Separation of Chiral Magnetic Effects From Flow Effects in U+U Collisions

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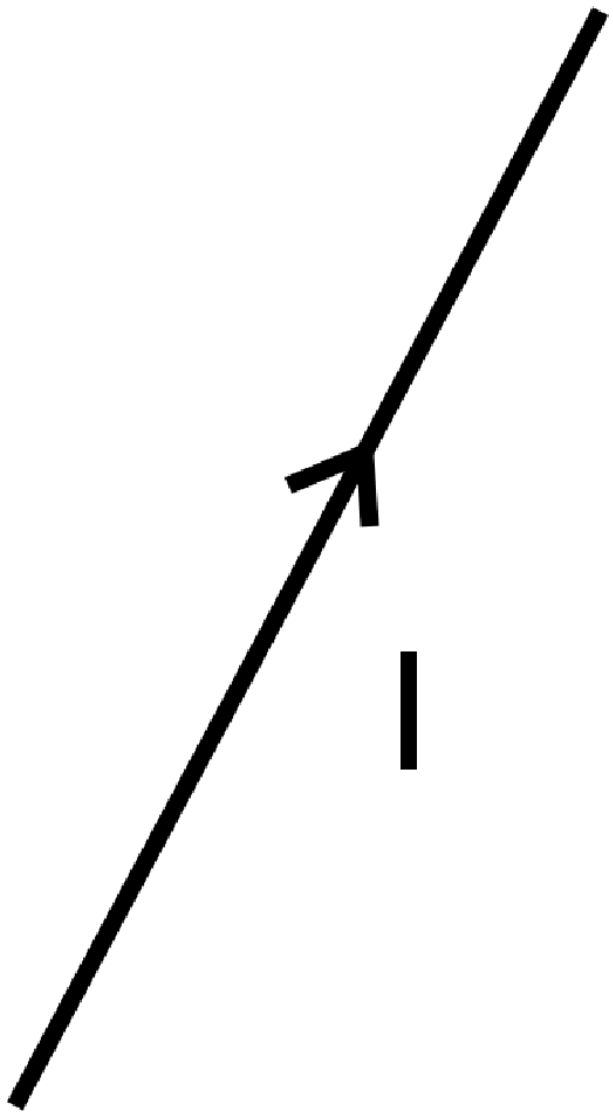
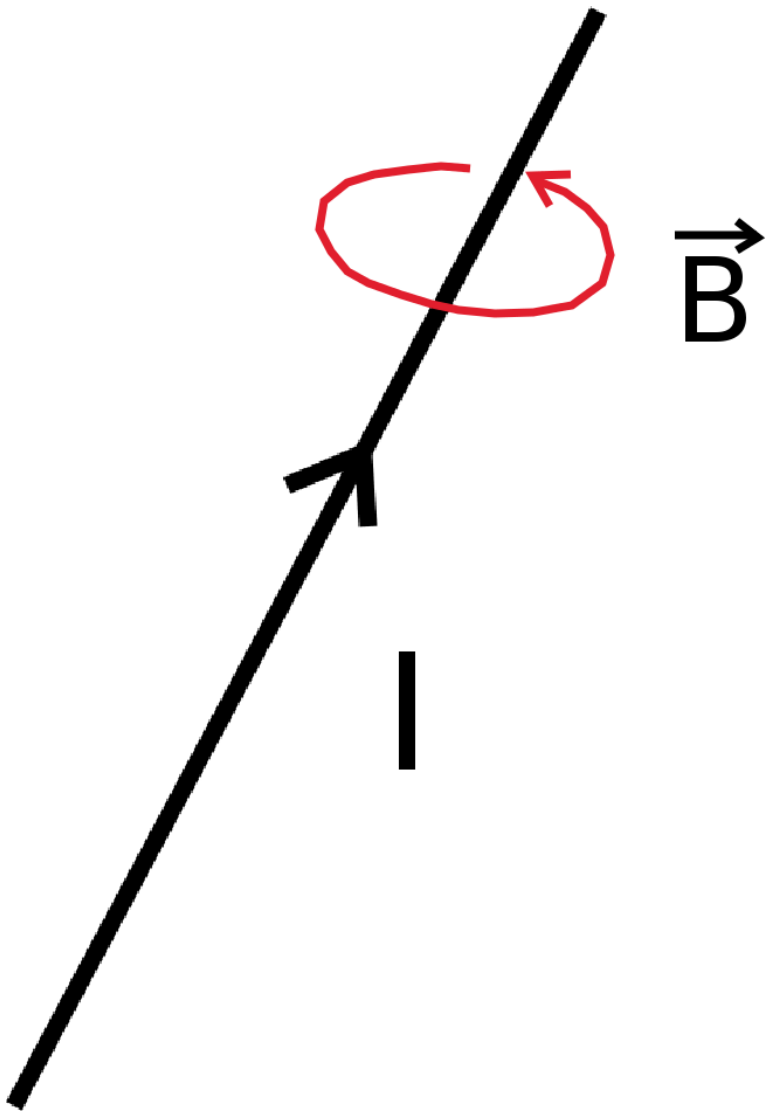
Based on 1412.5103: SC, Prithwish Tribedy

