

m_T Scaling Approach to π^0 and η mesons at LHC energies

Kajal¹, M. K. Singh¹, and P. K. Khandai^{2*}

¹Department of Physics, Institute of Applied Sciences and Humanities,
GLA University, Mathura - 281406, India. and

²Department of Physics, Ewing Christian College, Allahabad 211003, India.

We present a systematic analysis of transverse mass ($m_T - m$) spectra of π^0 and η mesons for Pb+Pb and p+Pb collisions. The published data on the invariant yields of π^0 and η mesons as a function of p_T was taken from the ALICE collaborations at the mid-rapidity region for various centrality cases. The main goal is to examine the identical spectral shapes and suppression patterns of π^0 and η mesons at various centre of mass energies in various systems. To examine the spectral morphologies of the meson from the provided π^0 spectra, we use the m_T scaling technique. We employ the modified Hagedorn function as a fit function in order to achieve this.

1. Introduction

The Quark Gluon Plasma is produced by heavy ion collisions in the laboratory at RHIC (BNL, USA) and at LHC (CERN, Switzerland). The Quark Gluon Plasma which is a thermalized state of matter and is believed to have existed in the early universe a few microseconds after the Big Bang. Measurements of hadron generation over a wide transverse momentum (p_T) range in various colliding systems are of special interest among the several observables that probe the QGP. In this study, we parametrize neutral π^0 spectra that were observed experimentally and then, using m_T scaling, we extract the spectra of the eta (η) meson. The study of π^0 and η mesons is crucial because π^0 are produced in large amount while η mesons have a hidden strangeness content and a mass that is four times that of π^0 mesons ($m_\eta = 547.86$ MeV and $m_{\pi^0} = 134.97$ MeV). The Pb + Pb collisions at $\sqrt{s_{NN}} = 2.76$ TeV. The data of invariant yields vs. p_T of π^0 and η mesons are taken from ALICE collaboration published data for different centrality instances. The transverse mass ($m_T - m$) spectra of π^0 and η mesons for various collision systems at various centre of mass energies are examined in this article. The main goal is to use the m_T scaling method to examine the

spectral structure and suppression pattern of π^0 and η mesons. In order to achieve this, we first fit the π^0 meson spectra with the modified Hagedorn function before obtaining the meson spectra by relative normalising of the m_T scaled spectra.

2. Result and Discussion

In our analysis, we parameterize the measured π^0 spectra using the modified Hagedorn function used by PHENIX collaboration with a minor replacement of p_T by m_T as follows:

$$E \frac{d^3 N}{dp^3} = \frac{A}{\left[\exp(-am_T - bm_T^2) + \frac{m_T}{p_0} \right]^n},$$

$$= f_\pi \left(\sqrt{p_T^2 + m_\pi^2} \right), \quad (1)$$

where A, a, b, p_0 and n are the fit parameters. The neutral pion spectra measured in Pb + Pb collisions at $\sqrt{s_{NN}} = 2.76$ TeV and p + Pb collisions at $\sqrt{s_{NN}} = 5.02$ TeV are fitted using this distribution. Using m_T scaling, we obtain the spectra of η meson using pion fit function as

$$E \frac{d^3 N}{dp^3} = S f_\pi \left(\sqrt{p_T^2 + m_\eta^2} \right) \quad (2)$$

The published data of π^0 and η mesons in the p_T range of 1 p_T 20 GeV/c in central (0 -10) and semicentral (20 -50) Pb+Pb collisions at $\sqrt{s_{NN}} = 2.76$ TeV are taken from the

*Electronic address: pkkhandai@gmail.com

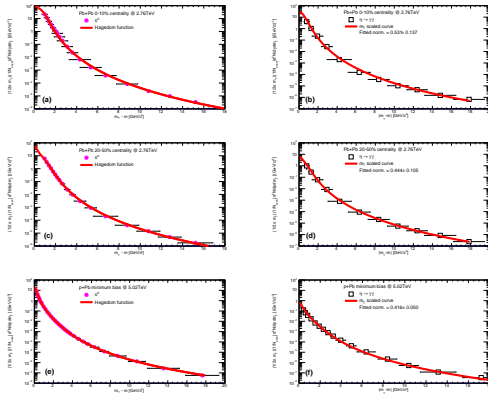


FIG. 1: figure (a) shows the invariant yields. ALICE experiment. The solid curves in (b) are the modified Hagedorn function. The solid curve in (b) is the m_T scaled curve. figure (c) shows the invariant yields. ALICE experiment. The solid curves in (d) are the modified Hagedorn function. The solid curve in (d) is the m_T scaled curve. figure (e) shows the invariant yields. The solid curves in (e) are the modified Hagedorn function. The solid curve in (e) is the m_T scaled curve.

ALICE experiment. The invariant yields and data/fit of the π^0 and η mesons as a function of $m_T - m$. We also discuss the results of π^0 and η mesons in a broad p_T range of $0.3 < p_T < 20$ GeV/c and $0.7 < p_T < 20$

GeV/c respectively in $p + Pb$ collisions at $s = 5.02$ TeV.

3. Conclusion

We have presented a systematic study of m_T scaling of π^0 , $Pb + Pb$ collisions at $\sqrt{s_{NN}} = 2.76$ TeV and $p + Pb$ collisions at $\sqrt{s_{NN}} = 5.02$ TeV. We notice that the power $n = 6$ at LHC energies suggesting quark-quark point scattering. We observe that π^0 are suppressed by similar amount and they have the common suppression pattern. We also notice that the modified Hagedorn function perfectly fit the π^0 spectra and the derived m_T scaled it is concluded that π^0 have identical spectral shape. Although the modified Hagedorn function gives a very good description of π^0 spectra, its parameters lack a physics interpretation [4].

References

- [1] E. V. Shuryak, *Phys. Rept.* **61**, 71–158 (1980).
- [2] D. Boyanovsky, H. J. de Vega, and D. J. Schwarz, *Annu. Rev. Nucl. Part. Sci.* **56**, 441 (2006).
- [3] S. Acharya et al. (ALICE Collaboration), *Phys. Rev. C* **98**, 044901 (2018).
- [4] S. Acharya et al. (ALICE Collaboration), *Eur. Phys. J. C* **78**, (2018).