Dependency of multiplicity characteristics of charged secondaries in ^{12}C-nucleus interactions at 4.5 A GeV

M. Saleem Khan[1], Praveen Prakash Shukla[1] and H. Khushnood[2],
1-Department of Applied Physics, MJPR, University Bareilly-243001
2-University Polytechnic, Jamia Millia Islamia New Delhi-110025
E-Mail: Saleem.hepru@gmail.com
Praveen.phru@gmail.com

Introduction:

With the commencement of heavy ion accelarators at Brookheaven, Dubna and CERN, availability of high energy proton beams comes in existence which have opened up an entirely new era in the field of heavy ion studies at relativistic energies. In emulsion experiments the main interest has been focused to study hadron-nucleus reactions. In this picture the nucleus can act as a suitable detector for space time development of hadron-nucleus reactions which can hardly be observed in the asymptotic states of generated particles in elementary hadron-nucleus reactions. Multiplicity characteristics of relativistic charged secondaries in high energy hadron-hadron and hadron-nucleus collisions have been studied by several workers [1-6]. In the present work we have presented some characteristics of charged secondaries produced in ^{12}C-nucleus interactions at 4.5 AGeV. We are discussing some features of multiplicity distribution at the same energy. 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 [11-12].

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 [18-22]. 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. 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 $< N_b >$, and $< N_s >$ with N_g is shown in Fig.1-2. The regression $< N_b(N_g) >$ and $< N_s(N_g) >$ may be represented by the following second order polynomial (4-5) quite well:

$$< N_b >= (-1.52 \pm 1.23) + (1.05 \pm 0.20)N_g + (-0.02 \pm 0.01){N_g}^2 \quad (4)$$

$$< N_s > = (2.85 \pm 1.03) + (0.96 \pm 0.16)N_g + (-0.02 \pm 0.01){N_g}^2 \quad (5)$$

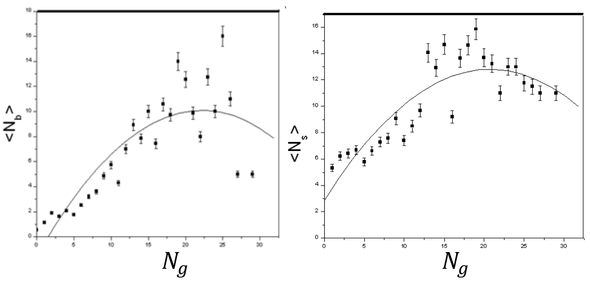

Fig.1-2: Variation of $< N_b >$, and $< N_s >$ as a function of N_g

It is interesting to note in the figure that the experimental data are in close agreement with those obtained by eq. (4-5). The continuous curves shown in Fig.1-2 correspond to eq. (4-5). It may be seen in the figure that the variation of experimental values of $< N_b >$ and $< N_s >$ with N_g 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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