Study of medium modifications in $Xe + Xe$ collisions at $\sqrt{s_{NN}} = 5.44$ TeV

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Introduction

In the present paper, we study the p_T spectra of charged particles in $p+p$ and $Xe+Xe$ collisions at $\sqrt{s_{NN}} = 5.44$ TeV using modified Tsallis distribution [1]. Here the data of $Xe + Xe$ collisions are taken from ALICE experiment [2] at mid-pseudorapidity region ($|\eta| < 0.8$). Here we discuss two types of medium effects, one is the transverse flow in the low to intermediate p_T region ($p_T \leq 7$ GeV/c) and the other is the energy loss in the high p_T region ($p_T > 7$ GeV/c), using the modified Tsallis distribution.

Modified Tsallis distribution

The newly modified Tsallis distribution function in different p_T regions is as follows:

$$E\frac{d^3N}{dp^3} = A_1\left[\exp\left(-\frac{\beta p_{\rm T}}{p_1}\right) + \frac{m_{\rm T}}{p_1}\right]^{-n_1} : p_{\rm T} < p_{\rm T_{th}} \quad \text{(1a)}$$

$$E\frac{d^3N}{dp^3} = A_2\left[1 + \frac{m_{\rm T} + \Delta m_{\rm T}}{p_2}\right]^{-n_2} : p_{\rm T} > p_{\rm T_{th}} \quad \text{(1b)}$$

(1c)

The Eq. 1a shows the thermal and collective behaviour of hadron spectra with the temperature $T = \frac{p_1}{n_1}$ and the average transverse flow velocity β. This is for low (to intermediate) p_T region (i.e $p_T \leq p_{T_{th}} = 7.0$GeV/c taken). The second Eq. 1b shows the energy loss ($\Delta m_{\rm T} = B\ (\frac{p_T}{q_0})^{\alpha}$) at high p_T region. Here, the parameter α quantifies different energy loss regimes for light quarks in the medium. The parameter B is proportional to the medium size and q_0 is an arbitrary scale set as 1 GeV. Here p_2 is not an independent parameter. The empirical parton energy loss in nuclear collisions at RHIC energies is found to be proportional to p_T.

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Results and Discussions

Here we observe from the Fig 1 that the modified Tsallis distribution function fits well with the measured data in a full p_T range. It is seen from Table I that the parameters n_1, p_1 and β are decreasing as we move from central to peripheral collisions which is occured due to large number of multi-scatterings occured among partons in central collisions than the peripheral collisions. The parameter $n_2 = 6.5$ is taken from $p+p$ collisions and the value of α remains within 0.56 to 0.77. The parameter B increases as we move from peripheral to the central $Xe + Xe$ collisions.

References

[1] P. Kumar, P. K. Khandai, K. Saraswat and V. Singh, *Int. J. Mod. Phys. A* **36** 2150059 (2021).
[2] ALICE Collab. (Shreyashi *et. al.*), *Phys. Lett. B* **788** 166-179 (2019).

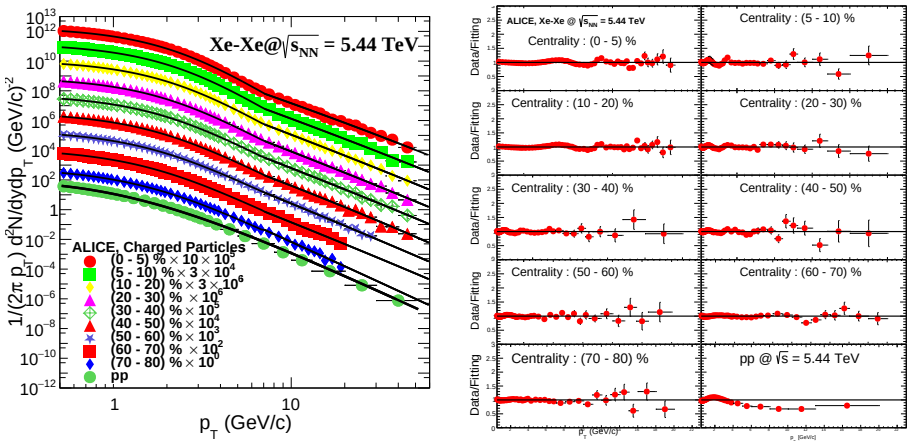

FIG. 1: Left panel shows the invariant yields of the charged particles as a function of the transverse momentum (p_T) for $Xe + Xe$ and $p + p$ collisions at $\sqrt{s_{NN}}$ = 5.44 TeV measured by the ALICE experiment [2]. The solid curves are the modified Tsallis distribution (Eq. 1. Right panel shows the ratio of the charged particle yield data and the fit function (Modified Tsallis distribution Eq. 1) as a function of p_T for $Xe + Xe$ and $p + p$ collisions at $\sqrt{s_{NN}}$ = 5.44 TeV.

TABLE I: The parameters of the modified Tsallis function (Eq. 1) obtained by fitting the charged particle spectra in $Xe + Xe$ collisions (for 9 centrality classes) and $p + p$ collisions at $\sqrt{s_{NN}}$=5.44 TeV.

centralities in $Xe + Xe$ collisions	n_1	p_1 (GeV/c)	β	α	B (GeV/c)	$\frac{\chi^2}{\text{NDF}}$
(0 - 5 %)	7.01 ± 0.46	1.59 ± 0.12	0.72 ± 0.04	0.56 ± 0.03	10.00 ± 2.90	0.33
(5 - 10 %)	6.99 ± 0.52	1.62 ± 0.15	0.71 ± 0.04	0.60 ± 0.04	10.00 ± 6.62	0.33
(10 - 20 %)	6.61 ± 0.41	1.51 ± 0.12	0.72 ± 0.04	0.64 ± 0.03	9.99 ± 4.00	0.28
(20 - 30 %)	6.17 ± 0.34	1.38 ± 0.09	0.73 ± 0.04	0.66 ± 0.02	9.99 ± 4.93	0.24
(30 - 40 %)	5.94 ± 0.32	1.31 ± 0.09	0.72 ± 0.04	0.65 ± 0.03	8.61 ± 1.17	0.25
(40 - 50 %)	5.73 ± 0.30	1.24 ± 0.09	0.70 ± 0.04	0.57 ± 0.06	5.27 ± 0.85	0.29
(50 - 60 %)	5.49 ± 0.28	1.15 ± 0.08	0.68 ± 0.05	0.69 ± 0.04	7.82 ± 1.12	0.23
(60 - 70 %)	5.40 ± 0.28	1.10 ± 0.08	0.64 ± 0.05	0.66 ± 0.06	8.00 ± 3.46	0.22
(70 - 80 %)	5.39 ± 0.32	1.07 ± 0.09	0.58 ± 0.06	0.77 ± 0.04	5.00 ± 3.27	0.69
$p + p$ collisions	4.48 ± 0.52	0.78 ± 0.12	0.62 ± 0.29	0.73 ± 0.13	9.99 ± 5.7	0.27