Interesting correlations among various parameters of charged secondaries in nucleus-nucleus 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. Investigation are carried out on the produced secondary charged particles with a common belief that these particles are more informative about the collisional dynamics and thus, could be effective in revealing the underlying physics of high energy relativistic interactions. 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 [1-7] have attempted to study the multiplicity correlations over widely different incident energies with different projectiles. The AALMT collaboration [9,10] have also studied the multiplicity correlations in 200 GeV proton-nucleus collisions.

In the present work, detailed study of multiplicity correlations among different charged secondaries produced in carbon-nucleus interactions at 4.5 A GeV has been done. The results obtained in present investigations have been compared with those obtained in hadron-nucleus collisions. Finally the findings of present work have also been compared with the predictions of various theoretical models put forward for explaining the reaction mechanism of multiparticle production in hadron-hadron, hadron-nucleus and nucleus-nucleus interactions at relativistic energies.

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 publications [11-12]. 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 $1.4g_o$-$10g_o$ are termed as grey tracks, where go represents the plateau ionization. Track with ionization greater than g_o is referred to as black track, while relativistic charged particle tracks have ionization less than 1.4 g_o 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.

It may be mentioned that the number of grey tracks, N_g, and shower tracks, N_s, taken together is termed as compound multiplicity, $N_c = N_g + N_s$.

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

Experimental results and discussion:

An analysis of multiplicity correlations in the energy range 20-200 GeV for proton-nucleus collisions was carried out by Azimov et al [13]. It showed that the inclination coefficients $[N_i(N_j)]$ are monotonic and can reasonably be approximated by lines with positive slopes. AALMT Collaboration [14] studied the charged particles multiplicity correlations at 200GeV for proton – emulsion collisions and observed that all the inclination coefficients are monotonic with positive slops. A Comparison of the data with the results obtained at low energy [16] shows full agreement with the correlation between black and grey particles multiplicities. A similar type of study has also been carried out at 24 and 400 GeV proton-emulsion interactions [7]. The study reveals that the correlations amongst multiplicities of slow particles do not depend on the energy of impinging hadrons. It is reported [7] that the values of inclination coefficients are positive and are in fairly nice agreement with the corresponding values reported in ref.14. It is also reported [7] that these correlations may represented satisfactorily by linear function with positive slopes.

The study of multiplicity correlations amongst the charged secondaries produced in relativistic nucleus-nucleus reactions was not paid due attention [16-22].Workers observed that these correlations like in hadron-nucleus collisions can be represented by linear relations with positive slopes. On comparing the findings of their results, they concluded that the multiplicity correlations do not depend on the mass of the projectile and the contribution of the recoiling nucleus towards the excitation energy of the residual nucleus is approximately the same for proton-nucleus and nucleus-nucleus interactions.

In order to study the nature of the multiplicity correlations amongst secondaries, an attempt has been made to investigate the multiplicity correlations amongst charged secondaries produced in 4.5 A GeV ^{12}C-nucleus interactions. The dependence of $< N_g >, < N_h >, < N_s >$

and$< N_c >$ withN_b is shown in Fig.1-4. The regression $< N_s(N_b) >$,$< N_g(N_b) >$$< N_h(N_b) >$ and $< N_c(N_b) >$ may be represented by the following second order polynomial (1-4) quite well:

$$< N_s >= (3.66 \pm 1.52) + (1.38 \pm 0.31)N_b + (-0.04 \pm 0.01){N_b}^2 \qquad (1)$$

$$< N_g >= (2.85 \pm 1.42) + (1.53 \pm 0.29)N_b + (-0.04 \pm 0.01){N_b}^2 \qquad (2)$$

$$< N_h >= (2.95 \pm 1.46) + (2.49 \pm 0.29)N_b + (-0.04 \pm 0.01){N_b}^2 \qquad (3)$$

$$< N_c > = (6.61 \pm 1.69) + (2.90 \pm 0.34)N_b + (-0.08 \pm 0.01){N_b}^2 \qquad (4)$$

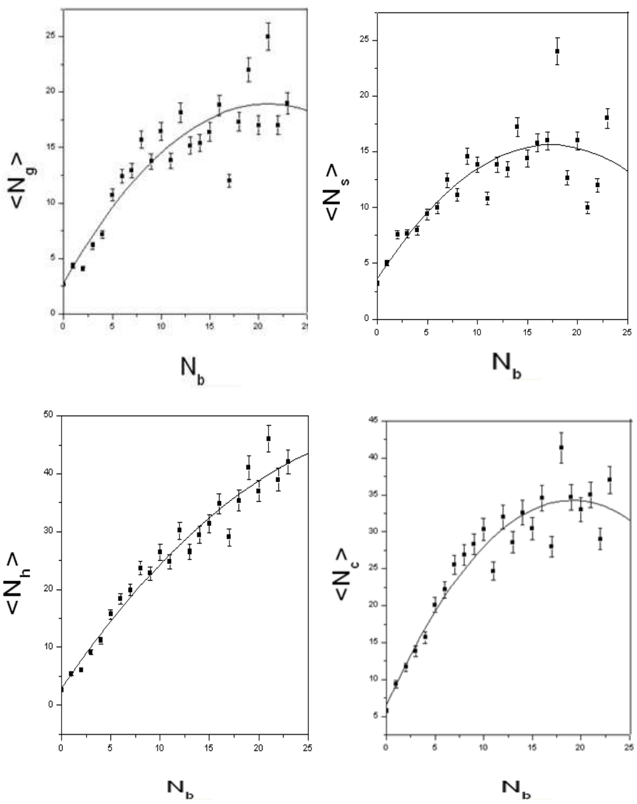

Fig.1-4: Variation of $< N_g >$,$< N_s >$,$< N_h >$ and$< N_c >$ as a function of N_b

The continuous curves shown in Fig.1-4 correspond to eq.(1-4). It may be seen in the figure that the variation of experimental values of$< N_g >$,$< N_s >$,$< N_h >$and$< N_c >$ with N_b may be represented by the second order polynomial. It is reported [6-14] that the multiplicity correlations may be represented by linear equation with positive slopes. Thus our results do not agree with the results obtained in high energy hadron-nucleus collisions [6-14].

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