The Measurement of jet-particle $v_2$ in p-Pb collisions at 5.02 TeV with ALICE at the LHC

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The azimuthal anisotropy of high-$p_T$ hadrons and associated jets is believed to originate from path-length dependent parton energy loss in the QGP formed in A-A collisions. However, in small systems, a non-zero $v_2$ is observed at high $p_T$, for both minimum bias and jet-triggered events. But, no jet quenching effect is observed from the measurement of $R_{pPb}$ and hadron-jet correlations in small systems.
In this presentation, the $v_2$ of particles produced in jets is measured at low $p_T$ in order to provide further information on the origin of such collectivity.

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- However, in small systems, a non-zero $v_2$ is observed at high $p_T$, for both minimum bias and jet-triggered events.
- But, no jet quenching effect is observed from the measurement of $R_{pPb}$ and hadron-jet correlations in small systems.
ALICE Experiment

• Forward Multiplicity Detector (FMD)
  • FMD3: -3.4<\eta<-1.7
  • FMD1&2: 1.7<\eta<5.1
• V0
  • Trigger and centrality
  • V0C: -3.7<\eta<-1.7, V0A: 2.8<\eta<5.1

Time Projection Chamber (TPC)
• Charged Particle Tracking
• |\eta| < 0.9

p-Pb 5.02 TeV (2016)
Minimum Bias Triggered Events ≈ 500M
Calculation of Correlation

\[
Y(\Delta \eta, \Delta \varphi) = \frac{1}{N_{\text{trig}}} \frac{d^2 N_{\text{assoc}}}{d\Delta \eta d\Delta \varphi} = \frac{S(\Delta \eta, \Delta \varphi)}{B(\Delta \eta, \Delta \varphi)}
\]

- The same sign charged particles measured in TPC acceptance (-0.8 < \eta < 0.8) are chosen as the trigger and associated particles, to construct 2-particle correlation
- Near-side jet peak is observed at \((\Delta \eta \sim 0, \Delta \varphi \sim 0)\)
Calculation of $v_2$

ALICE Preliminary

$p$-Pb $\sqrt{s_{NN}} = 5.02$ TeV

$2.0 < p_T^{\text{trig}} (\text{GeV}/c) < 3.0$

$1.0 < p_T^{\text{assoc}} (\text{GeV}/c) < 5.0$

TPC-TPC Correlation

V0A: 0-10%

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Calculation of $v_2$

- In each $(\Delta \eta, \Delta \phi)$ region of TPC-TPC pairs, the $v_2$ of trigger TPC tracks can be obtained with long-range TPC-FMD correlation.
- Non-flow contribution is suppressed by subtraction of low-multiplicity events.
- Factorization: $V_2^{\{2PC, \text{sub}\}} = v_2^{\{\text{TPC}\}} v_2^{\{\text{FMD}\}}$
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Extraction of Jet $\nu_2$}

- **ALICE Preliminary**
- **p-Pb $\sqrt{s_{NN}} = 5.02$ TeV**
- **TPC-TPC Correlation**
- **V0A: 0-10%**

2.0 < $p_T^{\text{ring}}$(GeV/c) < 3.0

1.0 < $p_T^{\text{assoc}}$(GeV/c) < 5.0

Extract Jet signal and background

**Extract Jet $\nu_2$**
Extraction of Jet $v_2$

ALICE Preliminary

- Double gaussian function is introduced to fit the jet signal, the sum of harmonics is used to fit background.
Extraction of Jet $v_2$

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- Jet signal and background are extracted separately, to calculate $S/B$.
Extraction of Jet $v_2$

- Jet signal and background are extracted separately, to calculate $S/B$

- The $S/B$ obtained in TPC-TPC correlation is used as the weight to extract the $v_2$ of jet particles, in each $p_T$ interval

$$v_2(\Delta \varphi, \Delta \eta) = \frac{S}{S+B} \times v_2(\text{Jet}) + \frac{B}{S+B} \times v_2(\text{Background})$$

Sum of 1st->5th harmonics
Results

- The positive $v_2$ of particles in jets is observed in p-Pb collisions.
- The jet-particle $v_2$ is significantly lower than inclusive $v_2$ of all charged particles.
- Consistent $v_2$ is observed with different associated-particle $p_T$ selection within uncertainties.
Results

- Observed $v_2$ of jet particles in $0.5 < p_T < 5$ GeV/c
- suppressed stronger compared to low and intermediate-$p_T v_2$ of jet triggered events in p-Pb collisions
  
  $\Rightarrow$ This measurement has large separating power of $v_2$ from hard and soft components
- comparable to high-$p_T v_2$ in p-Pb and Pb-Pb collisions
  
  $\Rightarrow$ Positive $v_2$ of jet particles observed in p-Pb collisions for the first time

Summary & Outlook

• First measurement of $v_2$ of jet particles in p-Pb collisions

• Positive jet-particle $v_2$ in p-Pb collisions is observed, which is comparable with the high-$p_T v_2$ measured by ATLAS

• No dependence on associated-track $p_T$ within uncertainties

Thank you for your attention!
Back up
Double gaussian function is introduced to fit the jet signal, the sum of harmonics is used to fit background.
Extraction of Jet $v_2$

- In each ($\Delta \eta, \Delta \phi$) region of TPC-TPC pairs, the $v_2$ of trigger TPC tracks can be obtained with long-range TPC-FMD correlation.
- The S/B obtained in TPC-TPC correlation is used as the weight to extract the $v_2$ of jet particles, in each $p_T$ intervals.

\[
\frac{S}{S+B} \cdot \frac{S}{S+B} \cdot a_0 + \frac{B}{S+B} \cdot \left( a_1 (1-a_7 y) + a_1 a_4 (1-\cos x) + 2a_1 (1+a_7 y) (a_2 \cos (2x) + a_3 \cos (4x) + a_5 \cos (5x) + a_6 \cos (3x)) \right)
\]

$x = \Delta \phi, \ y = \Delta \eta$