis of dielectron production in proton-proton collisions at $\sqrt{s} = 13.6$ TeV from LHC Run 3 recorded with ALICE. The increased topological separation power is demonstrated. Finally, DCA templates of expected sources are fitted to the data to separate the yield from prompt and non-prompt sources.

HK 16.5 Tue 15:00 HS 3 Chemie

Testing machine learning against finite size scaling in Lattice QCD — •Simran Singh[1], Reinhold Kaiser[2], Frithjof Karsch[3], Jan Philipp Klinger[2], Owe Philipsen[2], and Christian Schmidt[3] — [1]HISKP Rheinischen Friedrich-Wilhelms Universität Bonn, Bonn, Germany — [2]Institut für Theoretische Physik, Goethe-Universität Frankfurt, Frankfurt, Germany — [3]Fakultät für Physik, Universität Bielefeld, Bielefeld, Germany

Masked Autoregressive Flows (MAFs) provide a machine learning method for estimating the joint probability density of observables from data samples. In [1], MAFs were used to estimate the joint probability density of the chiral condensate and gauge action conditioned on lattice parameters like gauge coupling, bare quark mass and spatial lattice extent for degenerate quarks using highly improved staggered fermions, identifying the critical mass separating crossover and first-order regions. This work extends the MAF analysis to previously published data using unimproved staggered fermions [2], aiming to compare MAF predictions of lattice observables with actual data with the ultimate goal to compare the ML approach to determine the Z2 critical mass with the finite size scaling analysis of the kurtosis, which was used in [3] by the Frankfurt group.

1. F. Karsch et.al., PoS LATTICE2022 (2023)
2. F. Cuteri et.al., JHEP 11 (2021)
3. O. Philipsen, PoS LATTICE2019 (2019)

HK 16.6 Tue 15:15 HS 3 Chemie

QCD Anderson transition with overlap valence quarks on a twisted-mass sea — •Robin Kehr[1] and Lorenz von Smekal[1,2] — [1]Institut für Theoretische Physik, Justus-Liebig-Universität, Heinrich-Buff-Ring 16, 35392 Giessen, Germany — [2]Helmholtz Forschungsakademie Hessen für FAIR (HFHF), GSI Helmholtzzentrum für Schwerionenforschung, Campus Gießen

We investigate the QCD Anderson transition by studying the low-lying eigenmodes of the overlap operator in the background of gauge configurations with 2+1+1 quark flavors of twisted-mass Wilson fermions. The mobility edge, below which eigenmodes are localized, is estimated by the inflection point of the relative volume. The analysis of its temperature dependence suggests a close relation of localization to chiral symmetry restoration. We will present and discuss recent data on lower temperatures and with prior smoothing of the configurations with gradient flow as well as alternative definitions of localization and estimates of the mobility edge.

Based on: 10.1103/PhysRevD.109.074512, 10.48550/arXiv.2304.13617