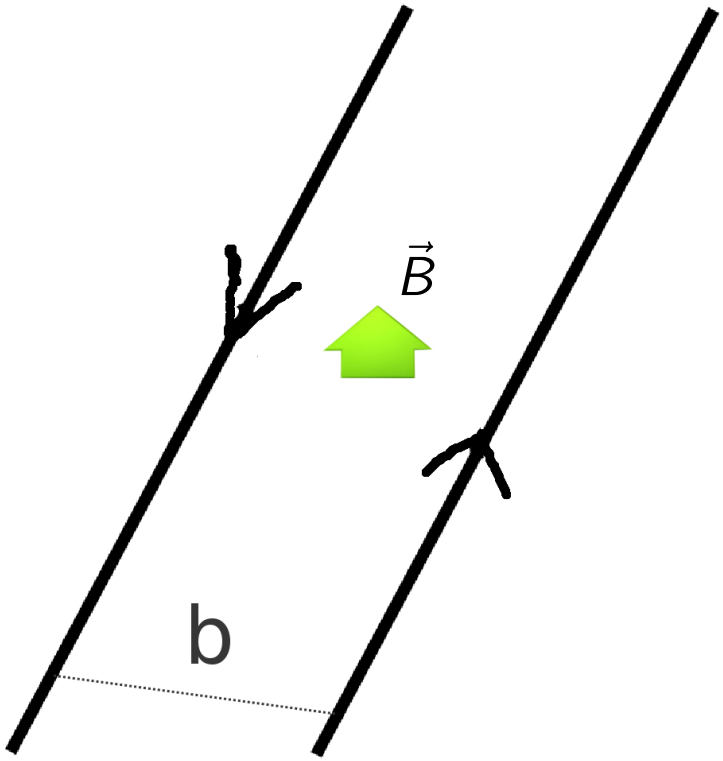
Current carrying wire



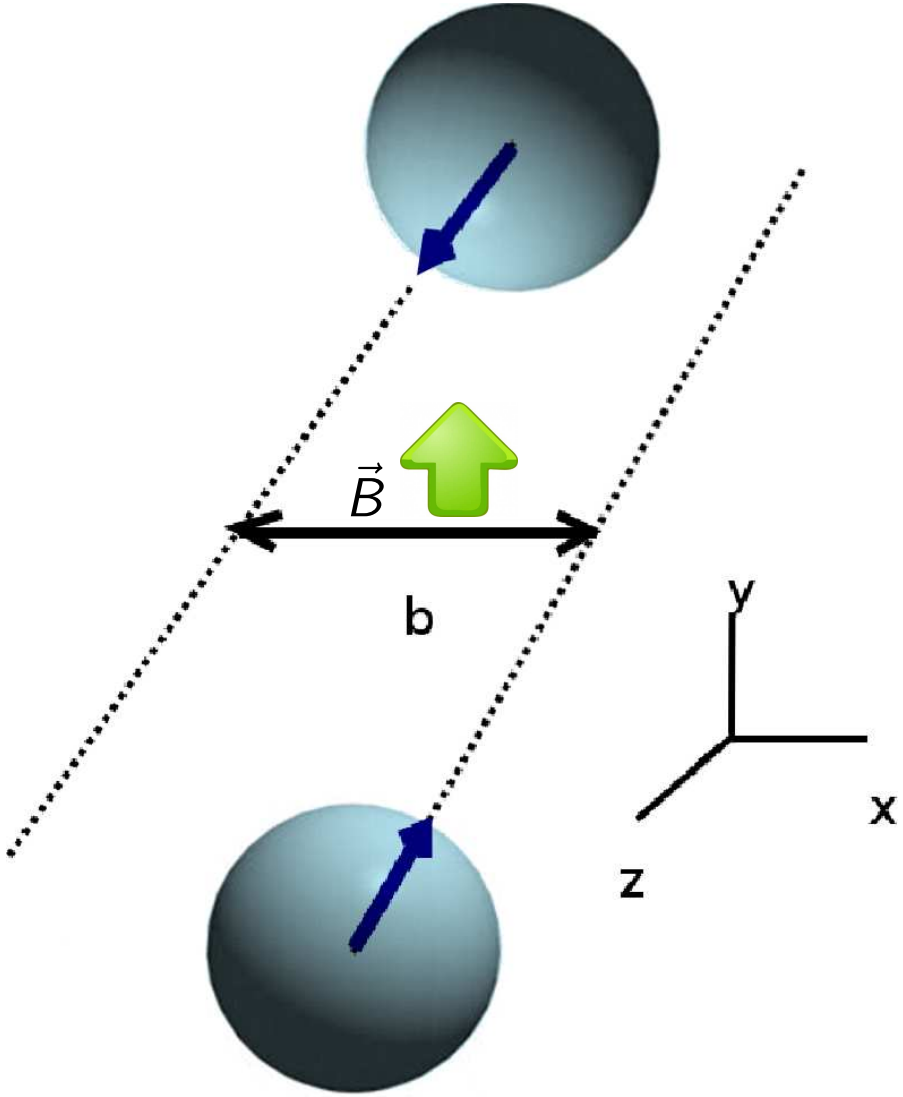
Current carrying wire: Magnetic Field



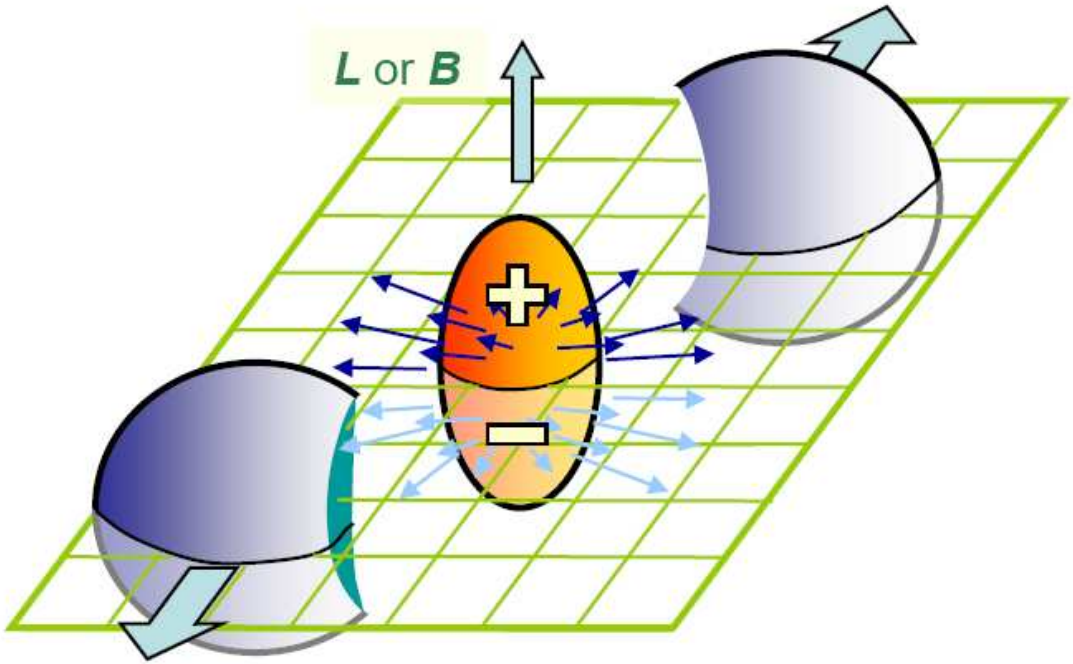
2 Current carrying wires: Magnetic Field



Magnetic Field: Heavy Ion Collision (HIC)

