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Multifractal study and multifractal specific heat of singly charged particles produced in ^{32}S–Em interactions at 200 AGeV

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Takagi moment method has been applied to investigate the multifractal behaviour of charged pions produced in the interaction of ^{32}S beam with nuclear emulsion at 200 AGeV in pseudorapidity space. Following this method the multiplicity distributions are found to obey power law behaviour for experimental data for different nuclear targets. The generalised fractal dimensions, D_q are found to decrease with increasing order of moments, q. The observation reflects the existence of multifractality in multiparticle production. The linear behaviour of D_q as a function of $\ln q/(q-1)$ favours the multifractal Bernoulli representation and the multifractal specific heat seems to have a universal value ($\sim$1/4) that does not depend on the type of ions and their energy. The experimental results have been compared with those obtained from simulated events of the Monte Carlo code FRITIOF.

1. Introduction

The study of non-statistical fluctuations in relativistic nuclear collisions has recently attracted a great deal of attention due to the possibility of extracting important information about the mechanism of multiparticle production in such collisions. Analysis of intermittency in terms of scaled factorial moments [1,2] has been applied recently to the particles produced in hadronic [3] and nuclear collisions [4–8] at relativistic energies. The phenomenon of intermittency reveals the self-similar behaviour of multiplicity fluctuations in particle production at high energy. However, the dynamical explanation of the origin of intermittency in some cases is not yet clear. The self-similarity observed in the power law dependence of scaled factorial moments reveals a connection between intermittency and fractality. Hwa [9,10] was the first to provide the idea to use multifractal moments, G_q, to study the multifractality and self-similarity in multiparticle production. However, the shortcoming in all these analyses is that the experimental data on the scaled factorial moments, F_q, and on the multifractal moments, G_q, only approximately show the expected linear behaviour on a log–log plot of moments against bin size as expected from the mathematical formulations. To overcome this difficulty, Takagi [11,12] proposed a new method for studying the multifractal structure of multiparticle production and successfully applied this methodology to probe fractality in UA5 data on proton–antiproton interactions [13] and TASSO and DELPHI data on electron positron annihilations [14,15]. It has been pointed out by Takagi that the deviations from the linear behaviour in a log–log plot may be partly due to the fact that the above methods are unable to give the required mathematical limit: the number of points tending to infinity. Recently, Bershadskii [16] has reported a new method for calculating multifractal specific heat. Following that method we also found out multifractal specific heat in our case. One of our main concerns in this paper is to study the multifractal specific heat in multiparticle production in high energy nucleus–nucleus interactions by the Takagi moment method because some consistency is observed in the values of the specific heat obtained using Takagi's method. However no

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