

Search for the Chiral Magnetic and Vortical Effects Using Event Shape Variables in Au+Au Collisions at STAR

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Abstract

Effects from quark chirality in heavy-ion collisions probe the topological sector of Quantum Chromodynamics, where parity and charge-parity symmetries are violated locally in strong interactions. However, the experimental observables for the chiral magnetic/vortical effect (CME/CVE) are dominated by elliptic flow and nonflow backgrounds. Recent STAR isobar data revealed a substantial background in the CME observable that prevented an unambiguous observation of the difference between two isobars. The Au+Au system has significant advantages over the isobar collisions, such as the larger magnetic fields and the lower statistical fluctuations. We improve the analysis method with event shape variables (ESV), and apply it to Au+Au collisions at $\sqrt{s_{NN}} = 7.7, 14.6, 19.6, 27,$ and 200 GeV in the search of the CME and CVE. After categorizing events based on ESV and extrapolating the CME/CVE observable towards zero flow limit, we report the $\Delta\gamma$ measurements using h - h and Λ - p correlations. To fully assess the possible CME signal, we employ a broad spectrum of observables and analysis techniques: with and without the particle pair information in constructing ESVs, utilizing invariant mass for differential studies, exploiting STAR Event Plane Detector and Zero-Degree Calorimeter to minimize nonflow backgrounds. We will discuss the physics implications on the beam energy dependence of the CME/CVE searches.