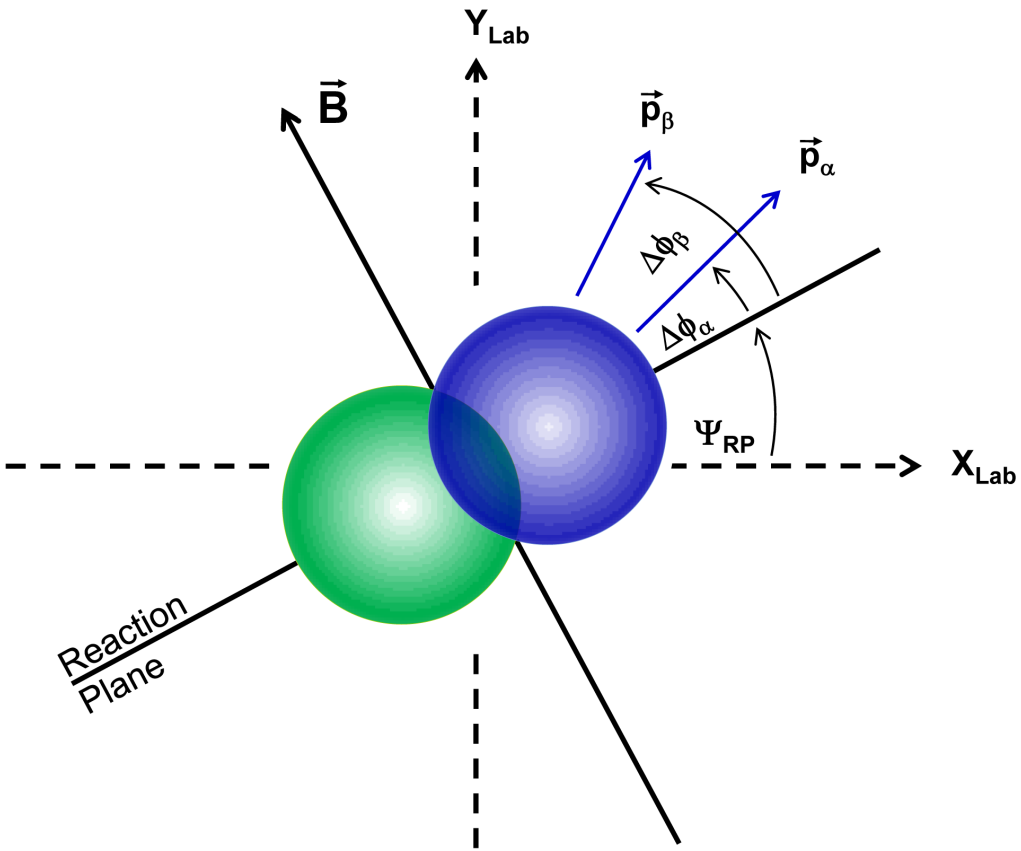


Chiral Magnetic Effect



Fukushima, Kharzeev, Mclerran, Warringa,..

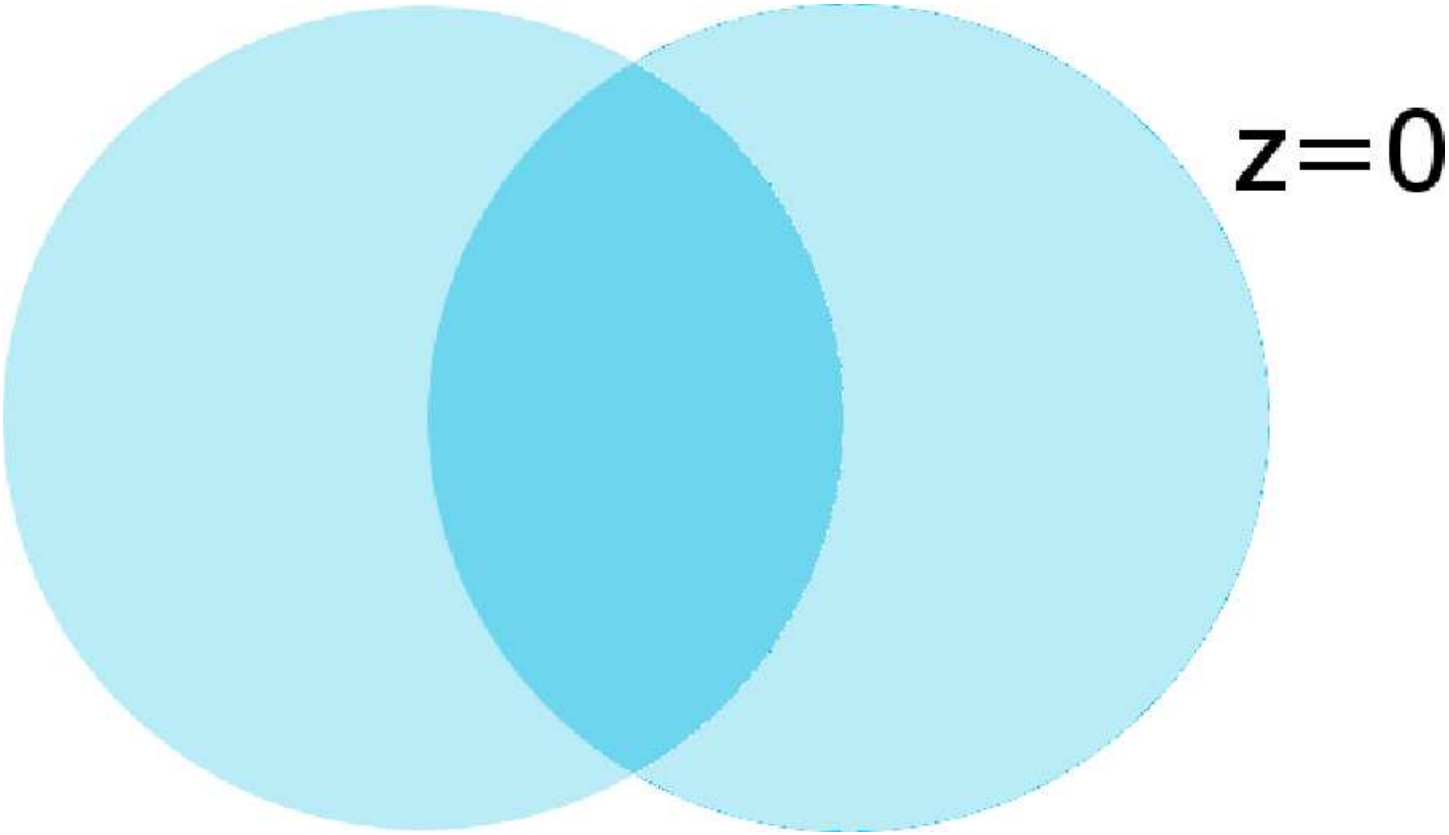
Chiral Magnetic Effect: Observable



$$\gamma^{ab} = \langle cos\left(\phi^a + \phi^b - 2\psi_{RP}\right)\rangle. \quad (1)$$

