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Study of net-proton and net-kaon fluctuations in FAIR energies using the PHQMD model

The Compressed Baryonic Matter (CBM) experiment at Facility for Antiproton and Ion Research (FAIR), Darmstadt, offers a unique opportunity to study the model-predicted first-order transition from hadronic phase to Quark Gluon Plasma (QGP) phase with high precision by using its exceptionally high collision rates of up to 10 MHz, far surpassing previous experiments.
Event-by-event fluctuations in nuclear collisions allow us to probe the correlation length (ξ) of the system, which captures how variables change together over space and time. Near a critical point, this correlation length becomes significant, even diverging in an infinite system, making fluctuation measurements a powerful tool in the search for the QCD critical point. The non-monotonic dependence of the kurtosis times variance, $\kappa\sigma^2$ (or C_4/C_2) of the net-proton (serving as a proxy for net-baryon) distribution on collision energy ($\sqrt{s_{NN}}$) is proposed as an indicator of the QCD critical point, due to its connection with the system's correlation length and susceptibilities. In this work, we present the results on net-proton fluctuations for Au+Au collisions in the range of collision energy 3.5-19.6 GeV using the newly developed Parton-Hadron-Quantum-Molecular-Dynamics (PHQMD) model [1]. This study provides novel insights into fluctuation behavior within the CBM energy range. The results have been compared with those obtained using the acceptance of Solenoidal Tracker at RHIC (STAR) experiment. Additionally, we calculate the cumulant ratios of net-kaon multiplicity distributions, as net-kaon fluctuations serve as effective indicators of net- strangeness fluctuations. PHQMD is a versatile model for studying heavy-ion collisions and cluster formation across diverse energies, integrating Parton-Hadron-String-Dynamics (PHSD) for QGP interactions and Quantum Molecular Dynamics (QMD) for baryon dynamics.
Our results tried to establish a baseline for understanding the fluctuations, aiding in the search for potential critical behaviors near the critical endpoint on the phase diagram in the CBM energy range.
Ref: 1. J. Aichelin et al., Phys. Rev. C 101 4, 044905 (2020)

Category

Experiment

Collaboration (if applicable)

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