Recent Results from STAR: Correlations

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Correlations: Probing QCD Matter

Heavy-ions at RHIC: Strong modification of Jet-like correlations
Interpreted in pQCD-inspired partonic energy-loss calculations

Goal: *quantitatively* measure properties of matter

Program at RHIC to extend measurements, interpretability throughout the next decade

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STAR: A Correlation Machine

**Tracking: TPC**

**Particle ID: TOF**

**Electromagnetic Calorimetry:**
BEMC+EEMC+FMS
(-1 ≤ η ≤ 4)

Heavy Flavor Tracker (2013)

Particle ID: TOF

Full azimuthal particle identification over a broad range in pseudorapidity

Forward Gem Tracker (2011)
Luminosity upgrade: stochastic cooling by 2012

RHIC enters the fb\(^{-1}\) era: 25 nb\(^{-1}\)/year * 197\(^2\) = 1 fb\(^{-1}\)

Upgrade program to expand reach and breadth of QCD studies

- **Forward Meson Spectrometer**: saturation physics in the forward direction
  - Complete: expect first preliminary d+Au results in a few weeks time

- **TPC DAQ Upgrade**: large datasets, low deadtime to fully utilize luminosity
  - Complete: taking data now

- **Barrel Time of Flight**: particle identification over 2\(\pi\) in azimuth
  - 75% complete, full completion by the fall

- **Forward Gem Tracker**: W charge-sign identification for spin
  - Expected completion: 2011

- **Heavy Flavor Tracker**: fully reconstructed charm to study parton flavor dependence of interaction with QCD matter
  - Expected completion: 2013
Clear signatures of jets in di-hadron correlations
Strong suppression of the away-side jet
BUT:

Strong bias in the types of jets examined
The jets we can see easily are the ones that are not modified

Conclusion strengthened with multiparticles: O. Barannikova, QM2008
\[\gamma\text{-Jet: Golden Probe of QCD Energy Loss}\]

- \(\gamma\) emerges unscathed from the medium
  - Probes deeply into the medium: different surface bias from hadron, dihadron
  - Fully reconstructed kinematics: measure real fragmentation function \(D(z)\)
Gamma-Jet: RHIC is clean

RHIC: Clean separation of $\gamma$ from $\pi^0$ for $p_T \sim 10$ GeV

Fragmentation contribution also expected to be small

LHC: 1 month run

$\pi^0$ suppression at RHIC & LHC

W. Vogelsang NLO
RHIC II $\mathcal{L} = 20$nb-1

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Gamma-Hadron Correlations

- First measurements made
  - Agree with theory within uncertainties
  - Higher precision needed
- Major progress possible in coming years with RHIC II

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Jet reconstruction: another way to constrain hard kinematics

Positive: large cross-section, so large p_T reach

Negative: large backgrounds, limited E resolution
Reconstruction of Jets

Calorimetric triggers to sample full luminosity
- Reach 50 GeV in 0.3 pb$^{-1}$
- Ample jets with fb$^{-1}$ for detailed QCD studies

Under control theoretically:
Cross-section agrees with NLO in p+p
Full Jet Reconstruction in Au+Au

- Sufficient luminosity and coverage, BUT complicated background subtraction, trigger biases
  - Background energy worst case scenario \( \sim 45 \text{ GeV} \)
- Still in its infancy: promising direction for RHIC II

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STAR and RHIC ready for precision studies of QCD in matter

- RHIC Luminosity Upgrade: ready to enter the fb$^{-1}$ era
- STAR Upgrades: coverage, precision, and ability to sample full luminosity

STAR’s strength: correlations over 2π, wide range in η

Large number of correlation measures made, and possible

- Proof-of-principle examples shown here: γ-hadron, Jets
- Small sample of the wide range of correlation analyses

Major progress in coming years

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