Observation of the Chiral Magnetic Effect in the Quark-Gluon Plasma Produced in Au+Au Collisions at the Relativistic Heavy Ion Collider

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Quantum Chromodynamics (QCD), or the theory of the strong interaction, states that at the high temperatures and densities produced in relativistic heavy-ion collisions, nucleons de- confine into their elementary constituents to create a plasma of chiral quarks and gluons, or the Quark Gluon Plasma (QGP). The large magnetic fields produced in the same collisions, can drive a chiral transport of the quarks in the QGP to generate an electric current and an ultimate separation of the positively and negatively charged particles emitted along the direction of the magnetic field. Studies of this so-called Chiral Magnetic E↵ect (CME) are crucial to the development of a detailed understanding of the properties of the QGP, as well as symmetry violations in QCD. This study was designed to observe and measure a CME- driven charge separation in Au+Au collisions from STAR data, using a new charge-sensitive in-event correlator that gives discernible responses for CME-driven charge separation and non-CME background-driven charge separation. The measurements show a characteristic concave distribution for charge separation about the event plane which signals the presence of an unambiguous charge separation induced by chiral transport of quarks in the QGP. The magnitude of the concave distribution, which is an estimate of the CME strength, increased as centrality increased as expected. This observation of CME provides an essential step toward a more fundamental understanding of anomalous transport in the QGP, and the interplay of chiral symmetry, axial anomaly, and gluonic topology.

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Third Award of $1,000