SEARCH FOR AN INTERMITTENCY SIGNAL IN Au+Au COLLISIONS*

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Results of a search for an intermittency signal in Au+Au collisions at 800 AMeV beam energy are presented. Data from the FOPI detector at GSI Darmstadt were analysed. No intermittency signal was found in either rapidity or charge distributions. Intermittency is present in azimuthal angle distribution.

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In this paper we present results of a search for an intermittency signal in Au+Au collisions at 800 AMeV beam energy. Intermittency is a statistical concept used in the analysis of fluctuations and correlations in multiparticle distributions. Intermittency analysis may yield information on the dynamics of the decaying system, *e.g.* it may help to determine which mechanism of fragment production is more adequate: sequential or prompt decay. To search for intermittency we used the method introduced by Białas and Peshansky [1]. They proposed to study the *horizontal normalised scaled factorial moments of rank i* :

$$\left\langle F_i^{\delta X} \right\rangle = \frac{\left\langle \sum_{m=1}^{M} k_m(k_m-1)\ldots(k_m-i+1) \right\rangle_{\rm ev} \Big/ \langle N \rangle_{\rm ev}^i}{\sum_{m=1}^{M} (k_m^{\rm INC})^i \Big/ (N^{\rm INC})^i}, \qquad (1)$$

where δX is the bin width of the distribution of variable X, M — the number of bins, k_m — number of particles in the m-th bin in an event, N — multiplicity in an event, $k_m^{\rm INC}$ — number of particles in the m-th bin of the

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inclusive spectrum, $N^{\rm INC}$ — number of particles in the inclusive spectrum. $\langle\ \rangle_{\rm ev}$ denotes averaging over the sample of events.

Intermittency implies a power-law dependence of normalised scaled factorial moments on the bin size

$$\langle F_i^{\,\delta X}\rangle \propto (\delta X)^{-\alpha_i} \quad . \tag{2}$$

The exponent α_i is called the "intermittency exponent". When intermittency occurs, the moments reflect the self-similarity at various resolutions. The exponent α_i is related [2] to the anomalous fractal dimension d_i

$$d_i = \frac{\alpha_i}{i-1} \quad . \tag{3}$$

It was shown in Ref. [3], that in the sequential process of fragmentation dimensions d_i are proportional to the rank i, while in a prompt process they are constant. Thus, an intermittency analysis of the distribution quantifies the fractal nature of the fluctuations and may yield important information on the dynamics of the decaying system.

Below the results of our analysis of the Au+Au collisions at 800 AMeV beam energy are presented. The data were obtained with the FOPI detector [4] at the SIS accelerator in GSI Darmstadt. The normalised scaled factorial moments were calculated for charge (Z), rapidity (y) and azimuthal angle (φ) distributions in an event-by-event analysis.

Mixing of events of different impact parameters may produce trivial intermittent behaviour, therefore it is very important to set stringent centrality selection criteria. Two selection criteria were used: high multiplicity (PM5) and a high transversal-to-longitudinal energy ratio (ERAT5) [5]. The ERAT ratio was calculated taking into account the relativistic relation between energy and momentum

$$\mathrm{ERAT} = \left(\sum_i \frac{{p_\perp}^2}{E+m}\right) \bigg/ \left(\sum_i \frac{{p_\parallel}^2}{E+m}\right) . \tag{4}$$

In Fig. 1 we show the values of moments: $\langle F_i^{\delta Z}\rangle$ (left) and $\langle F_i^{\delta y}\rangle$ (right), of rank $i=2$, 3, 4, 5, calculated for the charge and rapidity distributions, as a function of bin widths. There appears to be no intermittency signal present in our sample of events in distributions of these variables. This result is in agreement with our earlier findings [6] at 150 and 400 AMeV beam energy.

Intermittency behaviour is seen in the azimuthal angle distributions. In Fig. 2 the values of moments $\langle F_i^{\delta\varphi}\rangle$ of rank $i=2$, 3, 4, 5, are shown. Solid lines represent the best fit of the power-law function to the experimental data in the small bin region.

