$2d$ intermittency in ^{28}Si-Ag(Br) interaction at 14.5A GeV

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The 'intermittency' phenomenon, as an evidence of the dynamical fluctuation has been confirmed almost in all high energy collisions [1]. Recently we have reported a $1d$ intermittency in the ^{28}Si-Ag(Br) interaction at 14.5A GeV [2], which could not be reproduced by the Ultra-relativistic Quantum Molecular Dynamics (UrQMD) [3]. Since the actual process of particle production takes place in three dimension, the $1d$ analysis may not provide all information regarding the dynamics. Therefore, a $2d$ intermittency analysis is performed for the same set of data. The $2d$-space is constituted by the pseudorapidity (η) and the azimuthal angle (φ). To make the results independent of the shape of the underlying distribution instead of (η, φ) the cumulative variables (X_η, X_φ) [4] are used.

We calculate the $2d$ scaled factorial moments (SFM) F_q : $q = 2, 3, 4$ for a self-similar partitioning of the phase space. The results are shown in FIG.1 for both the data and the UrQMD simulation. The experimental F_q values are fitted with a straight line (leaving the first few points). The UrQMD points on the other hand are found to be scale independent. The intermittency exponents β_q along with the χ^2(dof) are given in TABLE I. Since the $2d$ space is asymmetric we further partition it in a self-affine way by introducing the Hurst exponent H. Following a method suggested in [5] we calculate $\langle F_2 \rangle$ over a wide range of H, and some of them are plotted in FIG.2. A quadratic function is used to fit the data. The curvature coefficient 'a' along with the χ^2(dof) values are given in TABLE II. The TABLE shows that the anomalous scaling of F_2 can be retrieved for two different values i.e., $H = 0.5$ and 2.5. Using these H values we also

TABLE II: The quadratic fit parameter (a) with χ^2(dof) for different H values.

H	a	χ^2(dof)
0.4	0.0051±0.0033	6.17(45)
0.5	0.0047±0.0026	4.79(45)
0.6	0.0066±0.0032	5.72(45)
1.0	0.0180±0.0023	13.5(45)
1.5	0.0126±0.0030	8.45(45)
2.0	0.0132±0.0036	8.56(45)
2.4	0.0051±0.0039	5.18(45)
2.5	0.0032±0.0021	3.60(45)
2.6	0.0041±0.0035	3.69(45)

TABLE I: The $2d$ intermittency exponents (β_q) of order $q = 2, 3, 4$ for $H = 1.0$: Experimental and UrQMD prediction.

	Experiment		UrQMD	
q	β_q	χ^2(dof)	β_q	χ^2(dof)
2	0.086±0.005	18.92(32)	0.0043±0.0027	04.27(14)
3	0.322±0.036	28.98(32)	0.0002±0.0046	10.28(14)
4	1.124±0.074	44.88(32)	0.0103±0.0092	26.45(14)

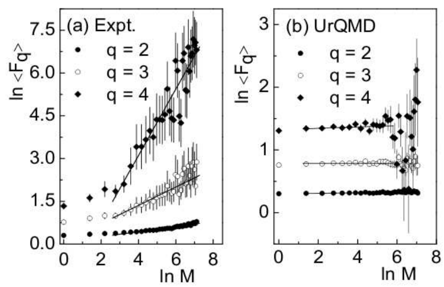

FIG. 1: $\ln \langle F_q \rangle$ vs. $\ln M$ for a self-similar process.

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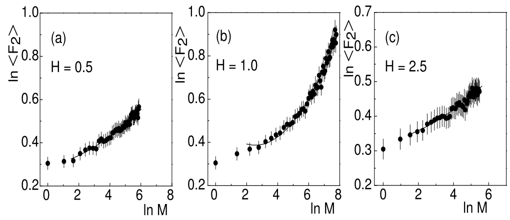

FIG. 2: $\ln\langle F_2\rangle$ vs. $\ln M$ for $H = 0.5,\ 1.0$ and 2.5.

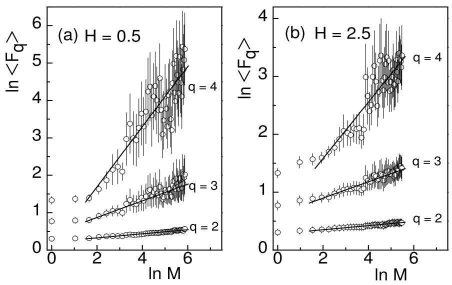

FIG. 3: $\ln\langle F_q\rangle$ vs. $\ln M$ for a self-affine process.

calculate F_3 and F_4 and plot them in FIG.3 against the resolution size. Corresponding β_q values are given in TABLE III. It is found that the β_q values for $H = 2.5$ are consistently less than those for $H = 0.5$.

TABLE III: The $2d$ intermittency exponents (β_q) of order $q = 2, 3, 4$ for $H = 0.5$ and 2.5.

	H = 0.5		H = 2.5	
q	β_q	χ^2(dof)	β_q	χ^2(dof)
2	0.053±0.004	06.39(46)	0.035±0.004	04.27(46)
3	0.222±0.012	27.06(46)	0.141±0.008	16.82(46)
4	0.778±0.033	46.23(46)	0.436±0.022	59.63(46)

The anomalous fractal dimension d_q defined as $d_q = \beta_q/(q-1)$ establishes a direct link between the intermittency and the (multi)fractality. For a random cascading process d_q increases linearly with q but for a QGP to hadron phase transition it should not change. A d_q versus q plot is given in FIG.4(a) which is in agreement with a cascading process. The intermittency strength

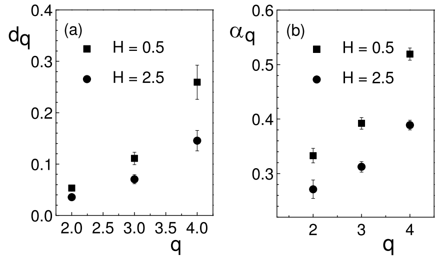

FIG. 4: Plot of (a) the anomalous fractal dimension, (b) the intermittency strength.

$\alpha_q = \sqrt{\frac{6\ln 2}{q}(D - D_q)}$, where $D_q(= D - d_q)$ is the generalised fractal dimesnion and D is the topological dimension of the underlying space [6]. In FIG.4(b) α_q is plotted against q. A linear rise of α_q with q once again supports the cascade model prediction.

Acknowledgments

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