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Signal of Unusual Large Fluctuations in ^{32}S-Em Interactions at SPS Energies

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An investigation on the presence of large dynamical fluctuations was carried out in the pseudorapidity phase space (η-space) of relativistic charged particles produced in ^{32}S-Em interactions at 200 AGeV/c by the method of scaled factorial moments, F_q, in terms of the new scaled variable $X(\eta)$ suggested by Bialas and Gazdzicki. The Nuclear emulsion technique was employed to collect the experimental data. We compared our experimental results with those obtained from simulated events by using Monte Carlo Code FRITIOF. The variation of $\ln F_q$ with $\ln M$ in pseudorapidity (η) phase space revealed a power law behavior. The values of the slopes, α_q, determined from the analyses of the F_q moments are discussed. The generalized fractal dimensions, D_q, determined from the above method are calculated and found to decrease with the order of the moments, q, indicating multifractality in multiparticle production. Also, the anomalous fractal dimension d_q obtained was found to increase linearly with the order of moments, q suggesting a self-similar cascade mechanism. In order to check for the presence of the statistical fluctuations, we generated uncorrelated Monte Carlo events (MC-RAND) randomly in -space based on the assumption of independent emission of particles and compared the results with the experimental and FRITIOF data. The experimental data on intermittency were found to exhibit a remarkable proximity to the analogous data obtained from the FRITIOF code. However, the uncorrelated Monte Carlo events exhibited no such dependence on M, which indicates the absence of a statistical contribution in the experimental data. The flat behavior in the Monte Carlo events is expected for an independent emission of particles.

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I. INTRODUCTION

The study of non-statistical fluctuations in pionization at high and ultra-high energy collisions is a subject of major interest in high energy physics for better understanding of multiparticle production mechanism. In relativistic heavy-ion collisions, it is possible to reach a very high temperature over extended domains many times larger than the size of a single hadron. Quantum chromodynamics (QCD) suggests that color confinement should occur, leading to a new phase of matter known as the quark gluon plasma (QGP). Fluctuation studies on the distribution of produced particles carries ample information about the dynamics of the emitting source in the large state of nucleus-nucleus interactions where the nuclear matter is highly excited and diffused. Bialas and Peschanski [1,2] were the first to resolve unusual fluctuations in a cosmic ray event (JACEE) [3] of heavy-ion interactions through the analysis of the distribution of produced particles with the help of scaled factorial moments (SFMs) in the rapidity phase space. They suggested a power-law scaling behavior of the SFMs on phase-space interval sizes down to the detector's resolution and described the phenomenon as "intermittency", in analogy with the turbulence bursts in classical fluid mechanics [4]. The scaled factorial moment method cannot only predict the existence of large non-statistical fluctuations but also be used to investigate clearer the patterns and the original fluctuations. The success of intermittency analysis in resolving non-statistical fluctuations in cosmic rays JACEE event inspired many other groups to study it more elaborately by using accelerator data on a wide variety of projectiles, targets and incident energies.

Most of the experimental results on the SFMs support the intermittent behavior. Various data sets [5–10] were presented in support of this interpretation, but the results from the analyses of various data were not enough for an unambiguous interpretation of the effect. With

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