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Vortical structure and the effects on directed flow in non-central relativistic heavy-ion collisions from a multiphase transport model

With the extreme temperatures and energy densities generated by ultra-relativistic heavy-ion collisions, a new state of matter—Quark-Gluon-Plasma (QGP), with surprising fluid properties will be cr sions can generate a large initial angular momentum, resulting in strong vorticity of $\omega \approx (9 \pm 1) \times 10^{21} s^{-1}$ in the fluid, estimated from the global Λ hyperon polarization measurements in Au+Au collisions. This vortical structure may change the azimuthal distribution of the particle produced in the QGP.

We study the global and local vortical structure during the parton expansion phase and the directed flow (v_1) of final charm and light flavor hadrons in Au+Au collisions based on a multiphase transport model (AMPT) framework. We find that inharmonious expansion dominates the parton dynamics, and the integral vorticity depends on the rapidity and momentum of the parton. We also initially input a global vortical pattern caused by the instant electromagnetic field into the partonic interaction phase. This initial global vortex will dissipate quickly during the parton expansion phase. But the dv_1/dy as a function of rapidity for final pion, kaon, protron and D-meson is changed compared to the default AMPT. The differences in the dv_1/dy between positive and negative charged particles are also studied and the values are comparable to the measurements at RHIC energy. These findings are expected to guide us to better understand and constrain the fireball's vorticity with the v_1 measurements in ultra-relativistic heavy-iron collisions.

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