Observation of medium-induced acoplanarity using γ_{dir} and π^0 triggered semi-inclusive recoil jet distributions in central Au+Au and p+p collisions at $\sqrt{s_{NN}}$=200 GeV by STAR

Nihar Ranjan Sahoo (for the STAR Collaboration)
Indian Institute of Science Education and Research (IISER), Tirupati, India

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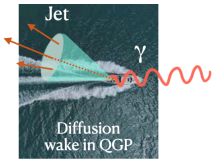
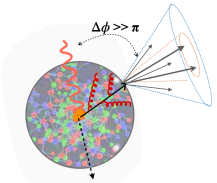
Abstract: We present measurements of azimuthal acoplanarity of direct photon (γ_{dir}) and π^0 triggered semi-inclusive charged recoil jet distributions in central Au+Au and p+p collisions at $\sqrt{s_{NN}}$=200 GeV. This study may probe jet wake effects and/or Rutherford-like scattering off of quasi-particles in the QGP. Marked medium-induced acoplanarity is observed with both triggers for recoil jets with R=0.5 but not R=0.2. We discuss a new insight of jet-medium interaction and compare different theoretical calculations.

Motivation

- In QGP, jet-medium interaction: jet quenching
- Jet acoplanarity: azimuthal angle difference between recoil jets and trigger particles
- Jet acoplanarity in the medium: another manifestation of jet-medium interactions
- Possible explanations for medium-induced jet acoplanarity: Rutherford-like scattering and/or diffusion wake in the QGP



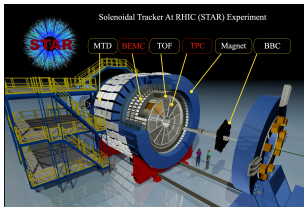
To study medium response: diffusion wake in QGP



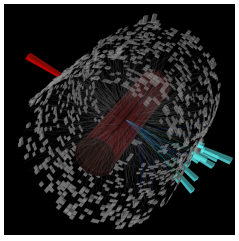
To study QGP microstructure: Rutherford-like scattering

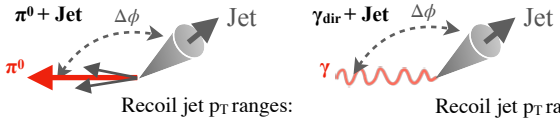
Measurements

- 0-15% central Au+Au and p+p data at $\sqrt{s_{NN}}$ =200 GeV
- Direct photon (γ_{dir}) and π^0 selection and discrimination [1] using the STAR electromagnetic calorimeter and Barrel Shower Maximum Detector
- Recoil charged jets are constructed using charged particles from the Time Projection Chamber for jet radii R=0.2 and 0.5 by anti-k_T algorithm [2]
- Uncorrelated background jet contribution mitigated using the mixed event (ME) method [3] at different $\Delta\phi$ ($=\phi^{trig} - \phi^{recoil\ jet}$)
- Unfolding method is used to correct for detector effects and heavy-ion background fluctuations using RooUnfold [4]
- γ_{dir} and π^0 transverse energy: $11 < E_T^{trig} < 15$ GeV
- Detailed analysis information available in [1]



γ_{dir} + jet event display in Au+Au at STAR





Recoil jet p_T ranges: 10-15, 15-20 GeV/c

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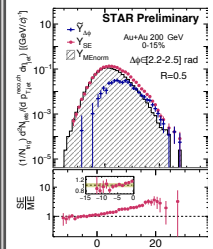
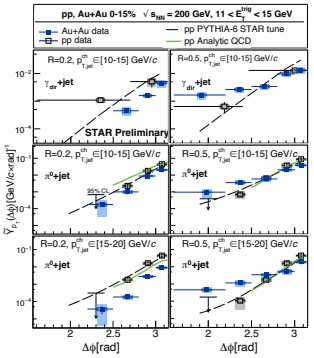
Yield in central Au+Au and p+p collisions

Uncorrelated background subtraction for one $\Delta\phi$ bin and R =0.5



- Normalised ME distribution for each $\Delta\phi$ bin is calculated by multiplying a constant extracted comparing respective SE and ME distributions for $p_{T,jet}^{reco,ch} < 0$
- Ratio of SE and normalised ME distributions is unit for $p_{T,jet}^{reco,ch} < 0$

Fully corrected yield as a function $\Delta\phi$



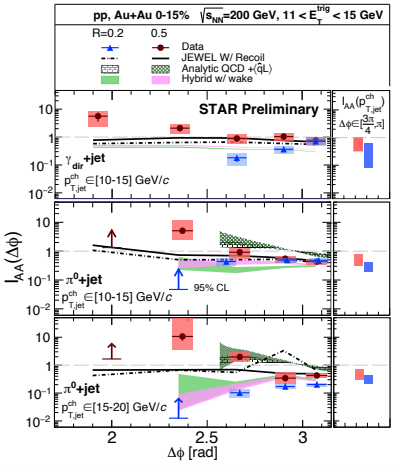
$\tilde{Y}_{\Delta\phi}(p_{T,jet}^{reco,ch}) = Y_{SE}(p_{T,jet}^{reco,ch}) - Y_{MEnorm}(p_{T,jet}^{reco,ch})$

$\tilde{Y}_{\Delta\phi}(p_{T,jet}^{reco,ch})$: Normalised ME subtracted jet distributions

$Y_{SE}(p_{T,jet}^{reco,ch})$: Recoil jet distributions of Same Event (SE)

$Y_{MEnorm}(p_{T,jet}^{reco,ch})$: Normalised ME distributions

I_{AA} as a function of $\Delta\phi$



$$I_{AA}(\Delta\phi) = \frac{\tilde{Y}(\Delta\phi)_{Au+Au}}{\tilde{Y}(\Delta\phi)_{p+p}}$$

- Suppression of $I_{AA}(\Delta\phi)$ for R=0.2 but enhancement for R=0.5 in central Au+Au relative to p+p collisions
- The same observation has been seen at the ALICE experiment using h+jet [5]
- Right panel data points are from[1]
- Significant jet R dependent medium-induced acoplanarity broadening is observed. At $\Delta\phi$ ~2.65, it is measured to be 20±2(sys) for π^0 +jet and recoil jet $15 < p_{T,jet}^{ch} < 20$ GeV/c
- Current theoretical models (Analytic QCD[6], JEWEL[7], Hybrid w/ wake [8]) with jet quenching fail to describe this observation in this kinematic range

Summary

- STAR reports measurements of the semi-inclusive acoplanarity distribution of charged-particle jets recoiling from γ_{dir} and π^0 triggers in p+p and central Au + Au collisions at $\sqrt{s_{NN}}$ = 200 GeV
- Significant R-dependent medium-induced acoplanarity broadening is observed in central Au+Au collisions
- These measurements provide new insight into the nature of the interaction between jets and the QGP

References

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IISER TIRUPATI

The STAR Collaboration