Study of Charged Pions Elliptic Flow in Heavy Ion Collisions At 62.4 GeV

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Introduction

Heavy-ion collisions at the Relativistic Heavy Ion Collider (RHIC) produce strongly interacting matter under extreme conditions of temperature and energy density, similar to those prevailing in the first few microseconds after the Big Bang [1]. The quark-gluon plasma (QGP) is a state of matter whose existence at high energy density is predicted by Quantum Chromo dynamics. The creation of this state of matter in the laboratory, and the study of its properties are the main goals of the ultra-relativistic nuclear collision program.

One of the experimental observables that is sensitive to the properties of this matter is the azimuthal distribution of particles in the plane perpendicular to the beam direction. When nuclei collide at non-zero impact parameter (non-central collisions), the geometrical overlap region is anisotropic. This initial spatial asymmetry is converted via multiple collisions into an anisotropic momentum distribution of the produced particles[2]. The azimuthal anisotropy is usually characterized by the Fourier coefficients [3, 4]. The flexibility of Relativistic Heavy Ion Collider (RHIC) provides different kinds of heavy ion collisions at different different energies for various colliding species.

In this work we studied variation of elliptic flow of particles π^+ and π^- with mean multiplicity at centre of mass energy 62.4 GeV. We also varied the collision species e.g. Au+Au and Cu+Cu.

Event Generation

We generated events using event generator HIJING. In HIJING we used Cu + Cu & Au+Au at 62.4 GeV minimum bias events. In HIJING it was predicted that flow values should be negligible [3].

Analysis

A commonly used method the azimuthal distributions are expanded in Fourier series where the coefficients of expansion are the measures of different orders of anisotropy [4]. This method is also called event plane method. For small values of these coefficients, the first two terms describe an elliptic shape. The first order anisotropy v_1 is called directed flow; it measures the shift of the centroid of the distribution. The second order anisotropy v_2 is called elliptic flow; it measures the difference between the major and minor axes of the elliptic shape of the azimuthal distribution.

one can characterizes this anisotropy in terms of a single-particle probability distribution for each collision event. By writing this distribution as a Fourier series with respect to the azimuthal angle of out-going particles ϕ, one can define flow coefficients v_n and event plane angles Ψ_n:

$$\frac{2\pi}{N}\frac{dN}{d\phi} = 1 + 2\sum_{n=1}^{\infty} v_n \cos n(\phi - \psi_n) \quad (1)$$

$$v_n e^{in\psi_n} \equiv \left\langle e^{in\phi} \right\rangle \quad (2)$$

Where the brackets indicate an average over the single particle probability and the event plane angles Ψ_n are chosen such that v_n are the (positive) magnitudes of the complex Fourier coefficients.

Results

We are going to present results for variation of elliptic flow v_2 with the mean multiplicity. We estimated the elliptic flow by above mentioned

event plane method and also by reaction plane angle from HIJING. Figure (1) shows elliptic flow variation with mean multiplicity for π^- at 62.4 GeV similarly Figure (2) shows elliptic flow variation with mean multiplicity for π^+ at 62.4 GeV similarly. Both the figures are for Cu+Cu and Au + Au collisions.

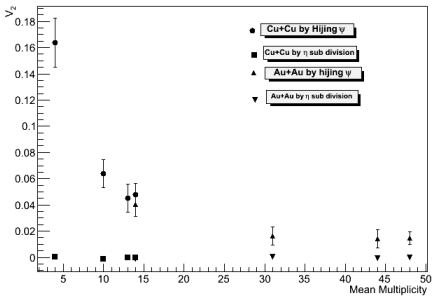

Fig. 1: Elliptic flow (v_2) variation with mean multiplicity for π^- at 62.4 GeV

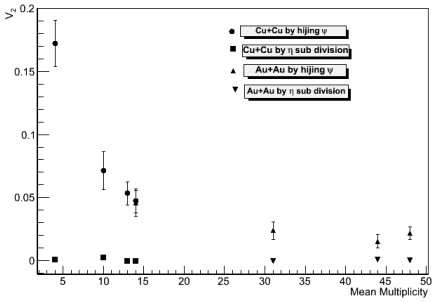

Fig. 2: Elliptic flow (v_2) variation with mean multiplicity for π^+ at 62.4 GeV

Conclusion

We know that theoretically HIJING doesn't have any flow value. But here we are getting the flow values using estimation of event plane angle which are very higher than the expected results. It shows that we should take care of the elliptic flow values when we estimate them using event plane angle.

These figures also shows mass dependency on the estimated flow values. Elliptic flow of Cu+Cu is more than Au+Au at 62.4 GeV. It shows that a heavy ion which is heavier than the other ion shows more flow then a lighter heavy ion.

References

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