Characteristics of compound multiplicity in ^{28}Si-Em interactions at 14.6A GeV

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Introduction

The multiplicity of charged particles in high energy nucleus-nucleus interactions is an important parameter which indicates how many particles are produced in that interaction. The multiplicity distributions of produced particles help in learning the interaction mechanism. Generally, it is accepted that in high energy nucleus-nucleus collisions, the emission of fast target associated particles mostly the knocked out protons known as grey particles, takes place at a relatively latter stage of the collision. These fast protons with range L $\geq$ 3mm and relative velocity $0.3 \leq \beta \leq 0.7$ lies in the energy range 30-400 MeV. Moreover, these grey particles (N_g) are often assumed to be the measure of the number of encounters made by the incident hadron inside the target nucleus [1]. Also the particles produced in the first stage of collision with relative velocity $\beta \geq 0.7$ are known as relativistic shower particles (N_s). These particles are mostly pions with a small admixture of charged K-mesons and fast protons. The analysis of the experimental data in terms of multiplicity distributions for grey and shower particles collectively known as compound multiplicity (i.e. $N_c = N_g + N_s$) introduced by Jurak and Linscheid [2] is one of the main source of information about the mechanism of particle production. Many workers [3-5] analyzed the data on nucleus-nucleus (A-A) and h-A collisions to investigate some interesting features of compound multiplicity distribution. In this paper an attempt has been made to study the compound multiplicity of grey and shower particles taken together and their characteristics with respect to other emitting particles in inelastic collision of ^{28}Si with nuclear emulsion at 14.6A GeV. The experimental results have been compared with those obtained by analyzing events generated with the computer code FRITIOF based on Lund Monte Carlo model [6] for high energy nucleus-nucleus interaction. The modified FRITIOF code used in present work is based on version 1.6 (10 June 1986) of authors B Nilsson-Almquist and Evert Stenlund, University of Lund, Lund, Sweden [6]. A large sample of 10000 ^{28}Si- emulsion events have been generated using the code, where the proportional abundance of different categories of target nuclei present in the emulsion material has been taken into account.

Experimental Technique

In this experiment two stacks of FUJI type emulsion exposed horizontally to a 14.6A GeV ^{28}Si- beam at the Alternating Gradient Synchrotron (AGS) of Brookhaven National Laboratory (BNL), New York, USA have been utilized for the data collection. The other relevant details about the present experiments and target identifications may be seen in our earlier publications [7].

Results and Discussions

In order to check the role of target size dependence on the compound multiplicity, the present data is categorized into three groups of CNO, AgBr and Emulsion events. The compound multiplicity distributions are plotted in Fig. 1(a-c) for ^{28}Si projectiles at 14.6A GeV with different target groups i.e. CNO, AgBr and emulsion. It is evident from the figures that the compound multiplicity distributions for different target groups become wider with increasing target size. The experimental results are compared with the FRITIOF generated events and the results are also shown in Fig. 1(a-c) for ^{28}Si projectiles at 14.6A GeV respectively. This indicates that the FRITIOF model reproduces satisfactorily the N_c-multiplicity distributions and thus exhibit a similar and consistent behaviour as discussed in the experimental results. Thus, there is a good justification to reproduce the overall compound multiplicity distribution by the considered code of the

FRITIOF. The average values of compound multiplicity, $\langle N_c \rangle$ of present experimental data along with the corresponding FRITIOF data (given in parenthesis) for different projectiles at different energies [8-10] are presented in Table 1, which clearly exhibits that the average compound multiplicity increases with mass number and energy of the projectile.

