



Chiral magnetic effect search in p+Au, d+Au and Au+Au collisions at RHIC

Jie Zhao (for the STAR collaboration) Oct. 27 2017

Purdue University, West Lafayette



- Chiral Magnetic Effect (CME)
- CME in small systems
- Results in p/d+A and A+A collisions
- Identification of backgrounds and

possible CME

Summary



Chiral Magnetic Effect (CME)

D. Kharzeev, etc. NPA 803, 227(2008)



 $j_V = \frac{N_c e}{2\pi^2} \mu_A B$, \square electric charge separation alone the B field

Configuration with non-zero topological charge (Q_w) converts left (right)handed fermions to right (left)-handed fermions, generating electric current along B direction and leading to electric charge separation

Harmonic planes in small systems

CMS collaboration, PRL 118(2017)122301; R. Belmont and J.L. Nagle, arXiv:1610.07964v1



 Ψ_2 : second-order event plane; Ψ_1 : first-order event plane

related to flow background

- \blacktriangleright Ψ_1 related to the magnetic direction (B), useful for CME signal
- > Ψ_1 and Ψ_2 correlated in A+A, signal and background entangled
- > Ψ_1 and Ψ_2 not correlated in p+A, d+A, signal and background disentangled

 Ψ_2 related to flow,

Multiplicity dependence in small systems



 $N(\alpha/\beta)$ represents the charged (+/-) particle multiplicity used for the correlator

Sizeable charge dependent signal in small system p+Au and d+Au collisions with respect to second-order event plane Ψ₂
v₂{2} with η gap of 1.0



Multiplicity dependence



> Background expectation: N dilution, proportional to flow v_2 {2}

- Right plot: if intrinsic particle pair-wise correlation is independent of N, background scenario would yield a constant as a function of N
- With topological charge sign fluctuations and magnetic field direction fluctuations, CME might yield different multiplicity dependence



Resonance decay background



Identify resonance bkg. by invariant mass



- AMPT has no CME, only background
- > AMPT show resonance structure in $\Delta \gamma$ as function of mass
- At large mass with smaller abundance difference between the unlike-sign and like-sign pairs, Δγ is consistent with zero

Identify resonance bkg. by invariant mass



DNP2017, Pittsburgh





Centrality	All (A)	M>1.5 (B)	B/A
50-80%	(7.45±0.21)E-4	(1.3±5.7)E-5	(1.8±7.6)%
20-50%	(1.82±0.03)E-4	(7.7±9.0)E-6	(4.3±4.9)%
0-20%	(3.70±0.67)E-5	(-0.1±1.8)E-5	(-3.8±49)%

- Resonance contribution of unlike minus like sign pairs decreases with increasing mass
- > At m>1.5 GeV/c², $\Delta \gamma$ is consistent with zero

Identify resonance bkg. and possible CME



Data are fitted with constant and exponential CME assumptions in mass
In the current approach, the statistical uncertainty is dominant



- > With respect to Ψ_2 : p+Au and d+Au charge dependent correlations are background. Peripheral Au+Au data are similar to that of p+Au and d+Au
- The scaled correlators from peripheral to mid-central Au+Au collisions are approximately constant over multiplicity. These data do not currently allow conclusive statements to be made regarding the presence of the CME
- > Identify resonance bkg. by the **invariant mass**
- > At m>1.5 GeV/c², $\Delta \gamma$ is consistent with zero within uncertainty
- > Observation of resonance structure in $\Delta \gamma$ at m<1.5 GeV/c². Two component fit is used to isolate the possible CME from bkg.