

Interplay of QCD and Electromagnetism in Heavy-Ion Collisions

(Ho-Ung Yee, UIC/RBRC)

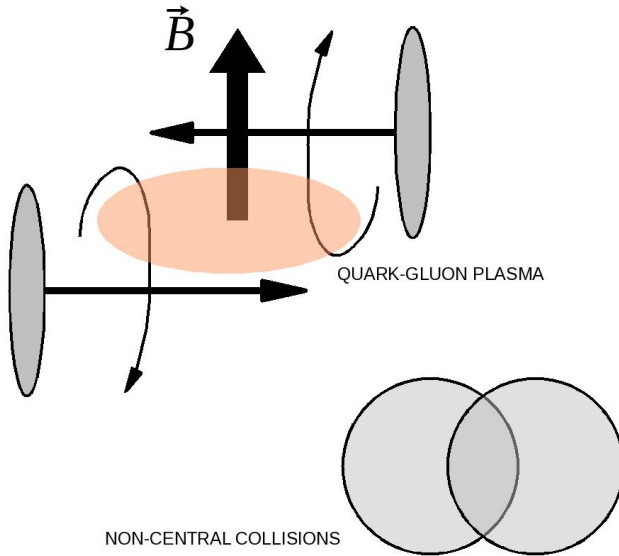
There are two closely related aspects in electrodynamics in heavy-ion collisions

1) Electromagnetism as a probe to QGP

: **Photon and di-leptons, or current spectral densities** as one of the fundamental properties of QGP. PHENIX/STAR photon and dilepton flow/rate measurements and lots of theory and numerical works -> **A significant size of works and community**

2) Dynamical interplay of QCD strong dynamics and EM dynamics

: Heavy-ions carry EM charge $Z \sim 10^2$, so the interaction strength is $Z \cdot \alpha_{EM} \sim 10^2 \cdot \frac{1}{137} \sim O(1)$: **Not Negligible**

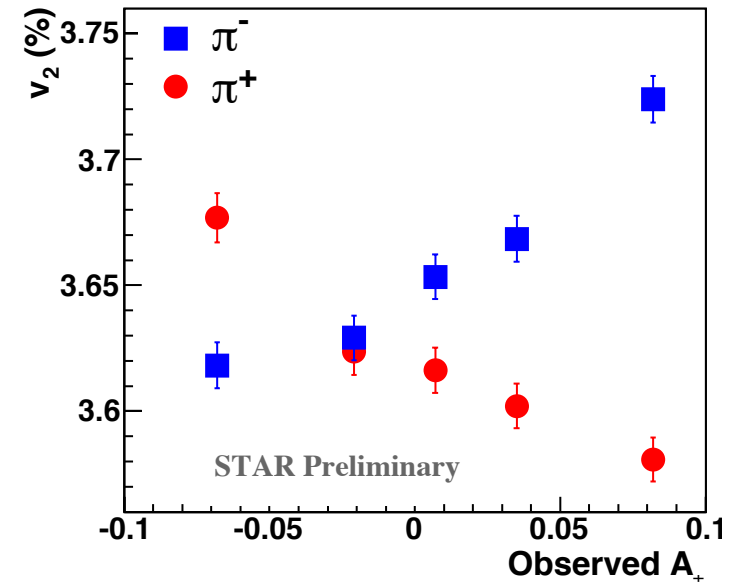


The strength of EM fields are of order $5 - 10 m_\pi^2 \sim (0.5 \text{ GeV})^2$ both electric and magnetic fields

There are interesting fluctuations of them

There are many interesting and fundamental physics that can arise as interplay of QCD with EM

- 1) Chiral anomaly/chiral symmetry breaking, such as Sphaleron physics (EW baryon genesis)
- 2) Chiral Magnetic Effect/Chiral Magnetic Wave
- 3) Flows affected by EM charge transports and EM fluctuations
- 4) Some low x fermionic partons may be highly affected by a large EM charge
- 5) **The physics is not fully explored yet !!!**



Summary

- 1) Flavor symmetry of QCD is an important ingredient of QCD itself. Electrodynamics is a part of it
- 2) Heavy-ion collision creates an interesting environment where, not only QCD, but also QED and its interplay with QCD can be relevant
- 3) This will probably result in a synergistic advancement in our understanding of the physics of QGP
- 4) Full fledged study on this can be one of promising directions in future research, both experimentally and theoretically

Implications on RHIC/LHC

- 1) Precision photon/di-lepton measurements, such as polarization measurements will be valuable
- 2) Charge conjugation odd ($C=-1$) observables :
Sensitive to $Z > 0$ --> **Must be related to EM**
- 3) pA versus $\bar{p}A$ difference can isolate EM interplay with QCD clearly