Identified charged particle production in proton-proton collisions at $\sqrt{s} = 13$ TeV

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Introduction

Quantum chromodynamics (QCD), the theory of strong interactions, predicts a phase transition from the hadronic matter to the deconfined states of quarks and gluons at very high temperature or very high baryon density [1, 2]. This deconfined states is known as Quark-Gluon Plasma (QGP). QGP can be created by the heavy ion collisions at relativistic energies. The heavy ion collisions at Relativistic Heavy Ion Collider (RHIC) and Large Hadron Collider (LHC) are performed to study strongly interacting matter at high energy density. The particle production in proton - proton (pp) collisions are used as the baseline for the heavy ion collisions. The particle transverse momentum spectra in the hadronic collisions are widely used for perturbative QCD (pQCD) calculations and phenomenological studies [1, 2].

In the present work, we studied the ALICE measured transverse momentum spectra of identified charged particles in pp collisions at $\sqrt{s} = 13$ TeV using the Tsallis distribution functions. We obatined the Tsallis parameters for pions, kaons and protons.

Tsallis Distribution Function

The transverse momentum spectra (p_{T}) of the particles produced in hadronic collisions can be described by the Hagedorn/Tsallis distribution function. The Tsallis distribution function is given as [1, 2].

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

Here $E(d^3N/dp^3)$ is an invariant yields. A, n and T are the fitting parameters. $m_{\mathrm{T}}(= \sqrt{p_{\mathrm{T}}^2 + m^2})$ is the transverse mass and m is the mass of the particle. The parameter n measures degree of non-thermalization. Larger values of n corresponds to multiple scattering centres. $n \approx 4$ for quark-quark point scattering. Eq. 1 describes both the bulk spectra in the low p_{T} region and the particles produced in QCD hard scattering reflected in the high p_{T} region.

Results and Discussions

Figure 1 shows the invariant yields of the identified charged particles (π^+, π^-, K^+, K^-, p, $\bar{p}$) as a function of p_{T} for pp collisions at $\sqrt{s} = 13$ TeV measured by the CMS experiment [3]. The solid curves are the Tsallis distribution functions fitted to the p_{T} spectra. Figure2 shows the ratio of the data to the fit value as a function of p_{T} in pp collisions at $\sqrt{s} = 13$ TeV. The ratio of the data to the fit value shows that the Tsallis distribution gives good description of the data for all particles, which can be seen from the χ^2/NDF values given in the table.

Conclusion

In this article, the transverse momentum spectra of the indentified charged particles in pp collisions at $\sqrt{s} = 13$ TeV using Tsallis distribution function has been reported. The Tsallis distribution function gives very good

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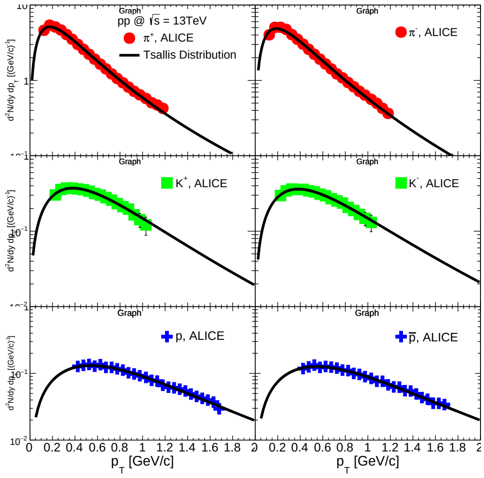

FIG. 1: The invariant yields of the identified charged particles as a function of p_{T} in pp collisions at $\sqrt{s}$ = 13 TeV measured by the CMS [3]. The solid curves are the Tsallis distribution function.

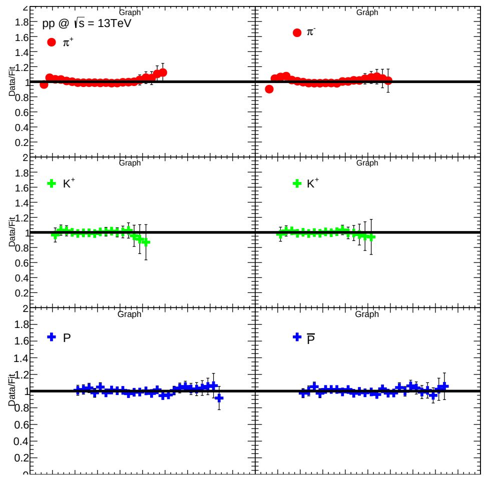

FIG. 2: The ratio of the identified charged particles yield data and the Tsallis function as a function of the p_{T} in pp collisions at $\sqrt{s}$ = 13 TeV.

description of the measured data of CMS experiment. The study of the effect of transverse flow is under process.

TABLE I: The values of Tsallis parameters of charged particles in pp collision at CMS experiment($\sqrt{s}$ = 13 TeV).

charged Particle	$\frac{dN}{dy}$	n	$T(GeV)$	χ^2/NDF
π^+	3.051 ± 0.069	5.633 ± 0.101	0.1 ± 0.004	0.294
π^-	242.426 ± 25.501	6.535 ± 0.703	0.115 ± 0.008	0.773
K^+	0.39 ± 0.391	8.36 ± 8.08	0.16 ± 0.08	0.087
K^-	3.934 ± 4.136	7.729 ± 7.243	0.154 ± 0.086	0.068
p	21.610 ± 1.505	6.374 ± 0.150	0.1 ± 0.022	0.333
$\bar{p}$	21.610 ± 1.505	6.374 ± 0.150	0.1 ± 0.022	0.333

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