# Study of Dependence of normalized multiplicity and reduced multiplicity on centre of mass system of charged secondaries in high energy heavy ion interactions at 4.5 A GeV

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**Introduction:** The study of the characteristic of charged secondaries was the aim of most of the experiments on high energy nucleon-nucleon and nucleus-nucleus collisions. Investigations are carried out on the produced secondaries with a common belief that these particles are more informative about the nuclear matter at high density and temperature. It was thought that collision of hadrons with nuclei, collision of nucleus-nucleus may provide some important information regarding elementary particles and their interactions which can never be known using a simple hydrogen target.In high energy experiments complex atomic nuclei is taken as target because it gives some unexpected results. Heavy ion accelerators, as Synchrophasotran at Dubna with energies up to 4.5GeV, alternating Gradient Synchrophasotran (AGS)at Brookheaven National Laboratory (BNL) in USA with 14.5 AGeV and Super Proton Synchrophasotran (SPS) at Cern in Geneva with 200 AGeV have opened new era in the field of heavy ion studies at relativistic energies. Multi-particle production in high energy nucleus-nucleus collisions is still a mystery as for as understanding of the dynamics of the production of secondary particles. From theoretical point of view it is believed that in high energy heavy ion collisions, a lot of hadronic matter produced for a very short period of time. This is the unstable states of nuclear matter under extreme collision of high energy density and high energy temperature. The main motivation for the study of nucleus-nucleus interaction is to understand the mechanism of high energy reactions and particle productions in nuclear matter. So for understanding the mechanism of multiparticle production in high energy hadron-nucleus collisions, the correlations amongst the secondary charged particles are studied. Several workers [1-3] have attempted to study the multiplicity correlations over widely different incident energies with different projectiles

**Experimental details:**

All the relevant information regarding emulsion stacks scanning procedure selection criteria and method of measuring the angles etc. may be found in our earlier propagations [4-5]. In the present work the correlation characteristics of relativistic charged particles, a random sample of 484 disintegrations caused by 4.5 A GeV Carbon nuclei in nuclear emulsion have been studied. The secondary charged particles produced in each interaction are classified into grey, black and relativistic charged particles. Tracks having ionization in the interval 1.4go-10go are termed as grey tracks, where go represents the plateau ionization. Track with ionization greater than go is referred to as black track, while relativistic charged particle tracks have ionization less than 1.4 go respectively. The number of grey, black and relativistic charged particles produced in an event is denoted by $N_g, N_b$ and $N_s$ respectively.

Furthermore, grey and black tracks taken together are referred to as heavily ionizing tracks in an interaction and their number is denoted by $N_b = (N_g + N_b)$.

**Experimental results and discussion:**

For investigating the dependence of parameters $R_A$ and $R_S$ on the total energy available in the centre of mass system "S". Values of S have been computed by using the geometrical model as follows [6]:

$$S = (M_p^2 + M_t^2 + 2M_pE_p)^{1/2} - (M_p + M_t) \qquad (1)$$

Where $M_p$ and $E_p$ denotes the rest mass and energy of the projectile in the laboratory system respectively, whilst $M_t$ represents the mass of cylinder cut in the target by projectile at impact parameter $b = 0$. The value of $M_t$ may be calculated by using the following expression [7-8]:

$$M_t = \left(\frac{3}{2}\right)\left(A_p^{\frac{2}{3}}.A_t^{\frac{2}{3}}m\right) \quad (2)$$

Where $A_p$ and $A_t$ denote respectively the mass number of the projectile and target, while m is the nucleon mass.Values of $R_A$ and $R_S$ have been estimated by using equations:

$$R_A = <N_S>_{BA}/<N_{ch}>_{PP} \quad (3)$$

$$R_S = <N_S>_{BA}/<N_S>_{PA} \quad (4)$$

Where $R_A$ and $R_S$ are the mean normalized multiplicity and reduced multiplicity respectively. $<N_S>_{BA}$ is the average number of charged shower particles, $<N_{ch}>_{PP}$ refers to the average number of charged particles emitted in p-p collisions and $<N_S>_{PA}$ denotes proton nucleus interactions at the same projectile energy[9-10]. The calculated values of $R_A$, $R_S$ and $S$ are given in Table 1 and the variations of $R_A$ and $R_S$ with $S$ are shown in figure1. This fig. displays the fact that both $R_A$ and $R_S$ grows linearly with increasing value of $S$.

**Table 1 :** Values of $R_A$, $R_s$ and S for different projectiles at 4.5 A G eV nucleus-nucleus collisions.

| Projectile | S GeV | $R_A$ | $R_S$ |
|---|---|---|---|
| Deuteron | 5.10 | 1.14± 0.29 | 1.78± 0.12 |
| α-particle | 9.42 | 2.59± 0.08 | 4.05± 0.13 |
| Carbon | 24.09 | 5.43± 0.20 | 8.45± 0.32 |
| Oxygen | 32.98 | 9.88± 0.45 | 15.39± 0.70 |
| Mg | 47.10 | 11.38± 0.38 | 17.73± 0.59 |

Values of $R_A$ and $R_S$ have been found to satisfy the following relationships for catastrophic events fitted by the method of least squares:

$R_A$= (10.70±1.86) ln S+ (-7.29±2.42) (5)

$R_S$=(16.63±2.89)lnS+(-11.33±3.76) (6)

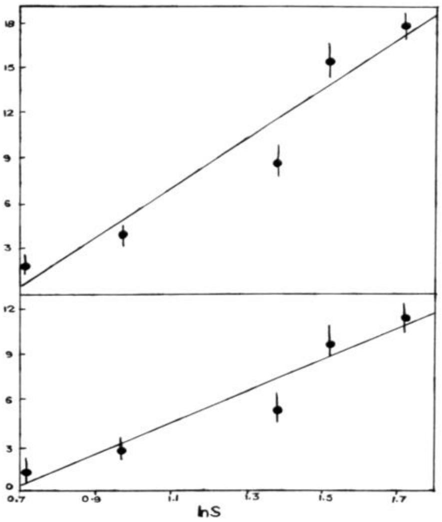


Fig.1 Dependence of $R_A$ and $R_S$ on S

On the basis of the study of normalized multiplicity and reduced multiplicity, we draw some important conclusion that the parameters $R_A$ and $R_S$ strongly depend on total available energy in the centre of mass system.

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