Charge dependent azimuthal correlations using Sliding Dumbbell Method to search CME in Au+Au Collisions with AMPT

Jagbir Singh[1],* Anjali Attri[1], and Madan M. Aggarwal[1]
[1]*Department of Physics, Panjab University, Chandigarh - 160014, INDIA*

Introduction

The electric field induced by strong magnetic field created by the highly energetic moving spectators, causes the separation of charged particles along the systems angular momentum direction known as Chiral Magnetic Effect (CME) [1]. The γ-correlator ($\gamma = \langle cos(\phi_a + \phi_b - 2.\Psi_{RP})\rangle$) has been proposed for the observation of charge separation [2]. Here, ϕ_a, ϕ_a represent the azimuthal angles of the particles a, b and Ψ_{RP} is the reaction plane angle.

Measurement Technique

We are investigating charge separation using Sliding Dumbbell Method (SDM) which searches event-by-event back-to-back charge separation as expected in CME. In this method, the whole azimuthal plane is scanned by sliding a dumbbell of $\Delta\phi = 90^o$ in steps of $\delta\phi = 1^o$ while calculating Db$_\pm$ for each $\Delta\phi$ region to extract a maximum value of Db$_\pm$ in each event, which is defined as:

$$Db_\pm = \frac{N_+^{forw}}{N_+^{forw} + N_-^{forw}} + \frac{N_-^{back}}{N_+^{back} + N_-^{back}} \tag{1}$$

where, N_+^{forw} (N_+^{back}) and N_-^{forw} (N_-^{back}) is the number of positively and negatively charged particles the forward (backward) side of dumbbell. Db$_\pm^{max}$ value is obtained with an asymmetry condition, $\mid Db_{asy} \mid < 0.25$, which is defined as:

$$Db_{asy} = \frac{Pos_{ex}^{forw} - Neg_{ex}^{back}}{Pos_{ex}^{forw} + Neg_{ex}^{back}} \tag{2}$$

Here, $Pos_{ex}^{forw} = N_+^{forw} - N_-^{forw}$ ($Neg_{ex}^{back} = N_-^{back} - N_+^{back}$) denotes the positive (negative) charge excess on forward (backward) side of dumbbell. The Db$_\pm^{max}$ distributions corresponding to different centrality intervals are obtained and further divided into ten bins. γ - correlator is computed for each centrality and Db$_\pm^{max}$ binning. Background estimation is obtained by reshuffling the charges of particles and randomizing the azimuthal angles of particles in a given event.

Analysis details

To study charge separation, we are injecting CME type signal externally in final state particles by flipping the charges of the particles in the AMPT [3] generated Au+Au events at $\sqrt{s_{\rm NN}}$=200 GeV. Four different samples are obtained with CME enriched events.

- Default AMPT i.e., 0% CME.
- Charge of one negative particle is flipped in ϕ range 45-135^o and charge of one positive particle flipped in ϕ range 225-315^o i.e., Fix-1 CME.
- 50% events are taken from default AMPT and 50% events from Fix-1 i.e., 50%Def+50%Fix-1 CME.
- Same as Fix-1 CME, except for one charge, two charges are flipped in ϕ range 45-135^o (225-315^o) i.e., Fix-2 CME.

*Electronic address: jagbir@rcf.rhic.bnl.gov

For each sample we have analysed ∼2 million events selecting the tracks in pseudo-rapidity region $\mid \eta \mid < 1.0$ and transverse momentum range $0.15 < p_T < 2.0$ GeV/c.

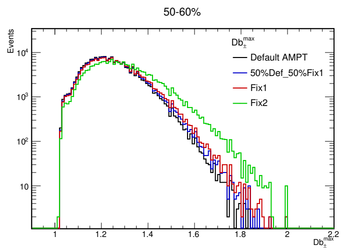

FIG. 1: Db$\pm^{max}$ distributions for 50-60% centrality.

Results and Discussion

The Db$^{max}_{\pm}$ distribution for 50-60% centrality events is presented for all CME enriched samples in Fig. 1. As the CME signal is increased the distributions shifts towards the higher value of Db$^{max}_{\pm}$.

Fig. 2 shows the $\Delta\gamma$-correlator ($\Delta\gamma = \gamma_{opp} - \gamma_{same}$) for different CME injected samples. It is seen that value of $\Delta\gamma$ increases with increase in the CME signal. Fig. 3 shows $\Delta\gamma$ versus centrality for diffrent Db$\pm^{max}$ bins.

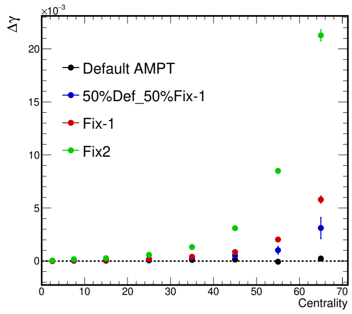

FIG. 2: $\Delta\gamma$ versus collision centrality.

The CME fraction is calculated using events having positive value of $\Delta\gamma$, from the following equation:

$$f_{CME} = \frac{\Delta\gamma_{AMPT} - \Delta\gamma_{Bkg}}{\Delta\gamma_{AMPT}} * f_{nevt} \qquad (3)$$

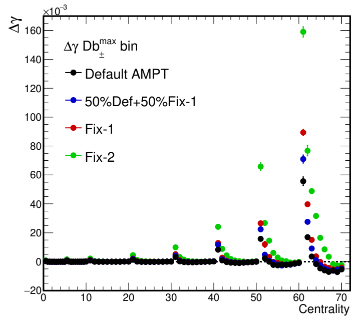

FIG. 3: The centrality dependence of $\Delta\gamma$ corresponding to different Db$^{max}_{\pm}$ values.

Fig. 4 displays f_{CME} versus centrality. It is found that fraction of events (f_{nevt}) exhibiting CME signal decreases with increasing collision centrality for different injected CME signal as seen in Fig. 3. Finally the extracted CME fraction decreases with increasing collision collision centrality. These results suggest that SDM can possibly extract CME enriched sample of events corresponding to top Db$^{max}_{\pm}$ bins.

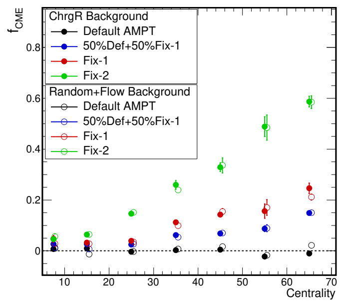

FIG. 4: CME fraction versus centrality.

References

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[3] Z. Lin *et al.*, Phys. Rev. C72 (2005) 064901.