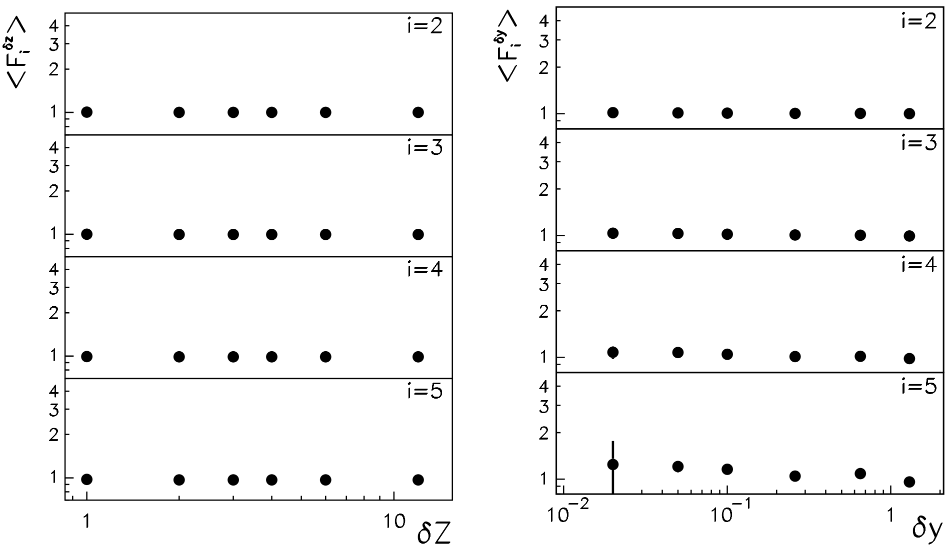

Fig. 1. Values of $\langle F_i^{\delta Z}\rangle$ — (left) and values of $\langle F_i^{\delta y}\rangle$ — (right), of rank $i = 2$–5, as a function of bin widths δZ and δy, respectively, for central Au+Au collisions, at 800 AMeV beam energy.

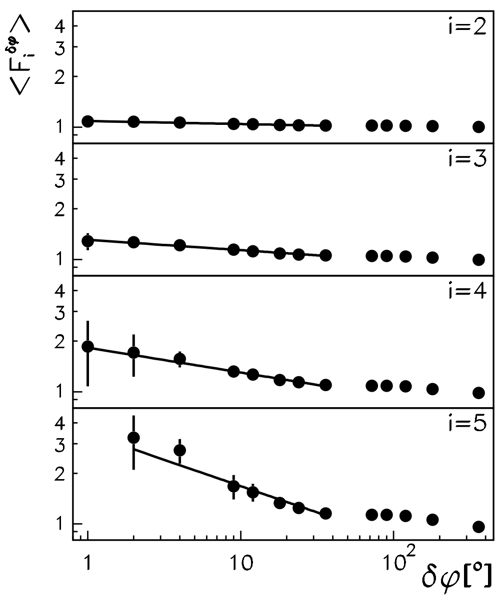

Fig. 2. Values of $\langle F_i^{\delta\varphi}\rangle$ of rank $i = 2$–5, as a function of bin width $\delta\varphi$, for central Au+Au collisions, at 800 AMeV beam energy.

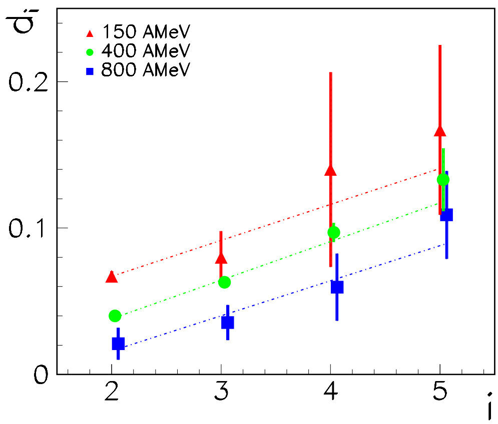

Fig. 3. Values of the anomalous fractal dimension, as a function of rank i, for Au+Au collisions.

The dependence of the anomalous fractal dimension on the rank i is shown in Fig. 3 for three beam energies: 800 AMeV (squares, this analysis), 150 AMeV (triangles [6]) and 400 AMeV (circles [6]). Dashed lines represent linear fits. The linear dependence of the fractal dimension on rank i may suggest the sequential mechanism of fragment production. It is interesting to note that with increasing bombarding energy the absolute values of the anomalous fractal dimension decrease, while the slope seems to remain constant. The decrease of the fractal dimension values with increasing energy has also been observed at ultra relativistic energies for light asymetric systems [7].

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