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Some observations on Levy stability and intermittency in nucleus-nucleus interactions at SPS energies

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ABSTRACT

The power law relation between higher order and second order scaled factorial moments is studied in one dimensional pseudo-rapidity phase (η) space in the interactions of ^{32}S beam with CNO, AgBr and Emulsion at incident energy of 200 AGeV. Observation for such a power law may indicate a self similar cascade mechanism in multiparticle production process. The values of slope, β_q are found to be independent of target size. The value of the scaling exponent $\upsilon = 1.412$ obtained is higher than the critical value $\upsilon = 1.304$, indicating that no second order phase transition exists in our data. The ratio of anomalous fractal dimensions, d_q/d_2 is found to increase with increase in the order of moments, q. The dependence of d_q/d_2 on q indicates a multifractal structure and the presence of self-similar cascading mechanism in our data. The d_q/d_2 values are well described by the Levy-stable distribution with Levy index $\mu = 1.562$ which is consistent with and lies within the Levy stable region ($0 \leq \mu \leq 2$). The multifractal spectrum is concave downward with a maximum at $q = 0$. The decrease in D_q with increasing q shows that there is a self affine multifractal behaviour in multiparticle production in our data.

1. Introduction

Recently, the observation of large density fluctuations of nonstatistical origin in small regions of phase space, called intermittency [1–2], has triggered considerable interest, both theoretical and experimental. Bialas and Peschanski [1–2] have proposed an attractive formalism to study these multiplicity fluctuations in terms of noise-suppressed scaled factorial moments (SFMs). They suggest that if a power-law dependence of scaled factorial moments on the rapidity bin size exists, it is clearly indicative of the presence of intermittency. Several theories have been propounded to explain intermittency, some of which are the formation and decay of jets in a self-similar pattern [1–4], phase transition and the formation of quark-gluon plasma [5], hadronic-Cerenkov radiation [6–7], Ising model [8], and multiparticle correlations [9–13]. Intermittent behaviour of secondary particles has also been confirmed in several experiments involving different projectiles and targets, namely, e^+ e^- annihilation [14], muon-hadron [15], hadron-hadron [16], hadron-nucleus [17], and nucleus-nucleus [18]. However, there is no indication for a single mechanism which could explain the observed intermittency in various collision processes. So it is required to study in detail and understand the intermittency more rigorously.

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