HK 19: Heavy-Ion Collisions and QCD Phases IV

Time: Tuesday 15:45–17:15 Location: HS 3 Chemie

HK 19.1 Tue 15:45 HS 3 Chemie

Characterising the hot and dense fireball with virtual photons at HADES — •Niklas Schild for the HADES-Collaboration — TU Darmstadt

The High-Acceptance-Di-Electron-Spectrometer (HADES) at GSI, Darmstadt, measures heavy-ion and elementary collisions at a few GeV beam energies, enabling the investigation of nuclear matter at high densities and moderate temperatures. One central pillar of HADES is the study of these collisions via rare electromagnetic probes, as their penetrating nature allows unique insights into the evolution of the collision throughout.

In this contribution, we present measurements of dileptons reconstructed from Ag+Ag and Au+Au collisions at $\sqrt{s_{NN}} = 2.55$ GeV and $\sqrt{s_{NN}} = 2.42$ GeV. Combination of these HADES data sets brings a unique opportunity to gain new insights into dilepton observables and their dependence on system size and centrality. For this purpose, we also employ a machine-learning approach, based on real data training, to identify and remove carbon collision contamination from the surrounding target material. This allows to extent previous studies to more peripheral collisions.

The main focus of this investigation is then set on the excess yield, and thereby the temperature of the fireball, as well as studies on collectivity, in particular via the measurement of the azimuthal anisotropy.

This work has been supported by ELEMENTS (500/10.006) and HGS-HIRe.

HK 19.2 Tue 16:00 HS 3 Chemie

Investigation of thermal and freeze-out contributions to the dilepton spectrum — •Jessica Ou Ya Vogel — TU Darmstadt

Measurements of dileptons emitted from heavy-ion collisions provide insights into the properties of the created fireball. As leptons are unaffected by the strong final-state interactions of the collision, they retain valuable information about the hot and dense medium formed during the heavy-ion reaction. The high baryon densities achieved in collisions at a few GeV induce significant medium effects on the spectral functions of vector mesons.

While short-lived ρ mesons predominantly decay within the fireball, radiating thermal dileptons, a substantial fraction of ω mesons decay outside the fireball due to their longer lifetime. These decays contribute to the freeze-out cocktail with the vacuum line shape of the vector mesons. High-statistics data from Ag+Ag collisions at $\sqrt{s_{NN}} = 2.55$ GeV, measured by the HADES collaboration, may allow for the isolation of these two different contributions and enable studies of in-medium modifications of the ω meson spectral function in the experimental data.

This work presents a framework that describes the vector meson freeze-out contributions using the shining method, while the thermal dilepton spectrum is determined via the coarse-graining model. By combining these two approaches, we aim to achieve a precise theoretical description of the invariant mass spectrum of thermal dileptons in heavy-ion collisions within the few GeV energy range.

This work is supported by the DFG through grant CRC-TR 211.

HK 19.3 Tue 16:15 HS 3 Chemie

In-Medium Vector Meson Polarization from FRG — •Maximilian Wiest[1], Tetyana Galatyuk[1,2,3], Lorenz von Smekal[3,4], and Jochen Wambach[1] — [1]Institut für Kernphysik - TU Darmstadt, Darmstadt, Germany — [2]GSI Helmholtzzentrum für Schwerionenforschung, Darmstadt, Germany — [3]Helmholtz Research Academy Hesse for FAIR (HFHF) — [4]Justus Liebig University Giessen, Germany

In this talk, we will discuss the FRG treatment of the chiral parity doublet model (PDM) to extract in-medium vector-spectral functions at finite spatial momenta. The PDM incorporates mesons and baryons as effective degrees of freedom including chiral and parity partners. Our theoretical approach is based on the Functional Renormalization Group (FRG) which represents a non-perturbative framework that is capable of including both quantum and thermal fluctuations. The in-medium rho-meson spectral function is calculated using the analytically-continued FRG (aFRG) method. Our results show strong modifications of the spectral functions with increasing spatial momentum. Using a coarse-graining approach, we can extract dilepton spectra from microscopic transport approaches using the obtained vector spectral functions and extract the impact of the mirror-baryon peak on the dilepton spectra. For comparison, we will also show corresponding calculations for state-of-the-art in medium spectral functions. The extraction of finite momentum spectral functions also gives access to the polarization signal of vector mesons, which carries information of the dominant production processes.

