Multiplicity Distribution of Particles Produced in 3.7A GeV/c ^{16}O-AgBr Collisions

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Introduction

Multiplicity distribution of secondary particles is regarded a very sensitive characteristics of relativistic nuclear collisions for testing predictions of various phenomenological and theoretical models proposed to explain the mechanism of multiparticle production in such collisions [1-4].

Multiplicity distributions of relativistic charged particles produced in high energy hadronic and nuclear collisions are reproduced [1-2] by the negative bionomial distribution (NBD) of the following form:

$$P(n, \bar{n}, k) = \frac{k(k+1)..(k+n-1)}{n!} \frac{(\bar{n})^n (k)^k}{(\bar{n}+k)^{n+k}} \quad (1)$$

where $\bar{n}$ and k are free parameters.The average multiplicity, $\bar{n}$ and the square of the dispersion, D^2 , defined by $D^2 = \langle n^2 \rangle - \langle n \rangle^2$ are related as:

$$D^2 = \bar{n} + \frac{\bar{n}^2}{k} \quad (2)$$

The parameters of the NBD function obviously vary with the process of interactions involved and depend on energy and pseudorapidity windows [2].

The processes involved in the production of relativisc charged particles can be explained reasonably well by the cascade mechanism [3]. According to the model, produced particles originate from a primary cluster; all the particles of a common cluster form a clan. The clans have no mutual interaction; however particle emitted due to decay of a clan are strongly correlated. In view of importance of multiplicity distribution of relativistic charged particles, n_s and distribution of compound multiplicity of particles produced in 3.7A GeV/c ^{16}O-AgBr collisions are investigated.

Experimental Details

Data on the interactions of 3.7A GeV/c ^{16}O beam from SPS, CERN with AgBr nuclei having $n_h \geq 8$, where n_h represents the number of charged particles produced in an interaction with relative velocity, $\beta \leq 0.7$, are analyzed. The number of charged particles having $\beta > 0.7$ in a collision is represented by n_s and compound multiplicity is denoted by n_c (= $n_s + n_g$) where n_g represents the number of charged particles emitted with relative velocities lying in the interval $0.3 \leq \beta \leq 0.7$. A matching sample of Monte Carlo AMPT generated events with the same description are also analyzed for the purpose of comparison.

Results and Discussion

The validity of NBD is tested by investigating the behaviours of n_s and n_c distributions of particles produced in 3.7A GeV/c O^{16}-AgBr collisions. Figs 1-2 exhibit n_s and n_c distributions for the experimental and AMPT simulated data. It may be noted from the figures that the shapes of both the distributions are nicely reproduced by the negative binomial distributions given by Eq. (1). It may also be observed from the figures that the distribution for the experimental data is slightly wider than the one for the AMPT data in both n_s and n_c distributions. The values of the mean multiplicity, $\bar{n}$, k and $\chi 2$/D.F. for the best fit to the data are obtained using the CERN standard programme MINUIT; these values are presented in Tables 1-2. The values of $\langle n_s \rangle$ and $\langle n_c \rangle$ obtained from the NBD fits are found to be comparable with their corresponding experimental values.

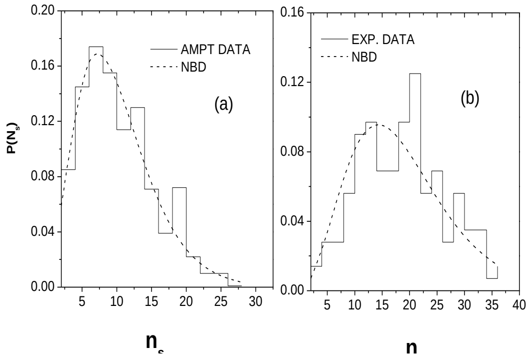

Fig. 1 n_s distributions of particles produced in 3.7A GeV/c ^{16}O-AgBr collisions for the experimental and AMPT data.

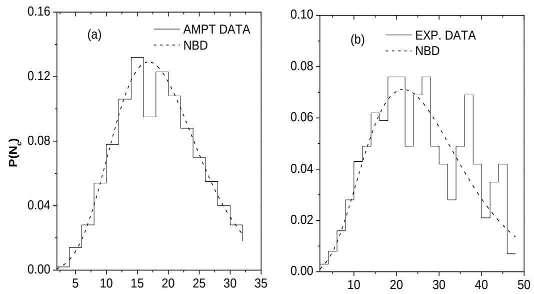

Fig. 2 n_c distributions (Eperimental and AMPT events) in 3.7A GeV/c ^{16}O-AgBr collisions.

Table 1. Values of the constants $\overline{n}$. and k appearing in Eq. (1) for the best fits to the experimental data on 3.7A GeV/c ^{16}O-AgBr collisions.

Type of distribution	Experimental	NBD parameters		χ^2 / D.F.
	< n >	$\overline{n}$	k	
n_s	17.79±0.69	18.27±2.21	4.63±0.51	0.84
n_c	24.22±0.93	26.30±3.31	5.56±0.66	0.83

Table 2. Values of the constants $\overline{n}$. and k appearing in Eq. (1) for the best fits to the AMPT data on 3.7A GeV/c ^{16}O-AgBr collision.

Type of distribution	AMPT	NBD parameters		χ^2 / D.F.
	< n >	$\overline{n}$	k	
n_s	9.938±0.18	9.48±0.49	4.43±0.89	1.10
n_c	17.76±0.20	18.57±0.80	11.33±1.24	1.20

Conclusions

From the study of multiplicity distributions of relativistic charged particles, n_s and compound multiplicity, n_c of the particles produced in 3.7A GeV/c ^{16}O-AgBr collisions, it is concluded that both the distributions can be nicely reproduced by negative binomial distribution (NBD) and this observation is also supported by the Monte Carlo AMPT model.

References

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