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The study of charged hadron distributions in relativistic heavy-ion collisions using holographic thermodynamics

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At the beginning of the 21st century, a new phase of strongly interacting matter, known as the quark-gluon plasma (QGP), was established [1]. To study QGP formation in heavy-ion collisions, the solution of system of relativistic hydrodynamics equations with a specific equation of state (EoS) is typically employed. In light of difficulties for non-zero baryonic potentials within Lattice QCD, various holographic models based on the AdS/CFT duality have been proposed to obtain the QGP EoS from the thermodynamic properties of a corresponding black brane in AdS_5 [2].

In this work, we discuss possible phenomenological approach for incorporating not only the baryon chemical potential but also the quantum numbers of strangeness and charge into holographic thermodynamics. The method proposed employs a phenomenological hypothesis inspired by the thermodynamic dependencies of the hadron gas model. The Thermal FIST [3] package helps us to find the definition for the full chemical potential, which behaves like a hadron gas in the characteristic temperature range. We apply machine learning methods to address regression and optimization problems during the calibration of the model's free parameters using LQCD results for quark masses that approximate the physical values [4]. For practical applications in heavy-ion collision studies, the holographic EoS with strangeness and charge is incorporated into the hydrodynamical packages MUSIC [5] and vHLE [6].

To obtain final hadronic spectra, numerical simulations were conducted using the iEBE-MUSIC and SMASH-vHLE frameworks. The various hadronic relations for charged pions, kaons and protons are studied using approach described.

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