STAR measurements on charge-dependent correlations in 27 GeV Au+Au collisions to search for the Chiral Magnetic Effect

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Abstract

The hot and dense medium created in relativistic heavy-ion collisions have been conjectured to be accompanied by an imbalance of axial charge leading to difference in the number of right-handed and left-handed quarks. Such an imbalance leads to a separation of electric charge in the direction of the extremely strong (10^{18} Gauss) magnetic field (B), produced by the protons in the colliding heavy ions [1]. This phenomenon is known as the Chiral Magnetic Effect (CME) and finding a conclusive experimental signature of it has become one of the major scientific goals of the heavy-ion physics program at the Relativistic Heavy Ion Collider (RHIC) [2]. A similar phenomenon of charge separation along the B-field direction has also been observed in condensed matter systems [3]. The observability of the CME in heavy-ion collisions has been argued to strongly depend on collision energy due to change in magnetic field lifetime, the domain size of axial charge imbalance and also on the possibility of formation of a medium where quarks and gluons are deconfined and the chiral symmetry of Quantum Chromodynamics is restored. The background contribution to the CME is also expected to change with the collision energy. While the studies of isobar collisions are ongoing at the STAR (Solenoidal Tracker At RHIC) experiment to make a decisive test of CME at top (200 GeV) RHIC energy. In this study, we present an analysis of a high statistics data sample of Au+Au 27 GeV collisions taken by STAR in the year 2018 with the newly installed Event-Plane Detector (EPD). At 27 GeV, the rapidity of colliding beam ($Y_{\rm beam}$=3.4) falls in the acceptance of EPD ($2.1 < |\eta| < 5.1$). Such unique kinematics enable us to use the inner half of EPD to measure the plane enriched with the spectator protons that generate (and highly correlated to) B-field. Similarly, the outer half of EPD measures the plane of the produced particles that is weakly correlated to the B-field. We compare the angular correlations of charged particles across these two planes to investigate if there is any evidence of charge separation along the direction of the B-field. Our results provide important insights on the search for the CME at lower collision energies.

References:

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2. Abelev et al. (STAR Collaboration), Phys. Rev. Lett. 103, 251601
3. Li et al., Nature Phys. 12 (2016) 550-554