Recent Results on Reconstructed Jets from PHENIX at RHIC

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August 6, 2016
The Physics of Jets

- Jets in A+A probe the QGP
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- $p+$A jets expected to be sensitive to nPDFs

Salgado et al., hep-ph/1105.3919 comparing nuclear PDF sets
⚠️ But, maybe the nucleus probes the structure of the nucleon in p+A?
PHENIX Jet Detection

- Tracking chambers for hadrons, EM calorimetry for photons.
- Jet results are for Anti-$k_T$ algorithm using combinations of EM energy and track $p_T$.
- Results unfolded to true jet $p_T$ scale using SVD using PYTHIA to construct the response matrix.
Jets in $p + p$ and $d + Au$

$p + p$ consistent with NLOJET++ w/ NNPDF2.3 and hadronization corrections from Pythia.

$d + Au$ measured in several different centralities.

Jets in $p + p$ and $d + Au$

$$R_{dA} = \frac{Yield_{d+Au}}{\langle N_{coll}\rangle Yield_{p+p}}$$

- Min bias $d + Au$ jets $N_{coll}$ scales
  - not terribly surprising.
Jets in $p + p$ and $d + Au$

\[ R_{dA} = \frac{\text{Yield}_{d+Au}}{\langle N_{coll} \rangle \text{Yield}_{p+p}} \]

- Min bias $d+Au$ jets $N_{coll}$ scales – not terribly surprising.

- But centrality dependence is quite surprising.
Probing the Nucleon

Similar results from ATLAS

$R_{CP}$ scales with proton $x$
Probing the Nucleon

- A proton with a high-$x$ parton will be “smaller” than average and strike fewer protons.
- Smaller $N_{\text{coll}}$ than average causing $R_{dA}$ to be greater than 1.
Jets in Cu+Au

- Anti-$k_T$ $R=0.2$ to reduce affect of underlying event.
- Data-driven underlying event determination
  - Reconstruct jets from randomly shuffled tracks and clusters.
  - Fake rate $\sim 30\%$ at 15 GeV and drops to 5% by 25 GeV.
Jets in Cu+Au

\[ \sqrt{s_{NN}} = 200 \text{ GeV}, \text{ anti}-k_t, R = 0.2 \text{ jet} \]
Jets in Cu+Au

- $R_{AA} \sim 0.5$ in central
- Hint of $R_{AA} > 1$ in peripheral.

$$R_{AA} = \frac{\text{Yield}_{Cu+Au}}{\langle N_{coll} \rangle \text{Yield}_{p+p}}$$
Probing the Nucleon Transverse Structure

\[ p_{out} = p_T^{assoc} \sin \Delta \phi \]

- \( p_{out} \) core Gaussian from intrinsic \( k_T \).
- Power-law tail due to hard gluon radiation.
PYTHIA magnitude doesn’t match the magnitude of the data but matches the magnitude of the slope.
Probing the Nucleon Transverse Structure

- PYTHIA magnitude doesn’t match the magnitude of the data but matches the magnitude of the slope.
- PYTHIA produces opposite sign slopes for $p_{out}$ Gaussian widths in Drell-Yan events compared to $\gamma$-jet and di-jet events.
Interactions with remnants can be handled in transverse momentum-dependent (TMD) PDFs for the Drell Yan case.

PHENIX has measured Anti-$k_T$ jets in $p + p$, $d + Au$ and $Cu + Au$ collisions.

Cu + Au suppression of jets in most central events.

d + Au $R_{dA}$ for different centrality may be interpreted as evidence of the nucleus probing the nucleon.

Direct $\gamma$-hadron and di-hadron correlations in $p + p$ are also sensitive to the transverse structure of the nucleon in very fundamental ways.