Comparative Study For Nucleus-Nucleus Collisions And Modified Cascade Evaporation Model At 4.5 A GeV

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Introduction

The study of the characteristics of secondary charged particles produced in nucleus-nucleus reactions at relativistic energies has received considerable attention during the recent years[1-6]. The reasons for investigating the production mechanism of secondary particles in heavy ion interactions might provide some valuable information about reaction mechanism in the nucleus-nucleus collisions. In relativistic heavy ion collisions, the secondary hadrons are formed instantaneously. There is a formation time between the collision and hadronization of the final state particles. They hadronize within the target nucleus and may reinteract with the surrounding target matter and produce cascade particles.Moreover,The studies on heavy ion interactions provide the means of distinguishing between the various theoretical models put forward to explain the mechanism of hadronization of final state charged particles in nucleus-nucleus reactions at relativistic energies and the characteristics of secondary charged particles produced in such collisions may be obtained by analyzing the experimental data on the secondary particles..There has been a rapidly growing hope that the collisions between the high energy particles and various atomic nuclei may provide information on multiparticle production that could never be obtained with a simple hydrogen target. Several models have been put forward to explain the mechanism of multiparticle production in relativistic heavy ion interactions. In the present work an attempt has been made to compare the predictions of modified cascade evaporation model, MCEM [6] with the results obtained in ^{12}C-nucleus and ^{28}Si-nucleus reactions at 4.5A GeV.

Experimental Technique

This work has been carried out using emulsion stacks exposed by 4.5 A GeV carbon and silicon nuclei at Dubna Synchrophasotron. In order to study the characteristics of secondary charged particles,random samples of 681 and 498 events produced in ^{12}C-nucleus and ^{28}Si-nucleus interactions respectively,have been analysed.This work has been performed using a stack of several pellicles of NIKFI-BR-2 type nuclear emulsion.The size of each pellicle is 18.7X9.7X0.06 cm^3 .The stack was exposed horizontally by 4.5 A GeV/c ^{12}C nuclei in the Dubna Synchrophasotron.However,in 4.5 A GeV ^{28}Si nucleus interactions,a stack of several pellicles of NIKFI-BR-2 type nuclear emulsion has also been used .The size of each pellicle is 16.9X9.6X0.06 cm^3. The stack was exposed horizontally by 4.5 A GeV ^{28}Si nuclei in the Dubna Synchrophasotron. All the relevant information regarding the emulsion stacks, method of measurement,selection criteria,etc.may be found in our earlier publications [1-3].

The tracks having relative velocity<0.3 are termed black particles and their number in an event is denoted by Nb.They are generally alpha particle and helium nuclei etc.However,the tracks with $0.3 \leq \beta \leq 0.7$ are referred as grey particles. The number of grey particles in an event is denoted by Ng.They are generally protons with a very little admixture of slow pions.The tracks with $\beta > 0.7$ are referred as shower particles.The numbers of charged shower particles in a star represented by Ns.They are generally pions.

Experimental Results

A systematic study has been carried out for the multiplicity characteristics of shower, grey and black particles emitted in the interactions of ^{12}C and ^{28}Si nuclei with nuclear emulsion at 4.5

A GeV. The average value of the multiplicities, i.e. the average multiplicity of shower ,<Ns> ,grey ,<Ng>and black,<Nb> particles are obtained in both type of interactions and are listed in the table along with the values calculated according to MCEM[6].It may be seen in the table that average values of grey,black and shower particles produced in 4.5 A GeV ^{12}C-nucleus and ^{28}Si-nucleus interactions are in fair agreement ,with in error, with their corresponding values calculated according to MCEM[6].

From the table, it follows that as the number of interacting projectile nucleons increases, the values of <Ns> increase. This indicates the possibility of describing the nucleus-nucleus reactions as a superposition of nucleon-nucleon collisions. The average value of grey,<Ng> is also found to increase with increasing mass of the projectile.

It may be seen in the table that the average value of grey particles <Ng> is found to increase with increasing mass of the projectile. This can be explained in terms of fireball model[7].This model predicts that the grey particles come from the participants volume and the number of participants nucleons increases as the volume of the cylinder cut in the target by the projectile increases. This volume increases with increasing projectile mass and consequently the value of <Ng>increases.

It may be observed in the table that the values <Nb> are nearly constant, with in errors. Since the black particles are evaporation particles from the target nuclei, then the constant value of <Nb> with the increasing mass of the projectile means that the excitation energy given to the target nucleus is independent of the projectile mass.

Conclusions

On the basis of the present study it may be concluded that the findings of the present work are in nice agreement with the fireball and modified cascade model.

On the basis of the present investigation it may be concluded that our results are in nice agreement with the prediction of MCEM.The results are also in agreement with the prediction of fireball model.

Table

Experimental and theoretical values of Nb, Ng and Ns in 4.5 A GeV nucleus-nucleus collision:

Type of interactions	Type of data	<Nb>	<Ng>	<Ns>
12C-Nucleus	EXP	4.39±0.09	5.98±0.13	8.06±0.13
	MCEM	4.42±0.20	6.11±0.20	7.46±0.30
28si-nucleus	EXP	4.98±0.49	7.30±0.44	11.97±0.84
	MCEM	4.66±0.20	7.54±0.40	11.60±0.40

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