Voloshin 2004

Magnetic Field: Heavy Ion Collision (HIC)



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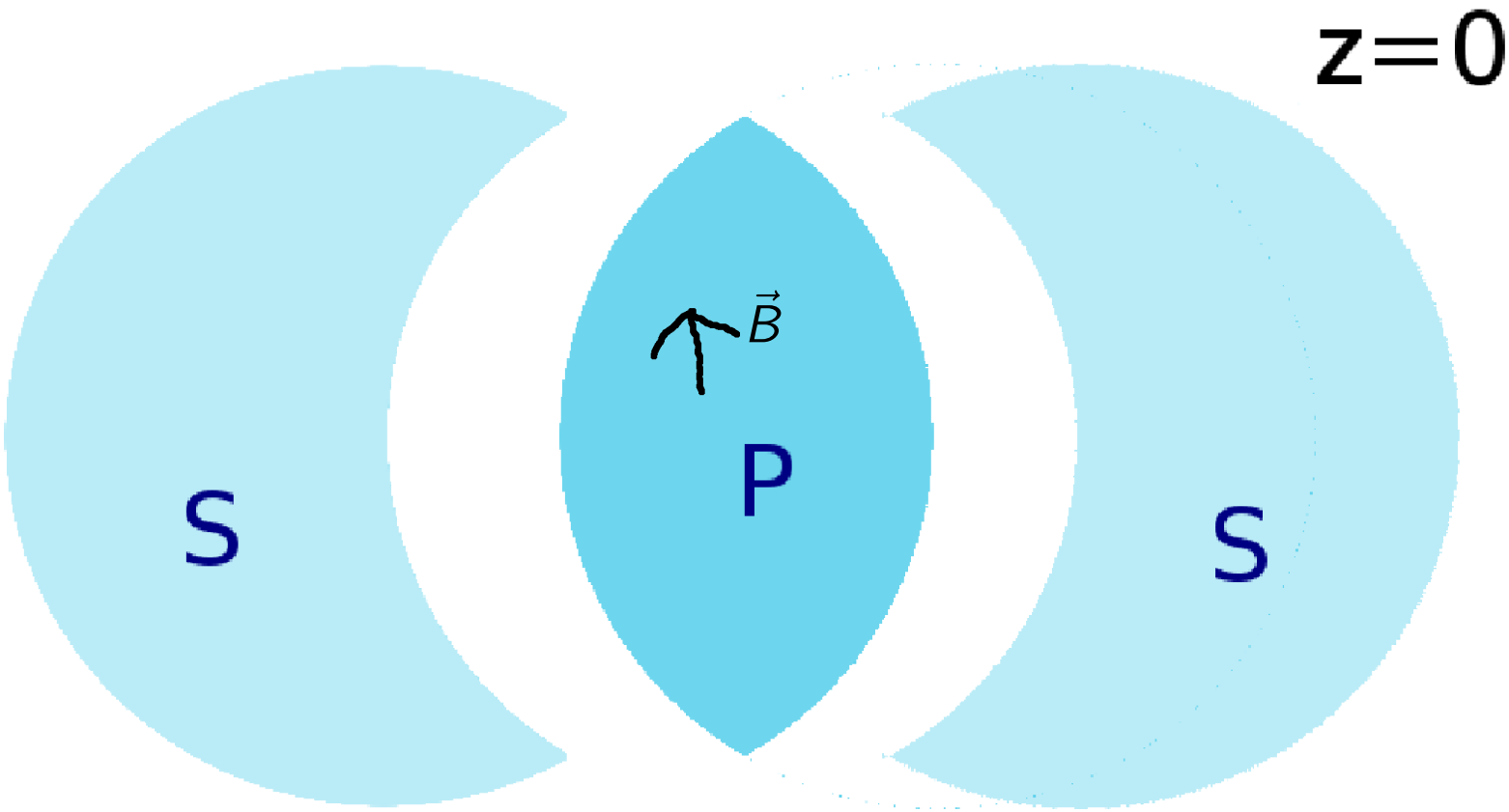
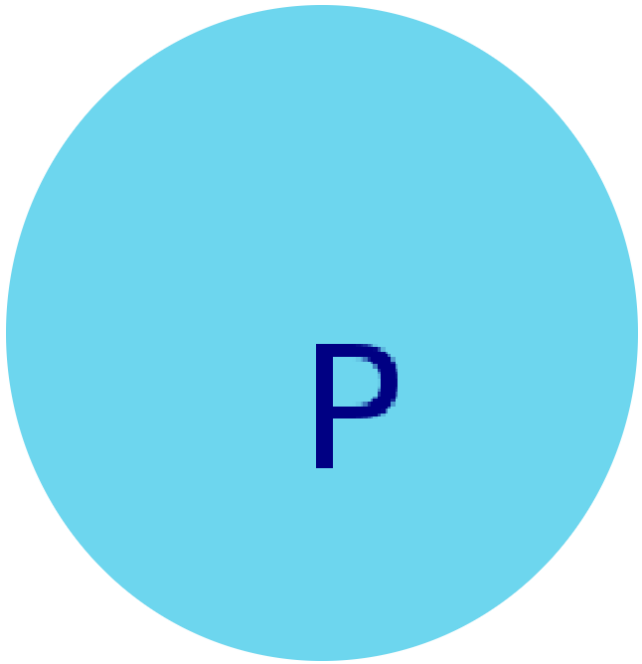
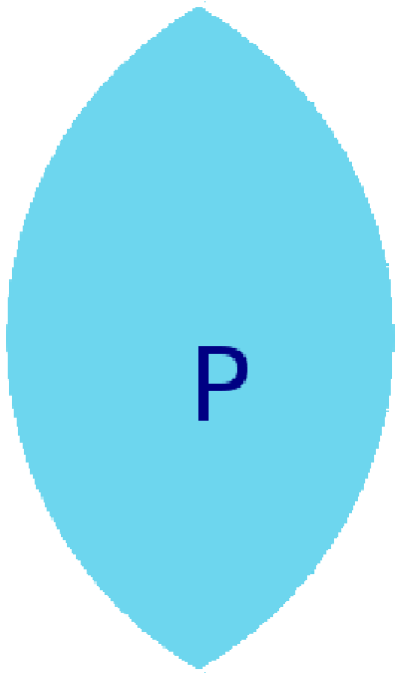


