Measurement of neutral pion v_2 in Pb-Pb collisions at $\sqrt{s_{NN}} = 2.76$ TeV by the ALICE experiment

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In central Pb-Pb collisions at $\sqrt{s_{NN}} = 2.76$ TeV at the Large Hadron Collider (LHC) in CERN, the yield of particles at high transverse momentum (p_T) is observed to be strongly suppressed as compared with the expected yield from p+p collisions scaled by the average number of the binary collisions. This suppression is explained by the energy loss of hard scattered partons in the medium created in heavy ion collisions. This suppression is called jet quenching. This suppression is quantified by the nuclear modification factor (R_{AA}), which is the ratio of the yield in Pb-Pb collisions to the yield in p-p collisions scaled by the nuclear thickness function $\langle T_{AA}\rangle$ as follows:

$$R_{AA}(p_T) = \frac{1}{< T_{AA} >}\frac{d^2N_{AA}/dp_Tdy}{d^2\sigma_{pp}/dp_Tdy}.$$

$R_{AA}(p_T)$ is well described by many models that employ different approaches for the calculation of parton energy loss. For a better understanding of the energy loss mechanisms, measurement of the path length dependence of the energy loss is crucial.[1)] Since the path length is highly correlated with the azimuthal angle with respect to the reaction plane ($\Delta\phi$), R_{AA} is measured as a function of ($\Delta\phi$).

The $R_{AA}(p_T, cent, \Delta\phi)$ is expressed as

$$R_{AA}(p_T, cent, \Delta\phi) = F(\Delta\phi, p_T)\cdot R_{AA}(p_T, cent),$$

where $F(\Delta\phi, p_T)$ is the ratio of the relative yield as given by

$$F(\Delta\phi, p_T) = \frac{N(\Delta\phi, p_T)}{\int d\phi N(\Delta\phi, p_T)},$$

and $N(\Delta\phi, p_T)$ can be expressed in terms of a Fourier expansion with $\Delta\phi$.

$$N(\Delta\phi, p_T) \propto 1 + 2\sum_{n=1}^{\text{inf}}(v_n\cos(n\Delta\phi)),$$

where v_n is the magnitude of the n-th order harmonic. The second harmonic, v_2, represents the strength of elliptic azimuthal anisotropy. Since high p_T particles are dominated by the jet fragmentation, the v_2 of jets is induced by the path length dependence of the energy loss.

The v_2 is obtained by fitting the azimuthal angular distribution of π^0 with

$$N(\Delta\phi, p_T) = N(1 + 2v_2\cos(2\Delta\phi)).$$

π^0's are identified by the invariant mass between two photons with a Photon Spectrometer (PHOS).[2)] Figure 1 shows the v_2 of π^0 values as a function of N_{part} at 6 GeV $< p_T <$ 20 GeV. The analysis is performed by using semi-central triggered data recorded in 2011 Pb-Pb collisions. Solid and dashed lines represent model calculations from pQCD-based (weakly coupled medium) and AdS/CFT-based (strongly coupled medium) energy loss models, respectively. In this plot, the v_2 of π^0 values shows the same tendency as the v_2 values of the charged particles qualitatively.[3)] Comparison of the model calculations and experimental results for v_2 of π^0 is currently in progress.

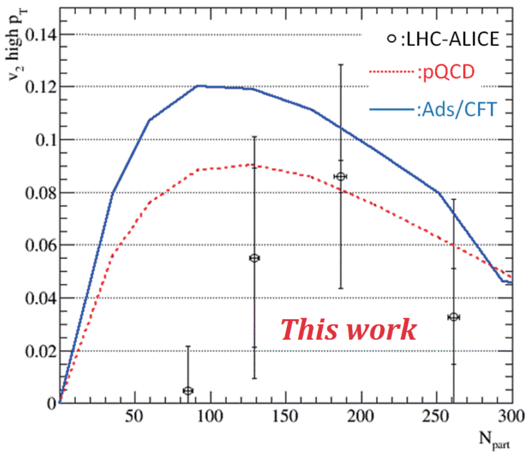

Fig. 1. v_2 of π^0 values as a function of N_{part}. The data points represent v_2 of π^0 measured by the LHC-ALICE experiment. Solid and dashed lines indicate model calculations using pQCD and Ads/CFT, respectively.

References
1) A. Majumber: J. Phys. G. Nucl. Part. Phys. 34, S377 (2007).
2) K. Aamodt et al., for the ALICE Collaboration: JINST 3, S08002 (2008).
3) B. Abelev et al., for the ALICE Collaboration: Phys. Lett. B719, 18-28 (2013).

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