HK 19.4 Tue 16:30 HS 3 Chemie

Dielectron Performance of the CBM Experiment — •Adrian Meyer-Ahrens — Institut für Kernphysik Münster, Münster, Deutschland

The Compressed Baryonic Matter (CBM) experiment is a fixed-target experiment currently under construction at FAIR in Darmstadt which will explore the QCD phase diagram at high net-baryon densities using heavy-ion beams in the kinetic energy range of 2-11 AGeV provided by the SIS100 accelerator complex. Dielectrons serve as versatile probes for properties of the hot and dense medium created in the collisions, since once produced, they do not interact strongly and escape the fireball undisturbed. Dielectron physics relies on the efficient reduction of combinatorial background, dominated by misidentified hadrons as well as electrons from photon conversions in the target or detector material. In this talk, simulation results concerning the dielectron performance of CBM with a focus on central Au-Au collisions at will be presented, with a discussion of background rejection using conventional cut-based selections and machine learning methods, as well as the determination the resulting invariant mass spectra and signal-to-background ratios.

HK 19.5 Tue 16:45 HS 3 Chemie

XGboost based direct photon and neutral meson analysis for ALICE $Pb-Pb$ collision at $\sqrt{s_{\mathrm{NN}}} = 5.02\,\mathbf{TeV}$ — •Abhishek Nath for the ALICE Germany-Collaboration — Ruprecht Karl University of Heidelberg, Germany

Direct photons act as a unique probe to characterize heavy-ion collision as they are color-blind and do not interact strongly with the medium once formed. Furthermore, being produced at all stages of collision, they are perfect to characterize the space-time evolution of the QCD medium. However, due to decays of neutral mesons (mostly π^0 and η) to γ, a large amount of background exists for such signals. This demands a precise measurement of the background since direct and decay photons are indistinguishable in a detector.

The current run 2 direct photons studies utilizing the Photon Conversion Method (PCM) are associated with large uncertainties specifically in $p_{\mathrm{T}} < 2$ GeV making the final direct photon yield less significant. This talk presents the use of classical machine learning models namely XGBoost with PCM to address the problem. We use the models to increase the photon sample's purity and efficiency. This is followed by measuring the neutral mesons via their strongest γ decay channel and finally obtaining direct photon measurement. A comparison between standard cut-based analysis and ML-induced analysis for both photons and neutral meson is conducted to assess the impact of the ML models on the significance of measurement

HK 19.6 Tue 17:00 HS 3 Chemie

Performance of the dielectron analysis in Pb-Pb collisions in Run 3 with ALICE — •Emma Ege for the ALICE Germany-Collaboration — Goethe University Frankfurt, Frankfurt, Germany

Correlated electron-positron pairs (dielectrons) are a unique probe to study the properties of the medium created in relativistic heavy-ion collisions. They are produced in all stages of the collision and leave the system without loss of information as they do not interact strongly with the medium. However, at LHC energies, the thermal dielectrons emitted in the early stages of the collision from the quark-gluon-plasma are outnumbered by a large contribution of correlated e^+e^--pairs from semi-leptonic decays of heavy-flavour (HF) hadrons.

The upgrade of the ALICE detector installed during the Long Shutdown 2 is crucial to boost the precision of thermal radiation measurement. The continuous readout of the TPC allows for higher data acquisition rate of up to 50 kHz in Pb–Pb collisions. Moreover, the new ITS with its higher granularity and closer location to the interaction point improves the pointing resolution by a factor of 2 compared to that in Run 2, leading to a better topological separation of prompt thermal radiation and e^+e^--pairs from HF hadron decays, and to smaller background from photon conversions in the detector material.

In this talk, the status of the dielectron analysis of a large data set of Pb–Pb collisions at $\sqrt{s_{\mathrm{NN}}} = 5.36$ TeV, recorded with the upgraded ALICE detector in Run 3, is presented. Topological separation capabilities based on distance-of-closest approach (DCA) and the impact of the detector upgrades on the dielectron analysis will be shown.