Transport model studies on reconstructed jets in a hot partonic medium

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Outline

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  • $\gamma$-jet imbalance
  • Jet Shape
  • Jet fragmentation function
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• Summary
AMPT model with triggered jet

- Dijet and γ-jet events for Pb+Pb 2.76-TeV collisions.
- String-melting AMPT simulations: 1.5 mb / 0 mb to turn on/off jet-QGP interactions.
Jet reconstruction

- Jet reconstruction: anti-kt algorithm, [Fastjet package, background subtraction, jet energy scale correction, jet efficiency correction]
- Dijet asymmetry: \( R=0.5, \ p_T,1>120 \ \text{GeV/c}, \ p_T,2>50 \ \text{GeV/c}, \ |\eta_{1,2}|<2, \ \Delta \phi_{12}>2\pi/3 \)
- \( \gamma \)-jet imbalance: \( R=0.3, \ p_T^{\gamma}>30 \ \text{GeV/c}, \ |\eta^{\gamma}|<1.6; \ p_T^{\gamma}>60 \ \text{GeV/c}, \ |\eta^{\gamma}|<1.44, \ \Delta \phi_{j\gamma}>7\pi/8 \)
- Jet fragmentation function and shape: \( R=0.3, \ p_T^{\text{jet}}>100 \ \text{GeV/c}, \ 0.3<|\eta^{\text{jet}}|<2, \ p_T^{\text{ch}}>1 \ \text{GeV/c} \)
- Jet \( v_n \): \( R=0.2, \ p_T^{\text{jet}}>45 \ \text{GeV/c}, \ |\eta^{\text{jet}}|<2 \)
Dijet characters

- Dijet $p_T$ spectra and back-to-back azimuthal correlation are not sensitive to the existence of partonic phase.
- Dijet asymmetry is enhanced due to strong parton cascade.

G.L. Ma, PRC 87, 064901 (2013)
A large dijet asymmetry ($A_J$) is produced by strong interactions between jets and partonic matter.

The final $A_J$ is driven by both initial $A_J$ and partonic jet energy loss.
• Jet losses more energy by strong partonic interactions than by hadronic interactions only.

• $R_{j\gamma}$ favors a partonic jet energy loss scenario.
γ-jet tomography of QGP

G.L. Ma, PLB 724,278 (2013)

- $x_{j\gamma}$ is sensitive to the birth information $(r, \theta)$ of γ-jet.

$\Delta \phi_{\gamma} > 7/8 \pi$

$30-50\%$

$50-100\%$

$X_{j\gamma} = p_{T\text{Jet}}/p_{T\gamma}$

Pb+Pb 2.76 TeV

$p_{t\gamma} > 60$ GeV/c  $|\eta| < 1.44$

$p_{t\text{Jet}} > 30$ GeV/c  $|\eta^{\text{Jet}}| < 1.6$

$\Delta \phi_{\gamma} > 7/8 \pi$
A tomography tool: $\gamma$-hadron + $\gamma$-jet

(G.L. Ma, PLB 724, 278 (2013))

- $(\gamma$-hadron correlation) + (selected $x_{j\gamma}$) is proposed as a good tool to do detail tomography of QGP.
Medium modifications of jet shape

- Agreement of jet shape between AMPT results and p+p data

- Dynamical evolution of modifications of jet shape:
  - Jet energy is redistributed towards larger radius via the strong interactions between jet and partonic medium.
  - Coalescence reduces the modifications of jet shape and gives qualitative features.
  - Hadron scatterings and resonance decays push the jet energy outwards further.

G.L. Ma, PRC 89, 024902 (2014)
Subleading jets have larger medium modifications than leading jets, in central Pb+Pb with large dijet asymmetries.
Jet fragmentation function

- Good agreement of jet fragmentation function between AMPT results and p+p data
- Jet fragmentation function evolves, but none of them can describe the data in Pb+Pb.
Decomposition of Jet fragmentation function

\[ R(\xi) = \lambda_f R_f(\xi) + \lambda_c R_c(\xi) \]

- **Fragmentation part** \([\lambda_f R_f(\xi)]\): more important for low-\(\xi\) range in more peripheral collisions.
- **Coalescence part** \([\lambda_c R_c(\xi)]\): more dominant for high- \(\xi\) range in more central collisions.

**TABLE I**: The fitting parameters of \(\lambda_f\) and \(\lambda_c\) for different centrality bins in Pb+Pb collisions at \(\sqrt{s_{NN}} = 2.76\) TeV.

<table>
<thead>
<tr>
<th>Centrality</th>
<th>(\lambda_f)</th>
<th>(\lambda_c)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-10%</td>
<td>0.377 ± 0.147</td>
<td>0.612 ± 0.120</td>
</tr>
<tr>
<td>10-30%</td>
<td>0.346 ± 0.156</td>
<td>0.616 ± 0.131</td>
</tr>
<tr>
<td>30-50%</td>
<td>0.599 ± 0.168</td>
<td>0.386 ± 0.137</td>
</tr>
<tr>
<td>50-100%</td>
<td>0.379 ± 0.370</td>
<td>0.527 ± 0.338</td>
</tr>
</tbody>
</table>

G.L. Ma, PRC 88, 021902(R) (2013)
Baryon vs meson in jet fragmentation function

- Large high-ξ enhancement of $R(\xi)$ for protons compared to for pions, due to the relative increase of coalescence part in central Pb+Pb collisions.

G.L. Ma, PRC 88, 021902(R) (2013)

STAR, PRL 97, 152301 (2006)
Jet $v_2$ vs $v_3$

Jet $v_2$\{ψ$_2$=0\} is consistent with jet $v_2$\{ψ$_2$\}.

Jet $v_3$ is smaller than jet $v_2$ for 45<$p_T<$60 GeV/c.

Jet $v_3$ is consistent with zero for 60<$p_T<$80 GeV/c.

\[ \Psi_n^r = \frac{1}{n} \left[ \arctan \left( \frac{r^n \sin(n\varphi)}{r^n \cos(n\varphi)} \right) + \pi \right], \quad v_n^{jet} = \langle \cos \left[ n(\phi^{jet} - \Psi_n^r) \right] \rangle. \]
Jet energy loss fraction

Jet energy loss fraction is dependent of the azimuthal angles with respect to $\psi_n$, which shows a path-length dependence of jet energy loss.

M. -W. Nie and G.-L. Ma, arXiv: 1403.0328
Jet $v_n$ vs $\varepsilon_n$

- The ratio $v_n/\varepsilon_n$ increases with $N_{\text{part}}$ in non-central Pb+Pb collisions.
- Jet $v_n$ is sensitive to initial spatial asymmetry $\varepsilon_n$ of partonic density for a given centrality bin.

M. -W. Nie and G.-L. Ma, arXiv: 1403.0328
Summary

- **Dijet asymmetries**: driven by both initial asymmetries and partonic jet energy loss\[1\].
- **γ-jet imbalance**: sensitive to birth information about γ-jet, which could enable detail tomography of QGP \[2\].
- **Jet Shape**: subleading jets have larger medium modifications than leading jets if large dijet asymmetry \[3\].
- **Jet fragmentation function**: decomposed into fragmentation and coalescence parts, which leads to large high-\(\xi\) enhancement for baryons \[4\].
- **Jet vn**: a path-length dependence of jet energy loss in parton cascade \[5\].

References: