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Probing initial baryon stopping and equation of state with rapidity-dependent directed flow of identified particles

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Using a (3+1)-dimensional hybrid framework with parametric initial conditions, we study the rapidity-dependent directed flow $v_1(y)$ of identified particles, including pions, kaons, protons, and lambdas in heavy-ion collisions. Cases involving Au+Au collisions are considered, performed at $\sqrt{s_{\rm NN}}$ ranging from 7.7 to 200 GeV. The dynamics in the beam direction is constrained using the measured pseudo-rapidity distribution of charged particles and the net proton rapidity distribution. Within this framework, the directed flow of mesons is driven by the sideward pressure gradient from the tilted source, and that of baryons mainly due to the initial asymmetric baryon distribution with respect to the beam axis driven by the transverse expansion. Our approach successfully reproduces the rapidity- and beam energy-dependence of v_1 for both mesons and baryons. We find that the $v_1(y)$ of baryons has strong constraining power on the initial baryon stopping, and together with that of mesons, the directed flow probes the equation of state of the dense nuclear matter at finite chemical potentials. We also provide predictions for the upcoming STAR Beam Energy Scan II measurements of the pseudo-rapidity dependent v_1 for charged particles at 27 GeV.

[1] L. Du, C. Shen, S. Jeon, and C. Gale, "Probing initial baryon stopping and equation of state with rapidity-dependent directed flow of identified particles", arXiv: 2211.16408.

Category

Theory

Collaboration (if applicable)

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