Magnetic field & Ellipticity tied up



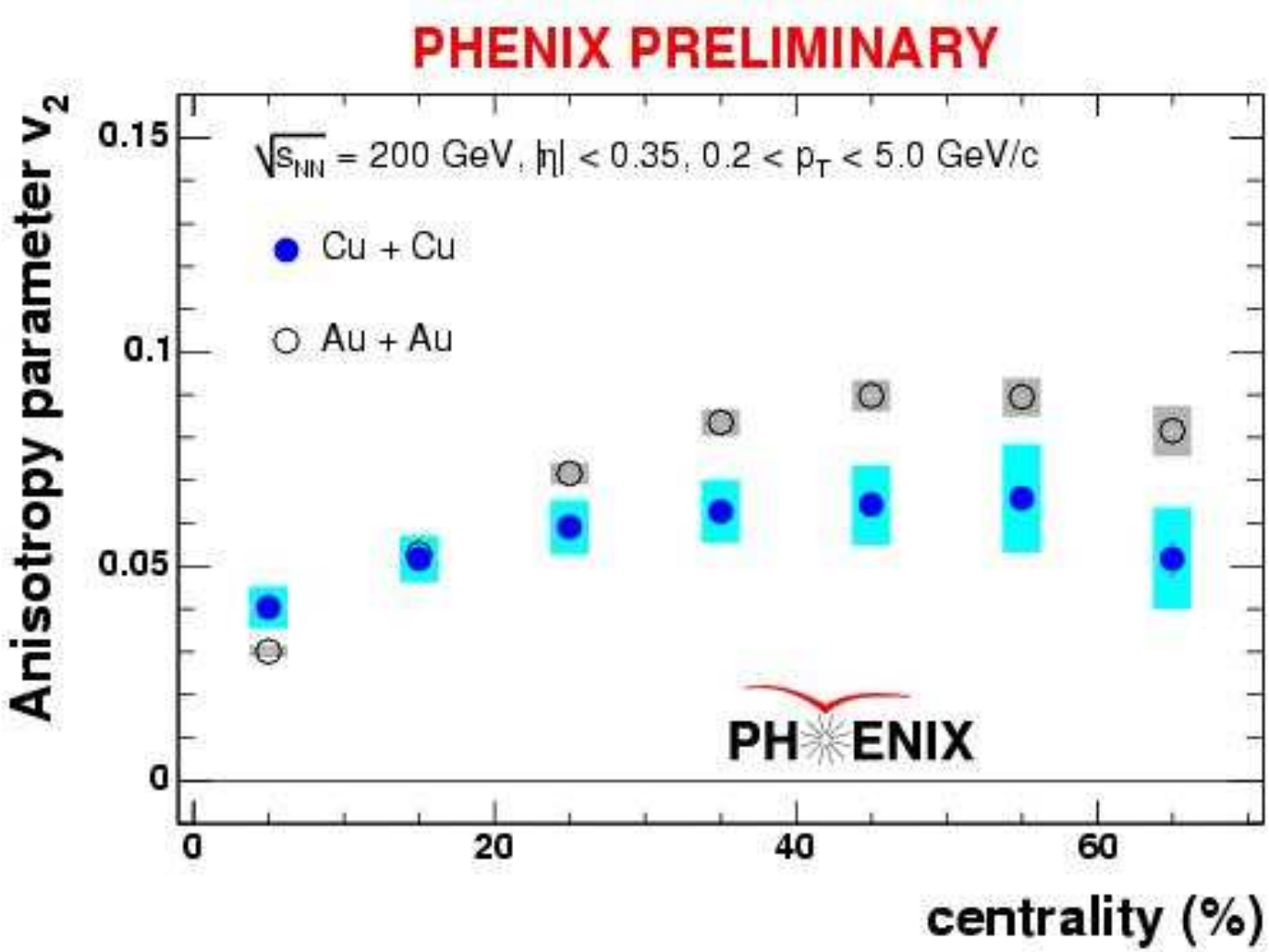
$S = 0 \implies \vec{B} = 0$. For such full overlap collisions, $\epsilon_2 = 0$ as well.

Magnetic field & Ellipticity tied up



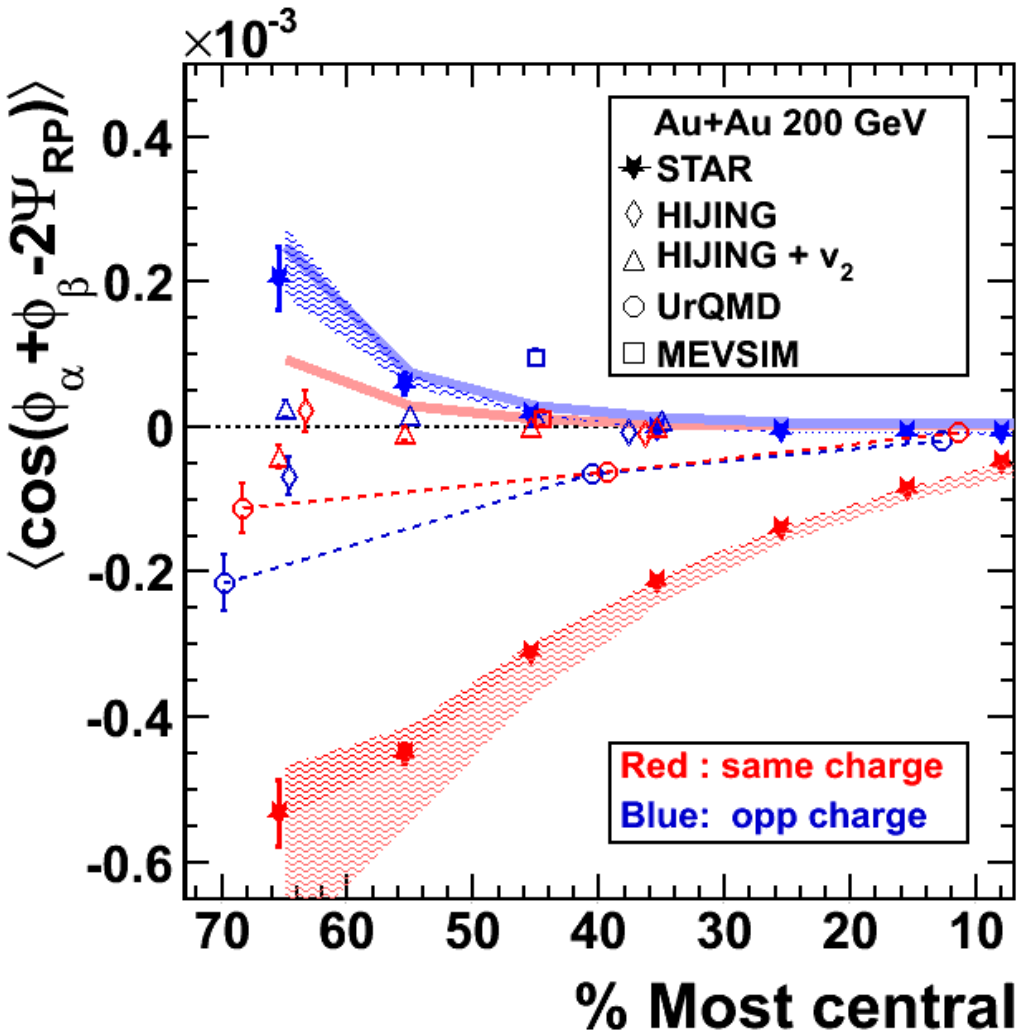
$S \neq 0 \implies \vec{B} \neq 0$. For such mid-overlap collisions, $\epsilon_2 \neq 0$ as well.

