Charge-dependent correlations relative to the 4th-harmonic event plane in Au+Au collisions at 27 and 39 GeV at RHIC/STAR

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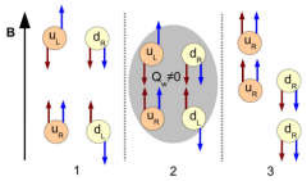
Abstract

In the chiral magnetic effect (CME), an electric current is induced in the presence of a chirality imbalance and the strong magnetic field created in high-energy nuclear collisions. One corresponding observable for the charge separation across the reaction plane ψ_{RP} is the charge-dependent two-particle azimuthal correlator, $\gamma_{112} = \langle\cos(\phi_\alpha + \phi_\beta - 2\psi_{RP})\rangle$. However, the γ_{112} contains both the CME signal and the flow background, complicating the interpretation of the data. In this poster we investigate the background mechanism with a modified correlator, $\gamma_{224} = \langle\cos(2\phi_\alpha + 2\phi_\beta - 4\psi_{RP})\rangle$. The γ_{224} only contains the background, and reflects the role played by the collective flow in the original γ_{112} correlator. We present the STAR data of γ_{224} as a function of centrality measured in Au+Au collisions at 27 and 39 GeV. The results will be compared with those obtained by the ALICE experiment at a much higher collision energy, and will also be compared with model calculations. The physics implications will be discussed.

Introduction

◊**Chiral Magnetic Effect (CME) -** Results from the strong magnetic field created in nuclear collisions and a local chirality imbalance; creates an electric current along B field.

$$\vec{J} = \frac{e^2}{2\pi^2}\mu_5\vec{B}$$

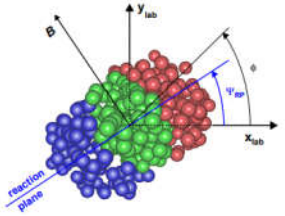


◊To search for a possible CME, one can study the Fourier series of the charged particle azimuthal distribution of produced particles:

$$\frac{dN}{d\phi} = 1 + 2\,v_1\langle cos(\phi - \Psi)\rangle + 2v_2\langle cos(2(\phi - \Psi))\rangle + \ldots + 2a_1 sin(\phi - \Psi)$$

Directed flow — Elliptic flow

where
$v_n = \langle\cos(n(\phi - \Psi))\rangle$
a is charge separation
n are flow harmonics



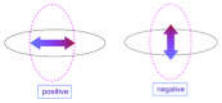
Motivation

◊The three-point correlator, γ_{112}, correlates a pair of particles with respect to the reaction plane ψ_{RP} :

$$\gamma_{112} = \langle\cos(\phi_\alpha + \phi_\beta - 2\psi_{RP})\rangle$$
$$= [\langle v_{1,\alpha}v_{1,\beta}\rangle + B_{in}] - [\langle a_{1,\alpha}a_{a,\beta}\rangle + B_{out}]$$

where α is the sign of electric charge.

Directed flow fluctuations relative to the elliptic flow plane

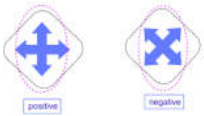


This correlation with respect to the second-harmonic plane contains CME charge separation signal as well as flow-related background.

◊For the new correlator γ_{224} all angles have been doubled:

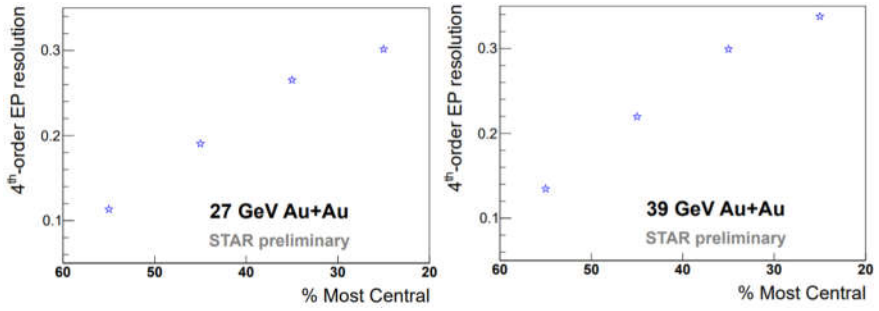
$$\gamma_{224} = \langle\cos(2\phi_\alpha + 2\phi_\beta - 4\psi_{RP})\rangle$$

Elliptic flow fluctuations relative to the quadrangular flow plane

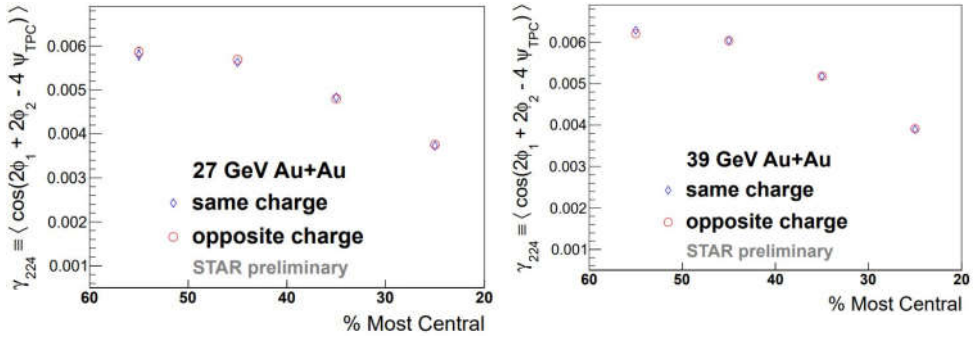


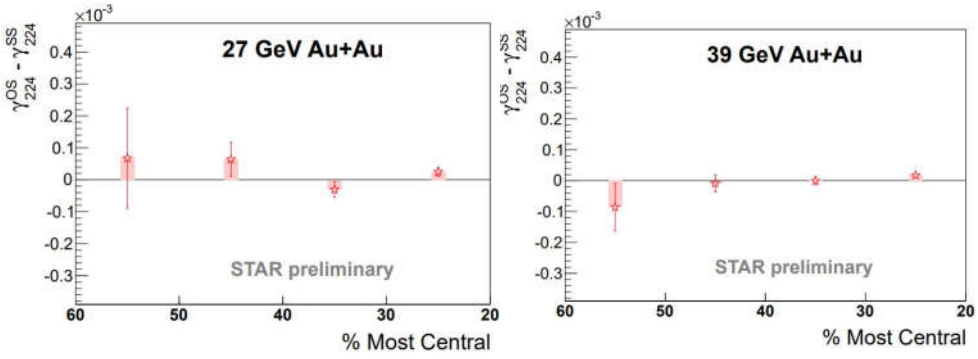
Correlations measured with respect to the fourth-harmonic plane should not contain any CME contribution.

Event Plane (EP) Reconstruction



STAR Results





Summary

◊ The original γ_{112} correlator contains the CME signal and background.

◊ We studied γ_{224} because it gives an insight to only flow-related background.

◊ Next would be to explore $\gamma_{123} = \langle\cos(\phi_\alpha - 2\phi_\beta - 3\psi_{RP})\rangle$ which would allow for a more accurate study of background vs. CME signal.

Acknowledgements

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