Scaling of charged particle multiplicity distrubutions in relativisitc nuclear collisions

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Introduction

Validity of KNO scaling in hadron-hadron and hadron-nucleus collisions has been tested by several workers[1-6] . Multiplicity distributions for p–emulsion interactions are found to be consistent with the KNO scaling hypothesis for pp collisions[2]. The applicability of the scaling law was extended to FNAL energies by earlier workers[5,6]. Slattery[7] has shown that KNO scaling hypothesis is in fine agreement with the data for pp interactions over a wide range of incident energies. An attempt, is, therefore, made to examine the scaling hypothesis using multiplicity distributions of particles produced in 3.7A GeV/c ^{16}O–, 4.5A GeV/c and 14.5A GeV/c ^{28}Si–nucleus interactions. The formulation of KNO scaling function states that at a given incident energy the following relations may hold:

$$P(n_s) = \frac{1}{<n_s>}\psi(z) \quad \text{and} \quad z = \frac{n_s}{<n_s>} \qquad (1)$$

where n_s is the number of secondaries produced in an interaction, $P(n_s)$ is the probability of the relativistic charged secondaries produced in the final state of the collision and Ψ (z) is an energy - independent function. Validity of KNO scaling may be tested by examining the behavior of the parameter, $S_n(z) = \sum_{i=n_s}^{\infty} P_i$ as a function of z.

For this purpose, a randon sample, comprising of 290, 555 and 1100 ^{16}O–nucleus interactions at 3.7A GeV/c and ^{28}Si–nucleus collisions at 4.5A and 14.5A GeV/c respectively are analyzed.

Results and discussions

Ψ (z) for various values of z at different projectile energies are displayed in Fig.1. It may be of interest to mention that multiplicity distributions of relativistic charged particles produced in 3.7A GeV/c ^{16}O–Em, 4.5A GeV/c and 14.5A GeV/c ^{28}Si–Em collisions are reproducible by the KNO scaling function, $\Psi(z)$. However, departure of results obtained for the experimental data from the KNO predictions are observed in the regions of higher multiplicities. This fact is clear from Fig.1,as all the data points at lower multiplicity values almost lie on the curve (Eq. 2) and clear deviation is only seen at the tails of the multiplicity distributions, where largest statistical errors are expected.

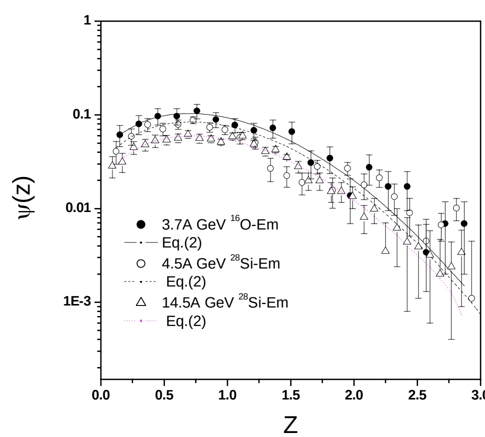

Fig.1 Variations of ψ(z) with z for 3.7A GeV/c ^{16}O-, 4.5A and 14.5A GeV/c ^{28}Si-emulsion collisions.

The solid curves in the plots are the best fits to the data obtained using the expression:

$$\psi(z) = (Az + Bz^3)\exp(-Cz) \qquad (2)$$

where A, B and C are constants. The values of these contants obtained for the best fits to the data are presented in Table1.

For testing the validity of KNO scaling, the values of the parameter, S_n (z) are estimated for 3.7A GeV/c ^{16}O-Em, 4.5A and 14.5A GeV/c ^{28}Si–Em interactions and the results are exhibited in Fig.2. The data for the parameter S_n (z) for the projectile energies considered by us are observed to overlap each other in the lower multiplicity regions. However, the deviations from the KNO predictions observed in the higher multiplicity regions hint towards occurrence of a new phenomenon contributing to high multiplicities in the collisions.

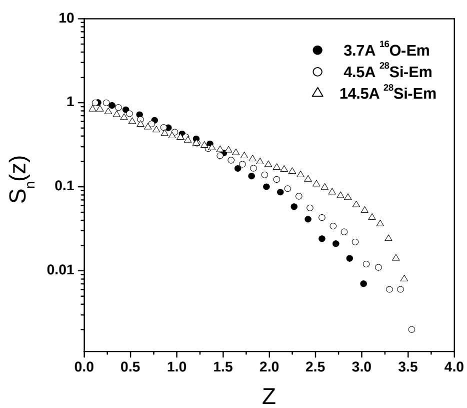

Fig.2 Plots for variation of S_n(z) with z in 3.7A GeV/c ^{16}O-, 4.5A and 14.5A GeV/c ^{28}Si-emulsion collisions.

Table1. Values of the constants A, B and C appearing in Eq. (2) obtained for the best fit to the data.

Projectile type	Constants		
	A	B	C
3.7A GeV ^{16}O-Em	8.42 ±1.42	10.33 ±2.43	2.49 ±0.86
4.5A GeV ^{28}Si-Em	10.29 ±1.85	12.56 ±1.93	2.49 ±0.90
14.5A GeV ^{28}Si-Em	10.26 ±1.94	12.81 ±2.06	2.51 ±1.00

Conculsions

Validity of KNO scaling is tested by studying the variations of S_n (z) with z for relativistic charged particles produced in 3.7A GeV/c ^{16}O–Em, 4.5A GeV/c and 14.5A GeV/c ^{28}Si–Em collisions. Scaling violations are minmal and further show occurrence of approximate scaling behavior.

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