Elliptic flow of neutral pion in Pb+Pb collisions at $\sqrt{s_{NN}} = 2.76$ TeV by ALICE experiment

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It has been observed in central Pb+Pb collisions at ($\sqrt{s_{NN}}$) = 2.76 TeV at the Large Hadron Collider (LHC) facility at CERN that the yield of charged particles at a high transverse momentum (p_T) is strongly suppressed compared with the expected yield from p+p collisions, assuming scaling with the number of binary collisions. This suppression is attributed to the energy loss of hard-scattered partons within quark-gluon plasma (QGP) created in heavy ion collisions. This phenomenon known as jet quenching. A useful way to quantify the suppression of high-p_T hadrons is to introduce the nuclear modification factor (R_{AA}), where the $p+p$ cross section is scaled with the thickness function $\langle T_{AA}\rangle$ of the two nuclei

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

Experimental data can be well reproduced by using multiple models employing different approaches that are used to calculate the energy loss of hard-scattered partons as they traverse the dense medium. To compare these models, improved experimental control of the path length L is required because the energy loss of a high-p_T parton increases rapidly with increase of the the distance traveled through the medium.[1)] Thus, the measurement of the energy loss with respect to the path length is expected to provide detailed information about the mechanism of the energy loss of the parton. If R_{AA} is measured as a function of centrality ($cent$) and the azimuthal angle ($\Delta\phi$) with respect to the event plane, $R_{AA}(L)$ can be determined. Therefore, the differential observable $R_{AA}(\Delta\phi)$ directly probes the path length dependence of the energy loss.

The $R_{AA}(p_T, cent, \Delta\phi)$ with respect to the azimuthal angle is factorized 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, given as

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

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

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

where v_n is the magnitude of the n-th order harmonic. The second harmonic, v_2, represents the strength of elliptic azimuthal anisotropy. The anisotropy v_2 at a low p_T is caused by the collective flow, which gives rise to the background in the measurement of $R_{AA}(p_T, \Delta\phi)$ for investigating energy loss.

The values of $\pi^0 v_2$ were calculated. π^0 v_2 was extracted by using the dN/dϕ method. In this method, 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 values are reconstructed by the invariant mass method with reconstructed energy obtained using a photon spectrometer (PHOS) in the ALICE experiment.[2)] Fig.1 shows $\pi^0 v_2$ values as a function of p_T. In this figure, all data for semi-central triggered events in 2011 are analyzed. Centrality is defined by V0 detectors, which are scintillation detectors, and covers the range from -3.7 to -1.7 and from 2.8 to 5.1 in pseudo rapidity. In this plot, $\pi^0 v_2$ values denote the same tendency of the v_2 values of the charged particles qualitatively.[3)] Calculations of $\pi^0 v_2$ are presently ongoing.

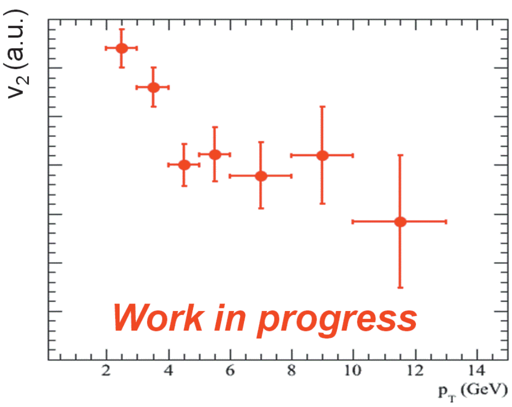

Fig. 1. $\pi^0 v_2$ values as a function of p_T. Bars indicate the amplitude of statistical errors estimated from all data for semi-central triggered events in 2011.

References

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