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

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

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 $\Delta \phi$.

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

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. $\pi^0 v_2$ was extracted by using the $dN/d\phi$ method. In this method, $v_2$ is obtained by fitting the azimuthal angular distribution of $\pi^0$ with

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

$\pi^0$ 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.

References