Dependency of Mean Multiplicity on the Average Number of Intra-Nuclear Collisions of charged secondaries in ^{12}C-nucleus interactions at 4.5 A GeV

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Introduction:

Study of secondary charged particles produced in central relativistic heavy ion interactions is attracting a great deal of attention during the recent years. It may be due to the fact that in the study of totally disintegrated events produced in heavy ion collisions, almost the whole projectile takes part in the reactions. The probability of total disintegration of Ag and Br nuclei of nuclear emulsion is quite small, leading to low statistics of the experimental data. Nevertheless, the study of catastrophic destructions is extremely important because during such collisions, the nuclear matter might be compressed to several times its normal density and consequently several interesting phenomena are expected to occur. During the catastrophic destruction, nuclear matter may undergo to phase transition of hadron gas into quark gluon plasma.

Multiplicity characteristics of relativistic charged secondaries in high energy hadron-hadron and hadron-nucleus collisions have been studied by several workers [1-8]. In the present work we have presented some characteristics of charged secondaries produced in ^{12}C-nucleus interactions at 4.5 AGeV. We have discussing about dependency of mean multiplicity on average number of intra-nuclear collisions of charged secondaries. 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:

In study of hadron-nucleus interactions at 4.5 A GeV, the nuclear emulsion is in general used as both target and detector. The target consists of three groups as hydrogen, a light [L], group of CNO targets and heavy [H], group of AgBr targets. The incident proton interacts in 5% with H, in 25% with CNO and in 70% with AgBr. The average number of encounters between an incident and the nucleons in the target nucleus is denoted by $\bar{\upsilon}$ and given as:

$$\bar{\upsilon} = (A\sigma_{hp})/\sigma_{hA} \qquad (1)$$

Where σ_{hp} & σ_{hA} are the inelastic cross-section for hadron-proton and hadron-nuceus interactions respectively [2-4]. Experimental values of ICS given as:

$\pi - A\ interaction$

$$= 0.74A^{0.25} \qquad (2)$$

$p - A\ interaction$

$$= 0.70A^{0.31} \qquad (3)$$

The particles emitted in the interactions are classified according to ionization produced along the track. Normally, we do not identify the particles. Consequently we simply knows them black, grey and shower particles. Detailed information regarding emulsion stacks, scanning procedure and classification of charged secondaries etc. may be found in our earlier publications [12-13].

Experimental results and discussion:

The study of multiplicity correlations amongst secondary charged particles produced in high energy hadron-nucleus collisions might provide some extremely useful information on the mechanism of multi-particle production and it allows us to discuss the dynamics of nucleus-nucleus reactions. According to the existing representation, the shower and grey particles characterize the fast stage of inelastic interactions between two nuclei, black particles correspond to the next stage of collisions, when the de-excitation process occurs through the evaporation of nucleus.

The multiplicity correlations amongst these secondary charged particles produced in high energy hadron-nucleus interactions have been studied by several workers [14-19]. In Figure, variations of $< N_b >$, $< N_g >$, and $< N_s >$ for total disintegration events with the average number of intra-nuclear collisions, $< \nu >$ are plotted. The value of <ν> is obtained by using a phenomenological formula of the following form [10]:

$$< \nu >= 0.73 A_p^{0.72} \quad (4)$$

Here A_p represents the mass of the projectile. The experimental data are found to satisfy the following relationship obtained by the method of least squares:

$$<N_b> = (-1.07\pm0.23) < \nu > + (17.14\pm0.83) \quad (5)$$
$$<N_g> = (0.98\pm0.23) < \nu > + (15.98\pm0.99) \quad (6)$$
$$<N_s> = (4.50\pm0.58) < \nu > + (-2.64\pm0.65) \quad (7)$$

We have plotted the experimental data in fig. 1.

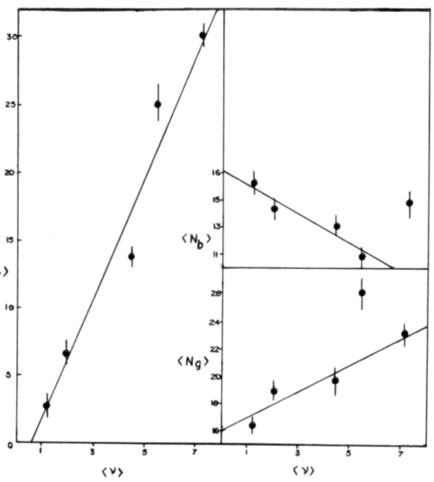

Fig.1: Dependence of $<N_b>$, $<N_g>$, and $<N_s>$ on $<\nu>$

It may be noticed in the figure that the total disintegration events are characterized by a rapid growth of $< N_s >$ as compared to the corresponding values for the total ensembles of elastic interactions. This result may be explained in terms of the predictions of the superposition model [11]. A similar result has also been obtained by [9]. On the basis of the study of the totally disintegrated events of Ag and Br nuclei caused by 4.5 GeV per nucleon carbon projectile, we draw important conclusions that average multiplicity of $< N_g >$ and $<N_s>$ increases rapidly, with <ν>. The value of $<N_b>$ is found to decreases with increasing value of <ν>.

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