Multiplicity correlations in 60 and 200A GeV/c ^{16}O-nucleus interactions

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Introduction

A large number of experiments have been carried out to investigate the dynamics of multiparticle production in relativistic nucleus-nucleus collisions. One of the major goals of these experiments was to study the Quark-Gluon substructure of nuclear matter and properties of bulk hadronic matter and its interactions under extreme conditions, i.e. at very high energy densities and temperature. The new state of matter expected to form under extreme conditions is known as Quark-Gluon Plasma (QGP)[1]. Certain aspects of relativistic nuclear interactions such as multiplicity distribution, multiplicity correlations and pseudorapidity distribution are expected to provide very useful information about the matter produced in relativistic nuclear collisions. Multiplicity correlations are the study of the variations of multiplicity of one type of secondary charged particles with the mean multiplicity of other type of secondary charged particles.

In the present work, results on various types of multiplicity correlations among secondary charged particles produced in 60 and 200A GeV/c ^{16}O-nucleus collisions are analyzed.

Experimental Details

Data sets comprising 422 and 223 events produced in 60 and 200A GeV/c ^{16}O-nucleus collisions respectively are investigated. Data sample include collisions with $n_h \geq 0$, where n_h represent the number of charged particles produced with relative velocities, $\beta \leq 0.7$. Secondary charged particles produced in these collisions are separated into black, grey, shower and highly ionizing particles (target fragments) in accordance with their specific ionization or velocity or range[2,3]. The multiplicities of black (b), grey (g), shower (s) and heavily ionizing tracks (h) produced in an interaction are represented by n_s, n_g, n_b and n_h respectively. The n_h tracks producing particles are defined as $n_h = n_b + n_g$.

Results and Discussion

Variation of multiplicity of a particular type of secondary charged particle with the mean multiplicity of the other type is expected to be of great significance in explaining multiparticle production. Shower and grey tracks producing particles characterize the first stage of the inelastic collision between the two nuclei and black track producing particles corresponds to the next stage of the collision when the de-excitation process occurs through the evaporation of nucleons.

To understand the nature of the multiplicity correlations [4-6], an attempt is made to investigate $<n_b>$ vs. n_s, $<n_g>$ vs. n_s and $<n_h>$ vs. n_s variations. For this purpose, correlations of the type: $<n_i(n_j)>$, where i, j = b, g, s and h with $i \neq j$ are studied.

In the present analysis, multiplicity correlations are represented by the least squares fittings of the type:

$$<n_i(n_j)> = b_{ij} + a_{ij}\, n_i$$

where 'a' and 'b' represent slopes and intercepts of the linear relationships respectively. The behavior of multiplicity correlations of secondary particles produced in interactions of and 200A GeV/c ^{16}O-nucleus collisions are examined. The variations of $<n_b>$, $<n_g>$ and $<n_h>$ with n_s are shown in Figs 1-2 along with their linear fits to the data. The values of inclination coefficients a_{ij} and intercepts b_{ij} for ^{16}O -AgBr at 60 and 200 A GeV/c are presented in Table 1.

Table 1: Slopes and Intercepts

Projectile	$\mathbf{n_s}$	$\mathbf{<n_b>}$	$\mathbf{<n_b>}$	$\mathbf{<n_h>}$
^{16}O-AgBr 60A GeV/c	n_s	0.01±0.004 7.40±0.390	0.10±0.006 3.23±0.360	0.12±0.007 10.53±0.520
^{16}O-AgBr 200A GeV/c	n_s	0.01±0.003 7.92±0.490	0.05±0.003 3.16±0.470	0.06±0.004 11.23±0.630

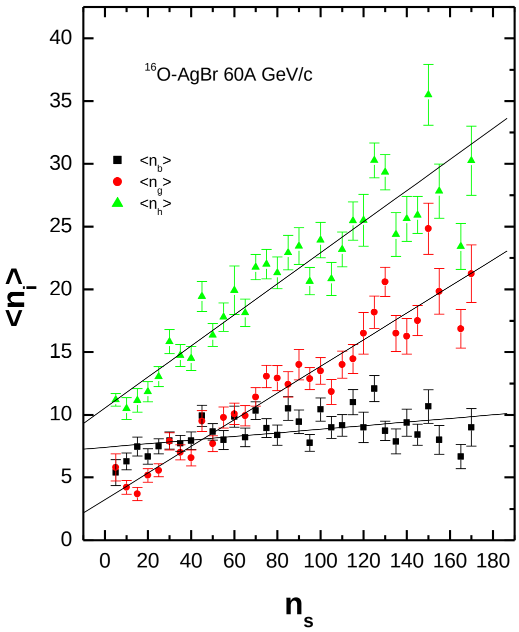

Fig. 1 Multiplicity correlations of various charged particles produced in the interactions of ^{16}O-AgBr at 60A GeV/c.

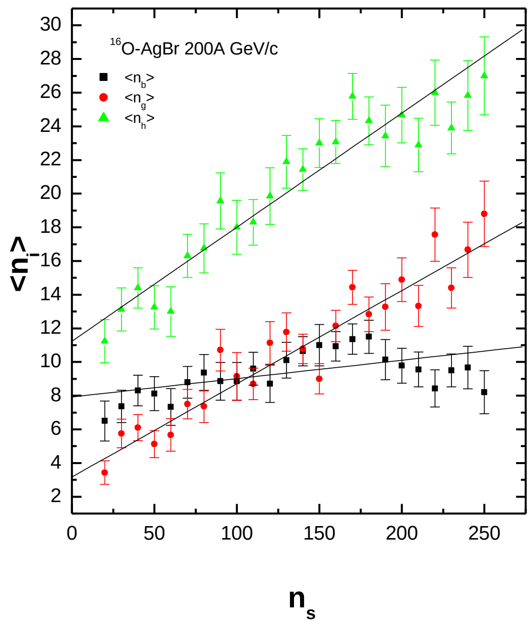

Fig. 2 Multiplicity correlations of various charged particles produced in the interactions of ^{16}O-AgBr at 200A GeV/c

Figure 1 shows the variations of $<n_b>$, $<n_g>$ and $<n_h>$ with n_s for ^{16}O-nucleus interactions at 60A GeV/c. It is clear from the figure that the values of $<n_g>$ and $<n_h>$ linearly increase with increasing values of n_s. But a saturation is observed in the values of $<n_b>$ vs n_s plot around $n_s \sim 80$ and 130.

Figure 2 shows the variations of $<n_b>$, $<n_g>$ and $<n_h>$ with n_s for ^{16}O-nucleaus interactions at 200A GeV/c. From the figure it is clear that there are linearly increasing relationships. Values of $<n_g>$ and $<n_h>$ increase with increasing the values of n_s. The values of $<n_b>$ shows a saturation trend around $n_s \sim$ 120 and 170.

Conclusions:

On the basis of present study the following important conclusions may be drawn:

1. The multiplicity correlations between $<n_b>$, $<n_g>$ and $<n_h>$ vs n_s are linear and represented quite well by the linear fits to the data.
2. All these figures support existence of strong correlations amongst various types of secondary charged particles produced.
3. The multiplicity of relativistic charged particles is found to be linearly related to the mean multiplicity of heavily ionizing particles.
4. The behavior of $<n_b>$ vs. n_s plot shows saturation for both the data sets.

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