

Probing initial longitudinal geometry and electromagnetic field with directed flows of soft and heavy flavor hadrons

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Relativistic heavy-ion collisions provide a unique opportunity to investigate properties of nuclear matter under extremely strong electromagnetic field. Using a heavy quark transport model that includes both collisional and radiative energy loss of heavy quarks, coupled to a (3+1)-dimensional viscous hydrodynamic model CLVisc, we study the initial longitudinal energy density distribution and the time evolution of electromagnetic field via both soft and heavy flavor hadron observables. With a systematic comparison between three different initial energy density profiles –Božek-Wyskiel, CCNU (Phys.Rev.C 104 (2021) 6, 064903) and Shen-Alzhrani, we find a counter-clockwise tilt of the initial geometry in the reaction plane is crucial for understanding the rapidity dependence of directed flow (v_1) of both soft hadrons and D mesons at RHIC and LHC (Phys.Rev.C 105 (2022) 3, 034901). Meanwhile, the difference of v_1 between D and Dbar is shown to be sensitive to the time evolution behavior of the electromagnetic field that generates opposite forces on c and cbar. This time evolution behavior is shown to be further constrained by the elliptic flow (v_2) of soft hadrons due to the force density (squeezing effect) induced by the magnetic field inside the paramagnetic QGP medium. Therefore, a simultaneous description of soft and heavy flavor hadron v_1 and v_2 is required for a stringent constraint on the properties of electromagnetic field produced in high-energy nuclear collisions. Additional observables, such as the v_1 (and Δv_1) of heavy flavor decayed leptons are predicted, which can be tested by experimental measurements in the near future(submit to PRC).

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