Some Important Features of Compound Multiplicity in ^{28}Si and ^{32}S with Nuclear Emulsion Collisions at 14.6 and 200 AGeV

Mir Hashim Rasool[1], M. Ayaz Ahmad[2], Muzamil Ahmad Bhat[1] and *Shafiq Ahmad[1]
1*Department of Physics, AMU, Aligarh -202002, INDIA*
2*Physics Department, TabukUniversity,Tabuk, KSA*
* *e-mail: sahamd2004amu@yahoo.co.in*

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 or emitted 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 $L \geq 3$mm and relative velocity $0.3 \leq \beta \leq 0.7$ lies in the energy range 30 to 400 MeV. 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 [1] is one of the main sources of information about the mechanism of particle production. In this paper we present our experimental results on the compound multiplicity of grey and shower particles and their characteristics with respect to other emitting particles in inelastic collision of ^{28}Si and ^{32}S with nuclear emulsion at 14.6 and 200 AGeV respectively.

Experimental Technique:

In this experiment two stacks of Ilford G5 nuclear emulsion plates exposed horizontally to a ^{32}S-beam at 200 AGeV from Supper Proton Synchrotron, SPS at CERN and two Stacks of FUJI type emulsion exposed horizontally to a 14.6 AGeV ^{28}Si- beam at the Alternating Gradient Synchro – Phasotron (AGS) of Brookhaven National Laboratory (BNL), New York, USA have been utilized for the data collection. In the present study, the method of line scanning has been used to pick up the interaction stars. A total of 729 and 330 inelastic interactions were picked up for the two used ^{28}Si and ^{32}S beams respectively. The other relevant details about the present experiments and target identifications may be seen in our earlier publications [2, 3].

Results and Discussions:

Compound Multiplicity Distributions:

The compound Multiplicity distributions of ^{28}Si and ^{32}S at 14.6 and 200 AGeV with different target groups i.e. H, CNO and AgBr in nuclear emulsion are shown in Fig.1 (a,b). It is evident from the figure that the distributions become wider with increasing target size for both ^{28}Si and ^{2}S-Em interactions. Also it is observed that the peaks of distribution shifts towards higher N_c values in ^{32}S as compared to ^{28}Si. This indicates that the more compound particles are being produced with increasing projectile mass number and energy of projectile nucleus, thereby confirming conversion of energy into mass.

The mean compound Multiplicity $\langle N_c \rangle$ of different projectiles [3-6] at different energy are presented in Table 1 which clearly shows that the average compound multiplicity increases with mass number and energy of the projectiles. The average value of compound multiplicity $\langle N_c \rangle$, its dispersion $D(N_c) = \sqrt{} \langle N_c^2 \rangle - \langle N_c \rangle^2$ and the ratio $\langle N_c \rangle / D(N_c)$ are given in Table 2. It may be noticed from the table that $D(N_c)$ of events with different target groups is higher for ^{32}S projectile as compared to ^{28}Si projectile. So we can conclude that the complete disintegration of nuclei increases with increasing energy of the projectile. However, the values of $\langle N_c \rangle / D(N_c)$ remains almost constant for both the projectiles.

Table 1 The mean values of compound multiplicities <N_c>

Energy/nucleon	**Collisions Type**	**<N_c>**
2.1 [6]	^{14}N-Em	14.14 ± 0.42
2.1 [5]	^{56}Fe-Em	23.17 ± 1.54
3.7 [5]	^{32}S-Em	16.62± 0.49
4.5 [3]	^{28}Si-Em	21.97±1.23
14.6 Present work	**^{28}Si-Em**	**24.20±0.17**
60 [4]	^{16}O-Em	36.28± 2.30
200 [4]	^{16}O-Em	59.34±3.10
Present Work	**^{32}S-Em**	**91.61±0.58**

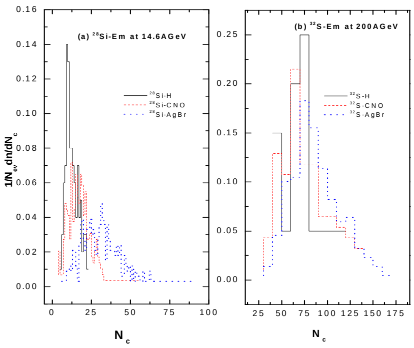

Fig. 1 : Compound multiplicity distributions for different emulsion targets in (a) ^{28}Si at 14.6AGeV and (b) ^{32}S at 200 AGeV with nuclear emulsion interactions.

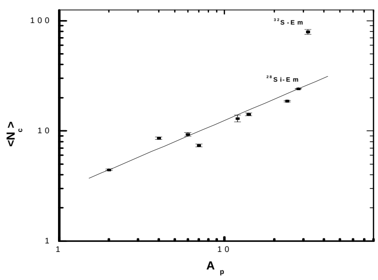

Fig 2 : Variation of <N_c> on the mass number A_p of different projectiles.

Table 2 Values of <N_c>, D(N_c) and <N_c>/D(N_c)

Projectile	Target	<N_c>	D(N_c)	<N_c>/D(N_c)
	H	77.10 ± 1.96	23.32 ± 1.12	3.30 ± 0.15
	CNO	83.28 ± 0.96	23.64 ± 1.11	3.52 ± 0.16
^{32}S at 200AGeV	Em	91.59 ± 0.53	27.90 ± 0.28	3.28 ± 0.23
	AgBr	96.34 ± 0.66	27.36 ± 0.42	3.52 ± 0.05
	H	13.05 ± 0.37	4.13 ± 0.25	3.15 ± 0.19
^{28}Si at 14.6AGeV	CNO	17.93 ± 0.77	7.28 ± 0.33	2.46 ± 0.13
	Em	23.89 ± 0.18	13.44 ± 0.11	1.82 ±0.02
	AgBr	32.05 ± 0.66	12.76 ± 0.63	2.51 ± 0.11

Variation of <N_c> with A_p:

Fig. 2 shows the variations of <N_c> with the mass number of projectile. It has been found that <N_c> increases rapidly with increasing mass of the projectile. The dependence of the average compound multiplicities on projectile mass number A_p has been studied using the following power law:

$$<N_c> = KA_p^{\alpha}$$

The values of K and α obtained from the least square fit are found to be 1.64 ± 0.10 and 0.45 ± .05 respectively. The compound multiplicity is nearly proportional to the linear dimension of the projectile nucleus upto A_p = 28. Similar results were found by other workers of different projectiles at different energies.

References:

[1] A jurak and A Lincheid Acta phys. Pol B 8 875(1977)

[2] S. Ahmad, et al *Int. J. Mod.Phys. E.*, vol. 18,(2009)

[3] M.Ayaz Ahmad, et al, International JournalofTheoretical and Applied Physics (IJTAP),Vol.2,(2012)

[4] P.L. Jain and M. M. Aggarwal: Phys. Rev. C44, 844(1990

[5] V.A. Antonchik et al., Sov. J. Nucl. Phys. 32, 164 (1980).

[6] G. M. Chernov et al., Nucl. Phys. A 280, 478 (1977).