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Probing of Equation-of-State at High Baryon Density with Baryons and (Hyper)nuclei with the PHQMD Model

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The equation-of-state (EoS) at high baryon density is crucial for understanding the behavior of nuclear matter under extreme conditions. The directed flow of protons and Λ baryons has long been recognized as a sensitive probe of the high-density equation of state (EoS). Moreover, the transverse momentum and rapidity distributions, as well as the collective flow of light nuclei and hypernuclei, offer valuable opportunities to further explore and enhance the sensitivity to the properties of high-baryon-density matter.

We employ the Parton-Hadron-Quantum-Molecular Dynamics (PHQMD) model to investigate the sensitivity of various observables to different equation-of-state scenarios. We consider two static EoS models, labeled "soft"and "hard", which differ in compressibility modulus, as well as a momentum-dependent soft EoS model. In PHQMD, (hyper)nuclei are formed dynamically throughout the entire heavy-ion collision by the potential interaction between nucleons, which is sensitive to the EoS.

In this talk, we will show our recent PHQMD results compared with experimental data from STAR at $\sqrt{s_{\mathrm{NN}}} =$ 3 GeV, HADES at $E_{\mathrm{kin}} = 1.23A$ GeV, and FOPI at $E_{\mathrm{kin}} = 1.2A$ and $1.5A$ GeV in Au+Au collisions. We find that the production and collective flow of light nuclei and hypernuclei are very sensitive to the choice of the nuclear equation of state. By studying these observables, we can extract valuable information about the underlying nuclear interactions and the properties of dense baryonic matter. Our results demonstrate that hypernuclei can serve as powerful probes of the high-density EoS, offering new insights for upcoming experiments such as CBM at FAIR.

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