Contribution ID: **836** Type: **Poster**

Response studies of the CME-sensitive sine observable to heavy ion backgrounds

Tuesday, 15 May 2018 19:10 (30 minutes)

A new sine observable, $R(\Delta s)$, has been proposed [1] to measure the Chiral Magnetic Effect (CME) in heavy ion collisions, where Δs is the $\langle \sin \phi \rangle$ difference between positive and negative charges (ϕ is the particle azimuth) and $R(\Delta s)$ is the ratio of the out-of-plane to in-plane Δs distributions. Studies with A Multi-Phase Transport (AMPT) and Anomalous Viscous Fluid Dynamics (AVFD) models show concave R(Δs) distributions for CME signals and convex ones for typical resonance backgrounds [1]. A recent hydrodynamic study, however, indicates concave shapes for backgrounds as well [2]. Preliminary STAR data, on the other hand, reveal concave $R(\Delta s)$ distributions in 200 GeV Au+Au collisions.

To better understand these results, we present a systematic study of the v_2 and p_T dependences of resonance backgrounds by toy-model simulations, based on the toy model used in our previous study [3]. The resonance v_2 introduces different numbers of decay $\pi^+\pi^-$ pairs in the in-plane and out-of-plane directions. The resonance p_T affects the opening angle of the decay $\pi^+\pi^-$ pair. Low p_T resonances decay into large opening-angle pairs, and result in more "back-to-back" pairs out-of-plane because of the more in-plane resonances, mimicking a CME charge separation signal perpendicular to the reaction plane, or a concave $R(\Delta s)$. High p_T resonances, on the other hand, decay into small opening-angle pairs, and result in a background behavior of convex $R(\Delta s)$. With this toy-model insight, we further investigate the responses of the $R(\Delta s)$ observable to AMPT backgrounds and AVFD CME signals,and the possible implications of the preliminary STAR data.

[1] N. Magdy, S. Shi, J. Liao, N. Ajitanand and R. A. Lacey, arXiv:1710.01717

[2] P. Bozek, arXiv:1711.02563

[3] F. Wang, J. Zhao, Phys. Rev. C95, 051901 (R) (2017)

Content type

Theory

Collaboration

Centralised submission by Collaboration

Presenter name already specified

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Session Classification: Poster Session

Track Classification: Chirality, vorticity and polarisation effects