CME or v_2 ?



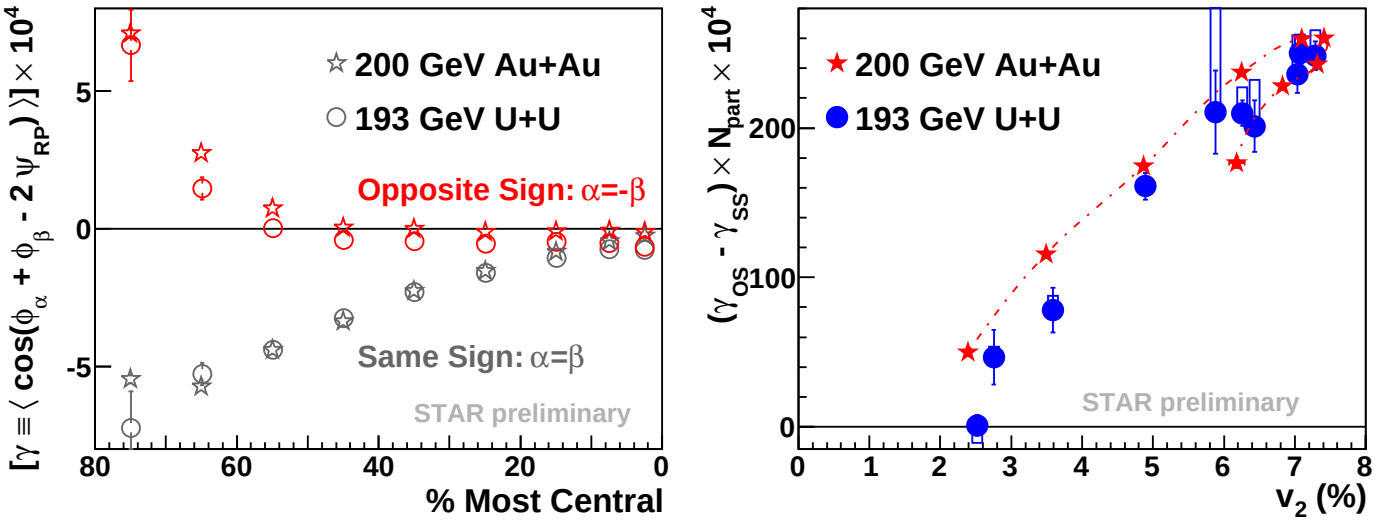
from arxiv:0329451

CME or v_2 ?



from 0909.1717

CME or v_2 ?

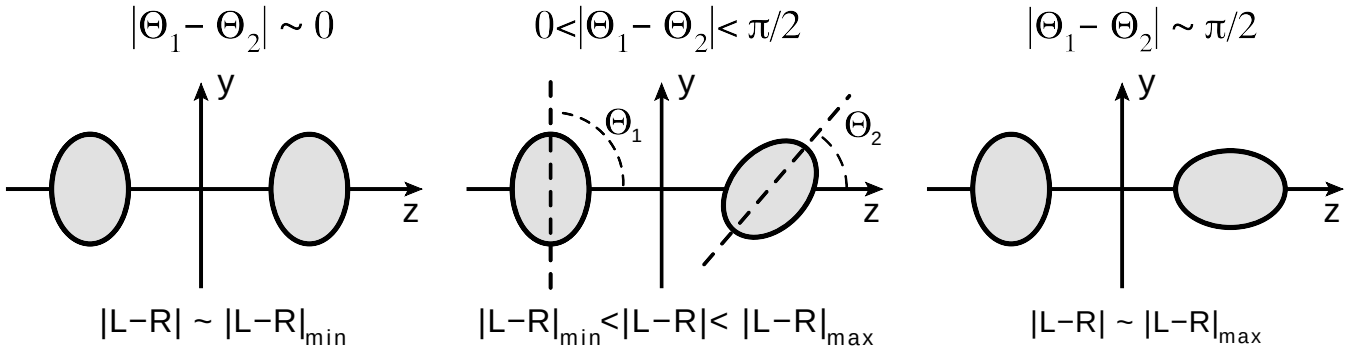


from 1210.5498

CME or v_2: Distillation Method

- Utilize the deformed geometry of U to untie v_2 and spectators ($\rightarrow \vec{B}$)
- Method:
  - Asymmetry in the number of spectators going towards right (R) and left (L) $|L - R|$ is a geometrical quantity in U+U due to deformation
  - Binning in $|L - R|$ provides an independent relationship between v_2 and spectators as compared to centrality binning $\rightarrow$ Multiple values of effective magnetic field at same v_2
  - Thus verify if γ^{ab} is (i) $\gamma^{ab}(v_2)$ or (ii) $\gamma^{ab}(v_2, B_{eff})$ or (iii) $\gamma^{ab}(B_{eff})$

