ρ^0 Vector Meson Production and Elliptic Flow in $Cu+Cu$ Collisions at $\sqrt{s_{NN}} = 200$ GeV in STAR at RHIC

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In recent years heavy ion physics program has gained a lot of momentum in studying the in−medium properties using vector mesons [1]. One such study is through the ρ^0 vector meson production in the heavy ion collisions. Since the ρ^0 life time $c\tau = 1.3$ fm is small compared to the life time of the system formed in heavy ion collisions, its study is an ideal probe to investigate the in-medium properties. The comparison of ρ^0 vector mesons produced in $Au + Au$, $Cu + Cu$ and $p + p$ collisions at the same center of mass energy can shed some light in understanding the properties of matter at extreme conditions. Also the study of elliptic flow parameter, v_2, of ρ^0 vector-meson has a special importance in relativistic heavy ion collisions. It has been proposed that the measurement of v_2 of the resonances can distinguish whether the resonance was produced at hadronization via quark coalescence or later via hadron re-scattering. The measurement of ρ^0 v_2 can potentially provide information on the ρ^0 production mechanism in relativistic heavy-ion collisions. In the intermediate p_T range ($1.5 < p_T < 5$ GeV/c), the elliptic flow parameter v_2, shows a deviation from the particle mass ordering for different hadron species observed at lower p_T. For identified hadrons, v_2 is found to follow a scaling with the number of constituent quarks n, which is expected from the quark coalescence model. ρ^0 being a meson, its v_2 is expected to follow the $n = 2$ in the universal curve of v_2^h (p_T/n) vs p_T/n. On the other hand, if ρ^0 is produced from the $\pi^+\pi^-$ scattering during hadronization, it would follow the $n = 4$ scaling (2 for each pion).

The main focus of this work is to study the $\rho^0 \rightarrow \pi^+\pi^-$ decay channel which has a branching ratio of ∼100%. In order to have a better signal to background ratio, the ρ^0 invariant mass was calculated using only tracks that originated close to the primary vertex, selection made based on a topology cut on the Distance of Closest Approach (DCA) between the track trajectory and the primary vertex position. Only tracks with DCA less than 3 cm were used in the analysis. In addition, the truncated mean of the dE/dx value of the charged particles were required to be within $\pm 3\sigma$ from the mean dE/dx value of the pions calculated from the Bichsel function [3]. The decay daughters are also required to have $|\eta| < 0.8$ and transverse momentum $p_T > 0.2$ GeV/c.

The invariant mass of ρ^0 is reconstructed in every event by taking $\pi^+\pi^-$ pair. The spectrum contains the signal as well as the combinatorial background. The shape of the combinatorial background in the invariant mass spectra is obtained by taking the like sign pairs ($\pi^+\pi^+$ and $\pi^-\pi^-$) in the same event. The final ρ^0 invariant mass spectrum is extracted by subtracting the background spectrum from the $\pi^+\pi^-$ invariant mass spectrum after suitable normalization as shown in Fig 1.

Since there are other resonances that contribute to the $\pi^+\pi^-$ invariant mass spectrum, the ρ^0 yield and mass were obtained after fitting the data with a hadronic cocktail [4].

The solid black line in Fig. 1 is the sum of all the contributions in the cocktail. The K^0_S has been fitted with a Gaussian function, the ω shape has been obtained from the HIJING

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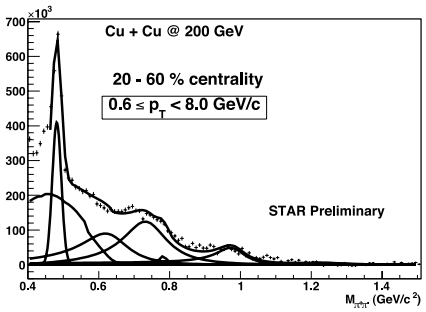

FIG. 1: $\pi^+\pi^-$ invariant mass distribution after background subtraction in $Cu + Cu$ collisions. The red line depicts the ρ^0 contribution.

event generator. The ρ^0, the σ^0, the f_0 and the f_2 were fit by relativistic Breit-Wigner functions [5] times the Boltzmann factor [6, 7] which accounts for the phase space (PS) in the hadronic cocktail. For the cocktail fit in this analysis the ρ^0 width was fixed at 160 MeV/c^2 and the σ^0 mass and width were fixed at 630 MeV/c^2 and 160 MeV/c^2 respectively in $Cu + Cu$ collisions. The temperature in the phase space was taken to be 120 MeV [8]. The detail of the invariant mass distribution and the hadronic cocktail function will be discussed in the conference. The methods and preliminary results on ρ^0 elliptic flow (v_2) measurement in $Cu + Cu$ collisions will be discussed.

References

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