Search for the Chiral Magnetic Effects Using Event Shape Selection with BES-II data at STAR

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Abstract

Heavy-ion collisions provide unique opportunities to probe the topological sector of Quantum Chromodynamics via chiral anomaly. However, experimental observables related to the predicted chiral magnetic effect (CME) are intrinsically convoluted with backgrounds related to elliptic flow and nonflow. Recently, the STAR experiment has revealed significant background contributions in the CME search using isobar collisions, preventing an unambiguous observation of the CME signal. We have developed a new analysis technique based on event shape selection (ESS) relying on variations of particle emission pattern to suppress the flow background in $\Delta\gamma$ measurements and applied it to the STAR Beam Energy Scan (BES) II data. The Au+Au system produces more intense magnetic fields than the isobars, while collisions at lower beam energies provide a longer-lasting magnetic field. The STAR Event Plane Detector enables us to construct the spectator plane with a good resolution, which better represents the magnetic field direction and effectively suppress the nonflow background. Using particles of interest to build the ESS variable, we project the $\Delta\gamma$ correlator to the apparent zero-flow limit. We will contrast our ESS with the method of Event Shape Engineering proposed in the literature[1]. Besides the single particle information, we also utilize particle pair momentum to systematically evaluate the residual background. We report the $\Delta\gamma$ measurements using h-h (excluding protons) in Au+Au collisions at $\sqrt{s_{\rm NN}}$ = 7.7, 11.5, 14.6, 19.6, and 27 GeV, and demonstrate a five-fold reduction of background. We will discuss the physics implications of the new results for the CME searches.

References

[1] J. Schukraft, A. Timmins, S. A. Voloshin, Phys. Lett. B **719**, 394 (2013).