Pion multiplicity fluctuations in p-p collisions at $\sqrt{S_{nn}}$= 13 TeV

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Introduction

In relativistic heavy ion collisions, the existance of large fluctuations in pseudo-rapidity space have been followed in cosmic ray JACEE[1] events and in different types of accelerator and collider experiments. It is evident that the intermittent fluctuations are nothing but the results of QGP phase transition. There are different types of method to identify such types of fluctuation for long range or short range η distribution. In order to study multiplicity fluctuations depending on the scale factorial moments, Bialas and Peschanski[1] gave an excellent idea about the scale factorial moments. He showed the dependency of scaled factorial moments on power law dividing the phase space into a pseudo-rapidity bin width. This scale factorial moments are known as intermittency.

1. Methodology

In one dimensional η space, the factorial moments F_q of order q is defined as

$$F_q = M^{q-1} \sum_{m=1}^{M} \frac{< n_m(n_m-1)....(n_m-q+1) >}{n_m^q} \tag{1}$$

Where M is the number of bins in η space and n_m is the number of particles in m^{th} bin. In presence of intermittency the factorial moment shows power like groths, i.e
$< F_q > \propto M^{\alpha_q}$ and $ln < F_q >= \alpha_q$ ln M + c
Where c is constant and we can get the value of α_q from this linear fit graph. $\alpha_q > 0$ and it is known as intermittency exponent. Now λ_q is the strength of the intermittency, can also be obtained from α_q

$$\lambda_q = \frac{\alpha_q + 1}{q} \tag{2}$$

Depending on the value of λ_q we will come to know weather the non-thermal phase tansition is possible or not. The fractal dimension d_q [2, 3] can also be obtained as

$$d_q = \frac{\alpha_q}{q-1} \tag{3}$$

Now we have calculated the value of β_q which is the ratio of higher order fractal dimension(d_q) to the second order fractal dimension(d_2)[4]

$$\beta_q = \frac{d_q}{d_2}(q-1) \tag{4}$$

We have also calculated the value of critical exponent γ

$$\beta_q = (q-1)^{\gamma} \tag{5}$$

From the value of gama we can get the idea about the quark-hadron phase transiton.

2. Result and discussion

In order to know the existance of non thermal and quark hadron phase transition we have analysed the variation of $< F_q >$ with respect to M for order of q (q=1,2,3,4,5,6) for the multiplicity of pp collisions at $\sqrt{S_{nn}}$ = 13 TeV. To generate the data sample we have used the Ultra Relativistic Quantum Molecular Dynamics (UrQMD). In fig.1 we have plotted ln$< F_q >$ vs ln M graph and we have seen that factorial moment F_q is increasing with increasing the number of bins for each value of q in one dimensional η space.

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TABLE I: Data of different parameters depending on the factorial moment analysis.

q	α	λ	d_q	β_q
1.0	0.1041 ±0.09198	1.1041 ± 0.09198		
2.0	0.26393 ± 0.13737	0.63197 ± 0.068685	0.26393 ± 0.13737	1.00 ± 0.27474
3.0	0.46226 ± 0.17474	0.4874 ± 0.05825	0.23113 ± 0.08737	1.7514 ± 0.22474
4.0	0.67929 ± 0.20548	0.4198 ± 0.05137	0.22643 ± 0.06849	2.5738 ± 0.20586
5.0	0.89684 ± 0.23257	0.0.3794 ± 0.04651	0.22421 ± 0.05815	3.3980 ± 0.19552
6.0	1.10435 ±0.25789	0.3507 ± 0.04298	0.22087 ± 0.05158	4.1843 ± 0.18895

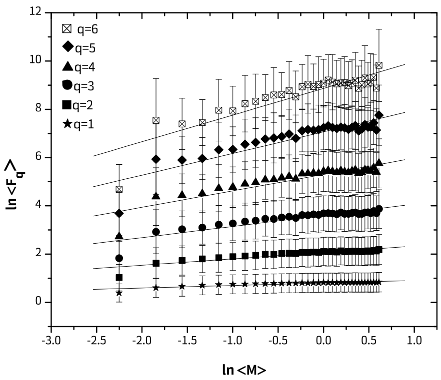

FIG. 1: $ln < F_q >$ vs ln M in η space.

Depending on this graph we have also calculated α_q, λ_q, β_q and γ which are listed bellow. From fig.2 we have observed the variation of λ_q with respect to q. It is seen that λ_q is decreasing with increasing q but does not show any distinct lower value which indicates that there is no non thermal phase transition in the multiplicities of the charged particles. From fig.3 we have seen the variation of β_q with respect to (q-1). This variation follows a straight line path and it is fitted with the equation $\beta_q = (q-1)^\gamma$. Depending on the above table we have also found the value of critical exponent γ=0.88. According to the GL theory if the value of critical exponent γ is around 1.304, then there must exists the quark-hadron phase transition. Therefore depending our data analysis we have seen that the value of γ is far away from 1.304. Now

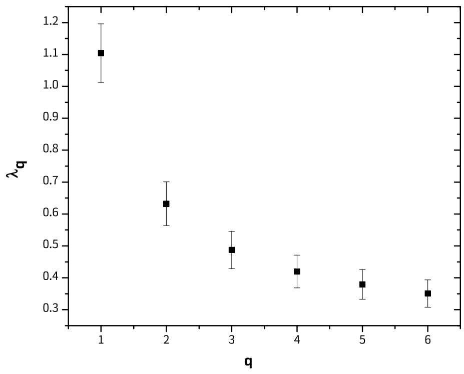

FIG. 2: λ_q with q in 1dimensional η space.

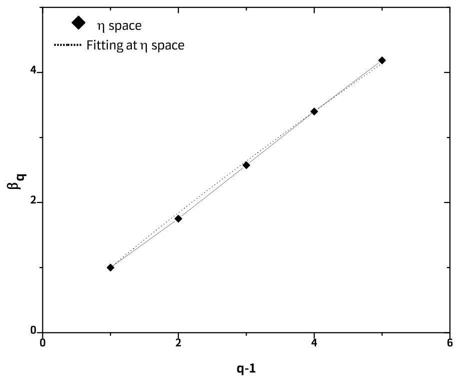

FIG. 3: Variation of β_q with $q-1$ in η space.

we can easily conclude that there no quark-hadron phase transition in the multiplicities of the pp collisions.

References

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