# Nonstatictical fluctuation in $^{16}$O-Ag/Br collisions at 200A GeV/c

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Presence of non-statistical fluctuations in the density distribution of singly charged particles produced in $^{16}$O-Ag/Br interactions at an incident momentum of 200A GeV/c, has been identified and characterized with the help of the intermittency technique [1]. Nuclear photo-emulsion data on $^{16}$O-Ag/Br events have been used in the analysis [2]. In each of the 280 events present in the sample, the projectile nucleus underwent complete fragmentation. The average shower track multiplicity $\langle n_s \rangle$ = 119.26 ± 3.59. The one-dimensional analysis of data is confined to pseudorapidity (η) and azimuthal angle (φ) spaces. We have calculated and plotted the Scaled Factorial Moments ($F_q$) of different orders (q = 2-6) both in the η-space (Fig.1) and in the φ-space (Fig.2). A power law type scaling behavior: $F_q = (\delta X)^{-\Phi(q)}$ at phase space resolution $\delta X$, characterizes the intermittency phenomenon. This scaling property is verified from the linear variations of $ln\langle F_q \rangle$ against $lnM$ in both η and φ space, where $M$ is the phase space partition number. For each q the best linear behavior is obtained by the Pearson's $r^2$ coefficient.

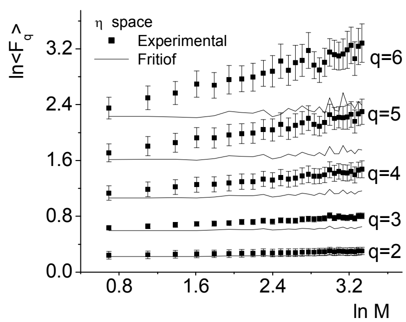


**Fig. 1**

In η-space the experimental results have been compared with the FRITIOF prediction [3] and in φ-space with the independent emission model. The intermittency exponent $\Phi_q$ is a measure of self-similarity in the density fluctuations beyond statistical origin. They are evaluated and there values are quoted in Table 1. In almost all cases the $r^2$ values are close to unity, confirming goodness of fit. In φ-space the $\Phi_q$ values are consistently higher than those in the *η*-space, indicating that, the observed intermittency effects are not independent of the basic phase space variable considered.

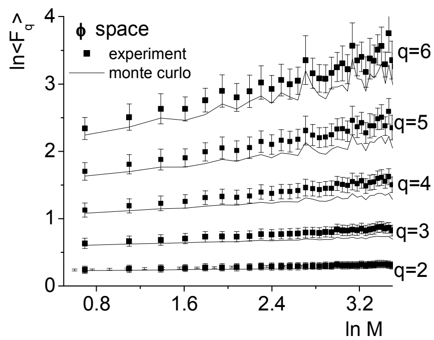


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**Fig. 2**

| | *η* – space | | φ - space | |
|---|---|---|---|---|
| q | $\Phi_q$ | $r^2$ | $\Phi_q$ | $r^2$ |
| 2 | 0.0289 | 0.939 | 0.0333 | 0.984 |
| 3 | 0.0779 | 0.935 | 0.0972 | 0.951 |
| 4 | 0.1534 | 0.930 | 0.1925 | 0.945 |
| 5 | 0.2534 | 0.927 | 0.3172 | 0.947 |
| 6 | 0.3771 | 0.915 | 0.4618 | 0.918 |

**Table 1**

To examine whether or not the intermittency effects are merely due to contributions coming out of lower order correlation functions, the normalized exponents defined as: $\zeta_q = \Phi_q / {}^qC_2$ for q ≥ 2, and three particle correlation in terms of the normalized slopes as: $\zeta_q^{(3)} = (q-2)\,\xi_3 - (q-3)\,\zeta_2$ are introduced in [4]. Both types of normalized exponents were evaluated and are plotted against q in Fig. 3 and Fig. 4, respectively. A more or less linear dependence of $\xi_q$ as well as of $\xi_q^{(3)}$ with q can be observed. From this analysis it cannot be unambiguously concluded that all correlations for q ≥ 4, can be understood in terms of a two and three particle correlations.

For a self-similar cascade mechanism the underlying probability density is described by a Log-Levy type of distribution function [5] that is characterized by a stability index (μ) considered to be a measure of the degree of multifractality within a physically allowed limit 0≤ μ ≤ 2. Under the Levy-law approximation, the ratio of anomalous dimensions is expected to follow a relation: $\beta_q = (d_q/d_2)(q - 1) = (q^{\mu} - q) / (2^{\mu} - 2)$.

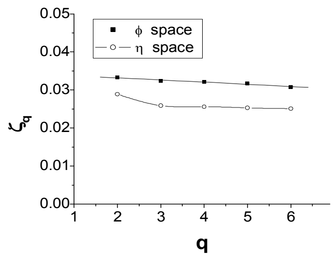


**Fig. 3**

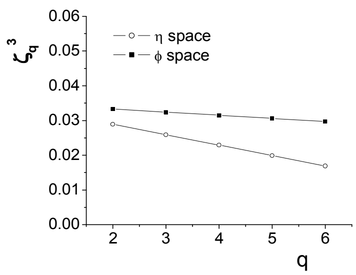


**Fig. 4**

In Fig. 5 our results on the anomalous dimensions ($d_q$) obtained from intermittency have been shown graphically. For the η-space: $\mu = 1.802$ and for φ-space: $\mu = 1.903$. In both cases $\mu > 1$, which indicate presence of wild non-Poisson type fluctuations in the density of particles.

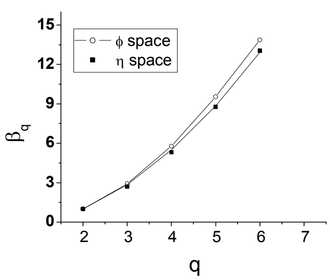


Fig. 5

According to the Ginzburg-Landau (GL) theory for phase transition, it has been predicted that a thermal phase transition may be a reason for intermittency, where a universal parameter ν [5] describes the variation of $d_q$: $d_q/d_2 = (q - 1)^{(\nu - 1)}$. It has been found from the Fig. 6 that $\nu = 1.571$ and 1.623 in $\eta$-space and φ-space, respectively. These values of are not at all close to the universally accepted value $\nu = 1.304$, necessary for a thermal phase transition to take place.

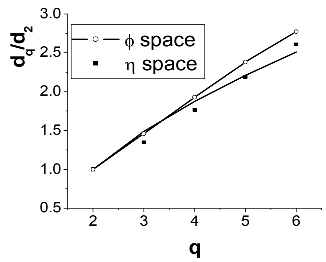


**Fig. 6**

The behavior of, $\lambda_q = \Phi_q/(q+1)$, as a function of q [5] can be utilized as another tool to check occurrence of non-thermal phase transition in particle production process. The plot is given in Fig.7, where no definite minimum indicates absence of non-thermal phase transition.

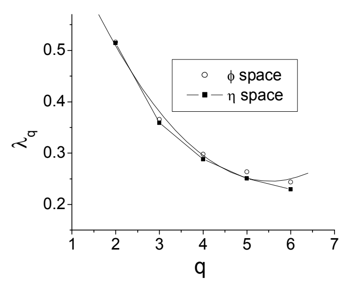


**Fig. 7.**

The presence analysis therefore indicates presence of weak intermittency in 1-dim, that cannot be explained by the simulated data. No definite conclusion can be drawn regarding the observed effects.

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**References:**

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