Strange hadron production in high multiplicity pp collision at $\sqrt{s} = 7$ TeV

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Introduction

The transverse momentum (p_T) spectra of hadrons measured in the pp and heavy ion collision reflect the condition of the system at the time of freeze-out. Hadrons form the bulk of particles produced and are usually the first and the easiest to be measured in a heavy ion collision experiment. The p_T spectra of of hadrons are very useful tools to study particle production mechanisms, thermalization and collective effects and at high p_T probe jet quenching effects.

Modified Tsallis Distribution Function

The transverse momentum spectra of hadrons can be described using the modified Tsallis distribution function including the transverse flow [1]. The modified Tsallis function is given by

$$E\frac{d^3N}{dp^3} = C_n \left[\exp\left(\frac{-\gamma\ \beta\ p_T}{n\ T} \right) + \frac{\gamma\ m_T}{n\ T} \right]^{-n}. \tag{1}$$

Here C_n is the normalization constant, p_T is the transverse momentum, $m_T(\sqrt{p_T^2 + m^2})$ is the transverse mass, β is the average transverse velocity of the system and T is the Tsallis temperature. The power n is related to the degree of non thermalization q as $n = 1/(q-1)$.

At low p_T Eq. 1 represents a thermalized system with collective flow and at high p_T it becomes a power law, as follows

$$\begin{aligned} E\frac{d^3N}{dp^3} &\simeq C_n\ \exp\left(\frac{-\gamma(m_T - \beta p_T)}{T} \right) \text{ for } p_T \to\ 0 \\ &\simeq C_n \left(\frac{\gamma m_T}{nT} \right)^{-n} \text{ for } p_T \to\ \infty\ . \end{aligned} \tag{2}$$

For very large $n(\to \infty)$ (or $q \to 1$) also the Eq. 1 takes Boltzmann form with transverse flow.

The measured p_T spectra of K_s^0, Λ and Ξ^- in different multiplicity classes in pp collision at $\sqrt{s} = 7$ TeV are fitted with modified Tsallis distribution (Eq.1). A combined fit of all three particles in each multiplicity bins is made keeping all the parameters free. The fitting range for K_s^0 it is 0.3 - 3.8 GeV, for Λ it is 0.3 - 3.8 GeV and for Ξ^- it is 0.3 - 3.8 GeV.

Results and Discussions

Figure 1 shows the invariant yield of strange particles K_s^0, Λ and Ξ^- as a function of p_T for pp collisions at $\sqrt{s} = 7$ TeV measured in CMS experiment [2]. The particles are measured in the mid rapidity $|y_{\text{CM}}| < 1$ in six multiplicity bins $\Big($(a) N_{trk} = [0 - 35], $< N_{\text{trk}} >$ = 14. (b) [35 - 60], 51. (c) [60 - 90], 79. (d) [90 - 110], 111. (e) [110 - 130], 134. and (f) [> 130], 161.$\Big)$. The solid curves are the modified Tsallis distribution fitted to the data. The combined fitting gives good description of the data for all multiplicity classes.

Figure 2 (a) shows the parameter n for the strange particles K_s^0, Λ and Ξ^- as a function of the multiplicity. Here n decreases with multiplicity and gets saturated at higher multiplicity bins. Smaller vlaue of n for larger multiplicity shows harder collisions. Figure 2 (b)

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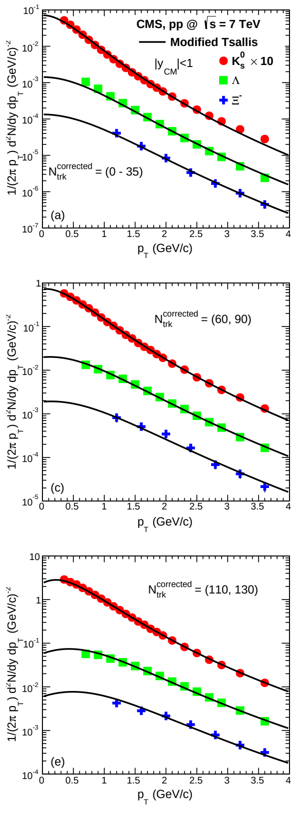

FIG. 1: The invariant yield of the strange hadrons as a function of the p_T for pp collisions in CMS experiment measured at $\sqrt{s}$ = 7 TeV. The solid curves are the fitted modified Tsallis distribution

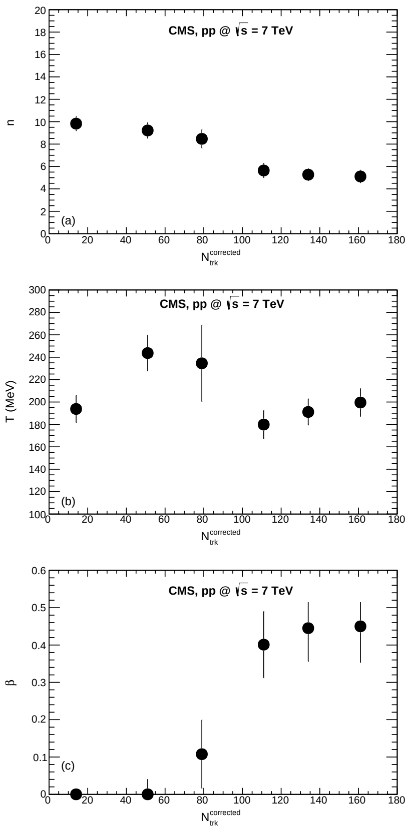

FIG. 2: The Tsallis parameter n, T and β for the strange hadrons as a function of multiplicity in pp collision at $\sqrt{s}$ = 7 TeV.

shows the Tsallis parameter T. We do not see any trend in the variation of temperature T with multiplicity. Figure 2 (c) shows the parameter β. It is negligible for the first two multiplicity bins and then increases up to 0.5 for large multiplicity bins.

The same analysis for the pPb collision at $\sqrt{s_{NN}}$ = 5.02 TeV and PbPb collision at $\sqrt{s_{NN}}$ = 2.76 TeV are under process.

Conclusion

We make a combined fit of strange particles p_T spectra using modified Tsallis distribution in pp collision. The parametter n decreases with multiplicity shows harder collisions in higher multiplicity bins. The higher multiplicity pp events show a radial flow of $\beta \sim 0.5$.

References

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