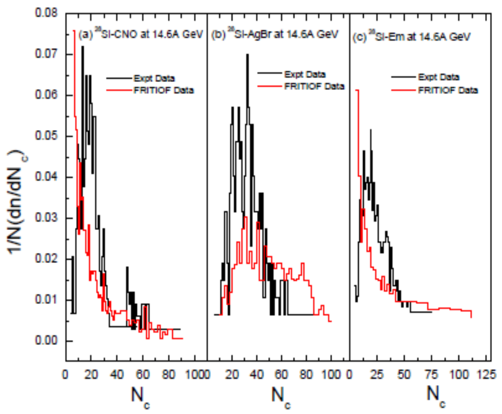

Fig. 1(a-c) : Compound multiplicity distributions in (a) ^{28}Si-CNO (b) ^{28}Si-AgBr and (c)^{28}Si-Em at 14.6A GeV along with the FRITIOF Data.

Table 1 The mean values of compound multiplicities $\langle N_c \rangle$

Energy A GeV	Collision Type	$\langle N_c \rangle$	Ref.
2.1	^{56}Fe-Em	23.17 ± 1.54	[10]
3.7	^{32}S-Em	16.62 ± 0.49	[10]
4.5	^{28}Si-Em	21.97 ± 1.23	[8]
60	^{16}O-Em	36.28 ± 2.30	[9]
14.6	**^{28}Si-Em**	**24.20 ± 0.17 (29.54 ± 0.26)**	**Present Work**

Multiplicity correlations among the secondary particles produced in nucleus-nucleus collisions have been widely studied which help to investigate the mechanism of particle production. In order to examine the behaviour of multiplicity correlations of secondary particles produced in nucleus-nucleus collisions, we have studied the following correlations in the interactions of ^{28}Si-Em at 14.6A GeV respectively. Fig. 2 shows the correlations of $\langle N_b \rangle$, $\langle N_g \rangle$, $\langle N_h \rangle$ and $\langle N_s \rangle$ with N_c for ^{28}Si-emulsion interactions at 14.6A GeV. The experimental results have been analyzed by using linear fits of type $\langle N_x(N_c) \rangle = c + N_c k$, where $N_x = N_b, N_g, N_h, N_s$ and the values of inclination coefficients, k, are presented in Table 2. It is evident from the figure that the values of $\langle N_b \rangle$, $\langle N_g \rangle$, $\langle N_h \rangle$ and $\langle N_s \rangle$ increases with increasing values of N_c. The increase of $\langle N_s \rangle$ with N_c is much stronger than the others at both energies and projectiles. Here also the inclination coefficients, k, obtained for the FRITIOF data (not shown in the figure) are in good agreement with the experimental data and are also given in the table along with the corresponding experimental data.

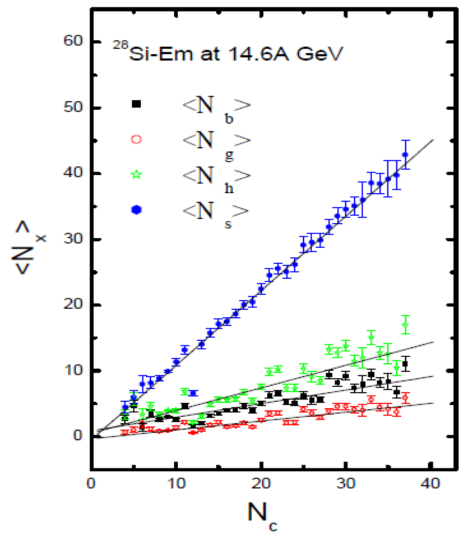

Fig. 2: Dependence of $\langle N_b \rangle$, $\langle N_g \rangle$, $\langle N_h \rangle$ and $\langle N_s \rangle$ on N_c in ^{28}Si -emulsion interactions at 14.6A GeV.

Table 2: Values of inclination coefficients.

Type of correlation	Inclination coefficients, k	
	Expt. Data	FRITIOF Data
N_c - $\langle N_b \rangle$	0.280 ± 0.007	0.080 ± 0.002
N_c - $\langle N_g \rangle$	0.181 ± 0.006	0.112 ± 0.006
N_c - $\langle N_h \rangle$	0.422 ± 0.005	0.122 ± 0.005
N_c - $\langle N_s \rangle$	1.433 ± 0.08	0.870 ± 0.009

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