Centrality dependence of Identified charged Particle Production in Pb+Pb collisions at $\sqrt{s} = 2.76$ TeV

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Introduction

In the ultimate conditions of energy density and temperature, nuclear matter undergoes a transition to a new phase of matter, which is governed by partonic degrees of freedom. This phase is knwon as Quark -Gluon Plasma (QGP). The study of hadrons production has a long history in nuclear and particle physics. The most basic physical observables in high energy hadron-hadron collisions are the absolute yields as well as the transverse momentum ($p_{\rm T}$) spectra of identified hadrons [1]. Present study is focused on the various fitting parameters using Tsallis distribution function for Pb+Pb collision at center of mass energy ($\sqrt{s}$) 2.76 TeV using ALICE collaboration data [2]. The $p_{\rm T}$-spectra in Pb+Pb collisions follow an equilibrium Boltzmann-Gibbs statistics, giving information about, particle yield, kinetic freeze-out temperature and radial flow.

In Pb+Pb collision, the temperature (T) governs soft collisions. This is related to the freeze out temperature for larger systems produced in relativistic heavy ion collision.

In the present work, using the Tsallis distribution function to draw systematic from the transverse momentum ($p_{\rm T}$) spectra of identified hadrons (only for pion plus (π^+)) measured in Pb+Pb collisions at LHC energy ($\sqrt{s} = 2.76$ TeV). We obtained the Tsallis parameters for π^+ at various centrality classes.

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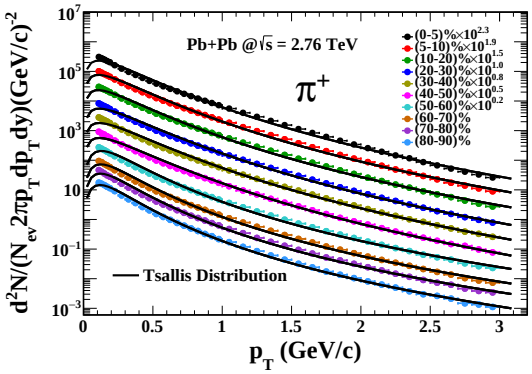

FIG. 1: The spectra of π^+ as a function of $p_{\rm T}$ in Pb+Pb collisions at $\sqrt{s} = 2.76$ TeV measured by the ALICE experiment [1]. The data is used in the fit at different centrality classes. The solid curves are the Tsallis distribution function.

Tsallis Distribution function

The transverse momentum ($p_{\rm T}$) spectra of the hadrons can describe the particle production mechanism, which can be illustrated by the Hagedorn/Tsallis distribution function [3, 4]. This function is given as

$$E\frac{d^3N}{dp^3} = A\left(1 + \frac{m_T}{nT}\right)^{-n}, \qquad (1)$$

where A, n and T are the fitting parameters. $E(d^3N/dp^3)$ is an invariant yield. $m_{\rm T}(= \sqrt{p_{\rm T}^2 + m^2})$ is the transverse mass, m is the mass of the particle. The parameter n measures degree of non-thermalization and gives a good idea of initial production. Larger values of n corresponds to multiple scattering centres and for quark-quark point scattering $n \approx 4$.

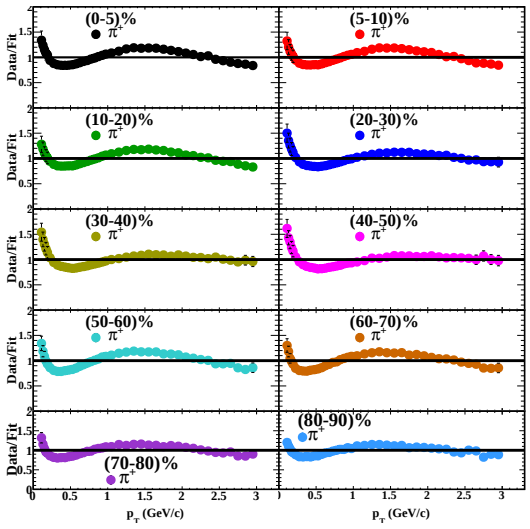

FIG. 2: Data-by-fit of π^+ as a function of $p_{\rm T}$ in the Pb+Pb collisions at $\sqrt{s} = 2.76$ TeV data used in the fit for different centrality classes.

Eqn. (1) describes both the bulk spectra in the low $p_{\rm T}$ region and particles produced in QCD hard scattering reflected in the high $p_{\rm T}$ region.

Results and Discussions

Figure (1) depicts the invariant yield at different centrality classes of the identified charged particle π^+ as a function of $p_{\rm T}$ for Pb+Pb collisions at $\sqrt{s} = 2.76$ TeV measured by the ALICE experiment [1]. The ratio of the data/fit values shows that the Tsallis distribution gives good description of the data for different centralities. This can be observed from the χ^2/NDF values displayed in the Table (I).

Conclusion

In this work, we have studied the Transverse momentum spectra of π^+ in the Pb+Pb collisions at $\sqrt{s} = 2.76$ TeV using Tsallis/Hagedorn distribution function. This function gives very good description of measured data from ALICE collaboration. The study of transverse flow effect of other identified charged particles e.g. $\pi^-, k^+, k^-, p, \bar{p}$ is under process.

TABLE I: Values of Tsallis parameters of π^+ in Pb+Pb collision at $\sqrt{s} = 2.76$ TeV (ALICE experiment).

Centrality (%)	$\frac{dN}{dy}$	n	$T(GeV)$	χ^2/NDF
$(0-5)$	4927.96 ± 768.547	8.8309 ± 0.288	0.0954 ± 0.0037	0.8586
$(5-10)$	4156.24 ± 422.624	8.7064 ± 0.274	0.0944 ± 0.004	0.82
$(10-20)$	3262.43 ± 319.061	8.525 ± 0.256	0.093 ± 0.0034	0.796
$(20-30)$	359.338 ± 12.917	9.047 ± 0.104	0.1 ± 0.0006	1.054
$(30-40)$	1176.27 ± 42.644	9.0901 ± 0.104	0.1 ± 0.0004	1.221
$(40-50)$	732.993 ± 26.9358	9.187 ± 0.1061	0.1 ± 0.00032	1.499
$(50-60)$	3440.55 ± 477.224	7.0901 ± 0.1687	0.0601 ± 0.0029	1.059
$(60-70)$	1430.11 ± 203.176	6.906 ± 0.1569	0.0555 ± 0.00270521	0.933
$(70-80)$	796.626 ± 118.724	6.7817 ± 0.1507	0.052 ± 0.0026	0.836
$(80-90)$	367.13 ± 53.496	6.827 ± 0.1497	0.0498 ± 0.0025	0.567

Acknowledgments

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