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The most vortical baryonic matter

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The study of strongly interacting matter under external conditions (such as high temperatures and/or baryon densities) provides unique insights into its fundamental theory, Quantum Chromodynamics (QCD). A nonzero angular momentum imposed on a QCD system can bring rich and intriguing phenomena, with the proton spin structure being a perfect example. A much larger QCD system with substantial angular momentum, produced by non-central heavy ion collisions, has attracted a lot of interest recently. This angular momentum induces nontrivial vortical fluid patterns in the fireball formed by the collision and eventually leads to spin polarization of final state hadrons, as shown by experimental measurements from the STAR, ALICE and HADES Collaborations. A clear understanding of the angular momentum initial conditions for the fireball, such as the total amount and its rapidity distribution, is, however, still lacking. In this talk, we demonstrate how baryon stopping plays a key role for the deposition of angular momentum toward the mid-rapidity region. By calculating rapidity loss after multiple binary collisions for wounded nucleons, we quantify the angular momentum initial conditions for heavy ion collisions from GeV to TeV beam energies. This also allows us to explain the beam energy dependence of experimental data for spin polarization as well as to reveal a nontrivial correlation between net baryon number and initial angular momentum in the fireball. Finally we introduce the ratio of angular momentum to net baryon number as a measure for comparing "spinning-ness"and show that the most spinning baryonic matter, created in heavy ion collisions at energies of a few GeV, is about an order of magnitude higher than a proton in terms of this measure.

Category

Theory

Collaboration (if applicable)

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