Deformed Geometry: Large Spectator Asymmtery



SC, Tribedy: 1412.5103

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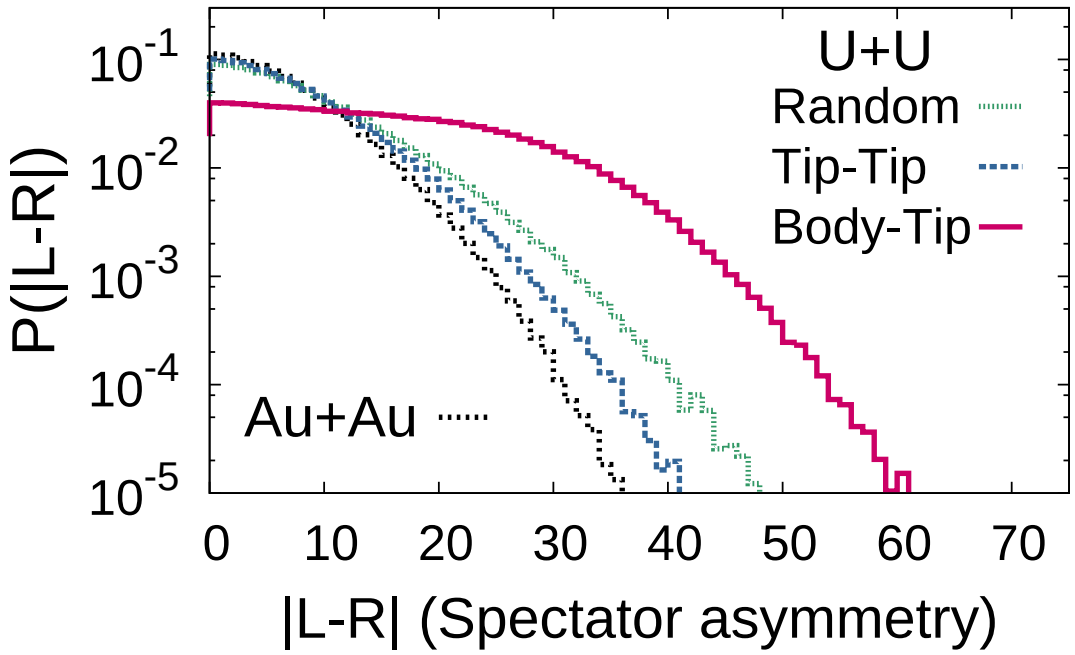

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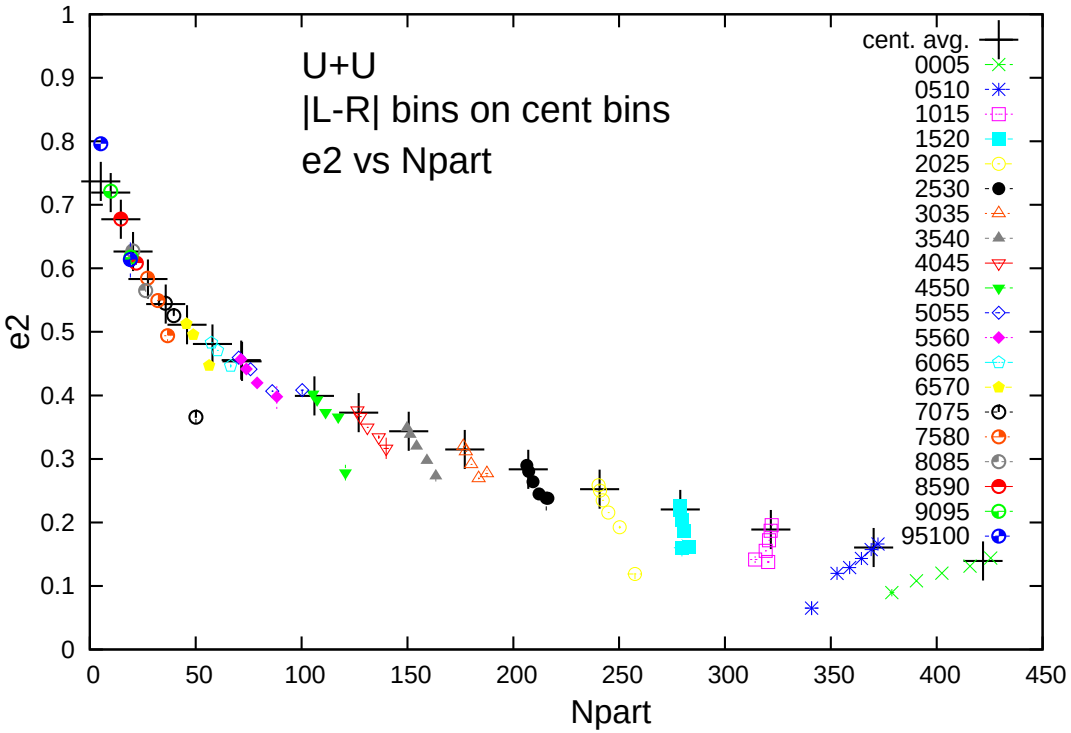
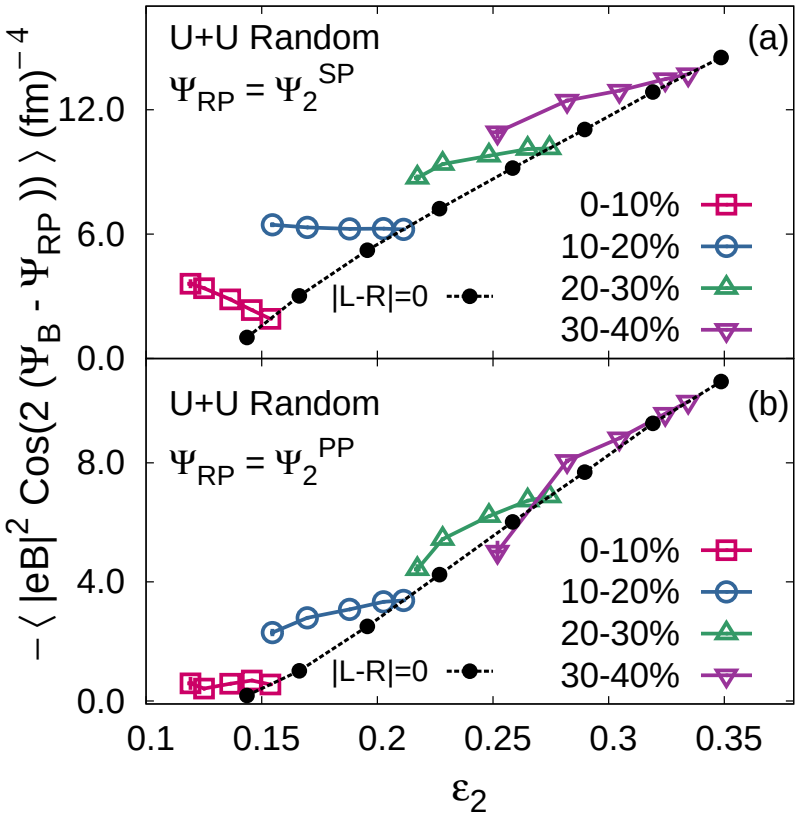
$|L - R|$ and centrality binning: Independent tuning parameters of ϵ_2



