From hydro to jet quenching, coalescence and hadron cascade

A coupled approach to solving the $R_{AA} \otimes v_2$ puzzle

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$R_{AA}$ v.s. $v_2(p_T)$ from low $p_T$ to high $p_T$

- CoLBT-hydro with Hydro-Coal-Frag hadronizations can simultaneously describe the $R_{AA}$ and collective flow from low $p_T$ to high $p_T$ regions in Pb+Pb collisions.

Transverse momentum spectra of identified hadrons

![Graph showing transverse momentum spectra](image)

- CoLBT-hydro nicely describes the spectra of identified hadrons, $P/\pi$ and $K/\pi$ from 0 to 20 GeV.
- $P/\pi$ in Pb+Pb is higher than pp; $P/\pi$ peak moves to higher $p_T$ in central collision.
- $P/\pi$ and $K/\pi$ approach to the p-p value at high $p_T$. 

$R_{AA}$ and $v_2 (p_T)$ at Au-Au at RHIC

- With parameters fixed at LHC, CoLBT-hydro nicely predicts the $R_{AA}$ and $v_2 (p_T)$ from 0 to 20 GeV in Au-Au at 200 GeV.

- CoLBT-hydro nicely predicts the $v_2 (p_T)$ of $\pi$, K and P from 0 to 6 GeV in RHIC.


Collective flow of identified hadrons

- CoLBT-hydro with Hydro-Coal-Frag works well for PID flow from 0 to 8 GeV.
- Quark coalescence is important for Pb+Pb collisions at intermediate $p_T$ range.
- NCQ scaling at intermediate $p_T$ are caused by interplay of hydro, coal. and frag.

Summary

• CoLBT-hydro with Hydro-Coal-Frag hadronization simultaneously describe the $R_{AA}$ and collective flow from low $p_T$ to high $p_T$ in Pb+Pb collisions.

• CoLBT-hydro also nicely describes the collective flow of identified hadrons with $p_T$ from 0 to 8 GeV.

• Quark coalescence is important in heavy-ion collisions.

• With parameters fixed at LHC, CoLBT-hydro excellently predicts the $R_{AA}$ and collective flow from low $p_T$ to high $p_T$ in Au+Au collisions at RHIC.

Coalescence-Fragmentation hadronization code is available here: [https://github.com/wenbin150110084/Coalescence_Fragmentation_code](https://github.com/wenbin150110084/Coalescence_Fragmentation_code)

Thanks for Your Attention
Back Up
**Framework of calculations**

**Hydro-Coal-Frag hadronization**

**Thermal hadrons, low $p_T$ (CLVis):**
- generated by hydro. with Cooper-Frye.
  - Meson: $p_T < 2p_{T1}$; baryon: $p_T < 3p_{T1}$.

- initial shower partons from pythia8 with $p_T > p_{T2}$

**Coalescence hadrons (Coal Model):**
- generated by coalescence model including thermal-thermal, thermal-hard & hard-hard coalesence.

**Fragmentation hadrons:**
- the remnant hard quarks feed to fragmentation.

**UrQMD afterburner:**
- All hadrons are feed into UrQMD for hadronic evolution, scatterings and decays.

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Transition from low $p_T$ to high $p_T$

- CoLBT-hydro nicely describes the spectra of charged from 0 to 20 GeV.
- Transition $p_T$ is higher in central collisions.

• With parameters fixed at LHC, CoLBT-hydro nicely predicts the spectra of $\pi^0$ and of $\pi^\pm$, K and P from low $p_T$ to high $p_T$ in Au-Au at 200 GeV.


NCQ scaling at RHIC and LHC

- NCQ scaling at intermediate $p_T$ are caused by interplay of hydro, coal. and frag.