Spectator Asymmetry: Disentangles flow from CME



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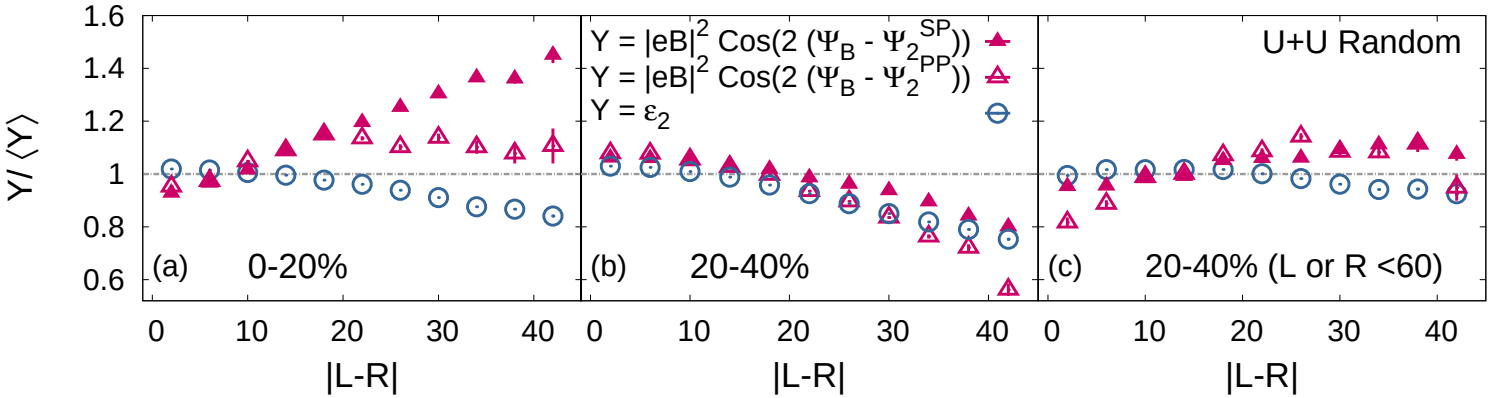

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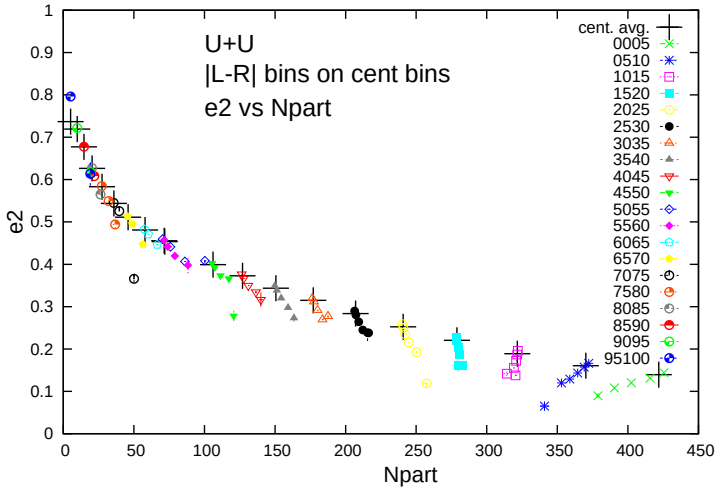
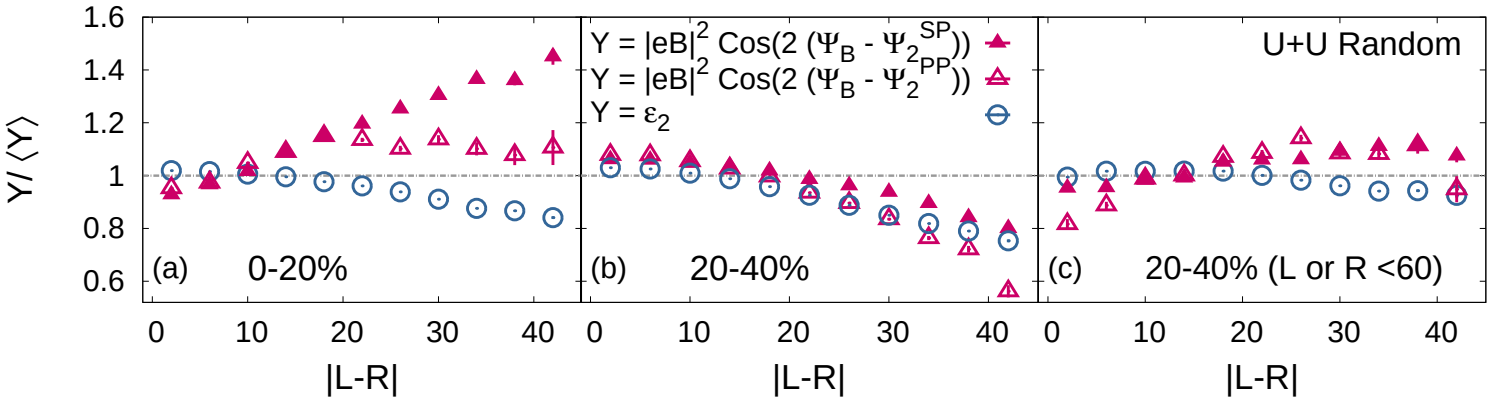
Summarising..

- Spectators decouple at the instant of collision $\rightarrow$ pristine source of initial state information
- Spectator asymmetry in deformed nucleus collision like U+U is an important quantity- initial state geometry encoded
- Thus could be applied to study different physics: jet quenching and system size, hydro response of the formed medium
- Here we demonstrated its application in disentangling flow from CME
- Role in symmetric collisions like Pb+Pb ? Purely dynamical origin, probes nucleon scale fluctuations.

Take home


U+U
|L-R| bins on cent bins
e2 vs Npart
cent. avg.
0005
0510
1015
1520
2025
2530
3035
3540
4045
4550
5055
5560
6065
6570
7075
7580
8085
8590
9095
95100
e2
Npart


Y/ ⟨Y⟩
Y = |eB|^2 Cos(2 (Ψ_B - Ψ_2^SP))
Y = |eB|^2 Cos(2 (Ψ_B - Ψ_2^PP))
Y = ε_2
U+U Random
(a) 0-20%
(b) 20-40%
(c) 20-40% (L or R <60)
|L-R|