Multiplicity Correlations in Relativistic Heavy Ion Collisions

Khushnood Husain
University Polytechnic ,Jamia Millia Islamia,New Delhi-110025
· * email: khushnoodhusain@gmail.com

1. Introduction

The study of heavy ion interactions has become a subject of interest during the recent years [1,2].This is perhaps due to the fact that the collisions between the high energy particles and various atomic nuclei may provide information on multiparticle production which could never be obtained with a simple hydrogen target [1].The mechanism of multiparticle production and the nuclear fragment process have been studied by several workers[1,2].Valuable information on the mechanism of multiparticles procuction process and the structures of the hot nuclear matter formed as a result of the collisions may be obtained experimentally from the study of correlations amongst different secondary charged particles produced in the relativistic nucleus-nucleus interactions.

Thus,in the present work and attempt has been made to investigate the correlations amongst different charged secondaries produced in 12C-emulsion and 28 Si-emulsion interactions at 4.5 AGeV.The results obtained in the present work are also compared with th results of the calculations performed according to the Modified Cascade Evaporation Model(MCEM)[1].

2. Experimental details.

Present work has been carried out using two emulsion stacks irradiated by 4.5 AGeV carbon and silicon nuclei beams at Dubna Synchrophastron.All the experimental details regarding the emulsion scanning ,measurement and selection criteria are given in our earlier publications[3,4].

The tracks formed in nuclear emulsion having relative velocity $\beta < 0.3$are known as black particles and their number in an event is denoted by Nb,while the tracks with $0.3 \leq \beta \leq 0.7$ are reffered as grey particle.The number of grey particles in an event is denoted by Ng.The tracks with $\beta > 0.7$ are termed as shower particles.The number of charged shower particles in a star is represented by Ns.

3. Experimental results and discussions

High energy heavy ion collisions take place in three steps.The first step is pionization with the production of shower particles,then there is the stage of recoil nucleus ,where most of the produced particles are grey particles and finally the evaporation of the excited nuclei with the emission of black particles produced in these reactions.

One of the effective methods for verifying the adequacy of a theoretical model for describing the nuclear reaction is to obtain the multiplicity correlations amongst the secondary particles produced in heavy ion collisions.

The multiplicity correlation between different secondary particles produced in the collisions of 4.5 AGeV of 12C and 28Si projectiles with the nuclei of nuclear emulsion have been investigated .such multiplicity correlation has been satisfactorily fitted using the following linear relation.

$$\langle Ni \rangle = a + k \langle Nj \rangle \quad (1)$$

Where Ni,Nj = Nb,Ng,Ns and $I \neq j$

The multiplicity correlations between <Nb>-Ns,<Nb>-Ng and <Ns>-Ng are shown in figs.1 and 2.The solid line in the figure correspond to eq.(1).The values of the parameter K are estimated by the method of least squarefit and are listed in table.The values of K estimated by using the MCEM are also given in the same table.It may be seen in the table that the experimental value of K are in nice agreement with those obtained by MCEM[1].

Table 1: Values of slop K of fitted straight lines for different multiplicity coorelations in 4.5 A GeV nucleus-nucleus interactions

Types of correlations	12C-Emulsion	28Si-Emulsion	Reference
<Nb>-Ns	0.62±0.02	0.16±0.02	Exp.
	(0.51±0.02)	(0.42±0.03)	MCEM
<Nb>-Ng	0.61±0.04	0.89±0.10	Exp.
	(0.75±0.03)	(0.69±0.02)	MCEM
<Ns>-Ng	1.51±0.06	1.59±0.03	Exp.
	1.06±0.03	(1.17±0.04)	MCEM

It is interesting to note in the figures that the value of <Nb> increases linearly with Ns upto Ns ~10 and beyond this value of Ns it gets saturated in both type of interactions.This results may be interpretated as the residual target nucleus attains a constant excitation energy and temprature at a certain value of Ns.At higher values of Ns,an excess amount of enrgy may be pumped to the system to be consumed into a phase transition in the target nuleus system.The constancy of <Nb> also indicates that the critical temperature for the phase transition is independent of the projectile mass at the same projectile energy.
One can also be observed from the figures that <Nb> increases linearly with Ng upto a certain value of Ng.This observation shows a close relation between the cascade stage which is characterized by the emission of grey particles (recoil nucleons and subsequent stage of evaporation) during which the black particles (evaporated particles) are emitted .
From the figures,it may be seen that <Ns> increases linearly with Ng upto Ng ~ 10 i.e <Ns> increases with the increase of the numbers of interacting projectile nucleons,it may be due to the fact that Ng may be taken as a good measure of the number of encounters made by the projectile inside the struck nucleus.

4. Conclusions

The dependence of <Nb> on Ng suggests that the increasing number of recoil protons does not result in a decrease of the mean number of evaporation products due to the smaller number of protons available for evaporation.
The study of multiplicity correlation <Nb>-Ns suggest that <Nb> reaches a constant value almost equal to 10.The constancy of the plateau value of <Nb> may indicate that the critical temperature for the phase transition is independent of the mass number of the projectile nucleus.The results obtained in the present work may also be reproduced quiet well with the help of modified cascade evaporated model put forward for explaining the mechanism of multiparticles production.

References

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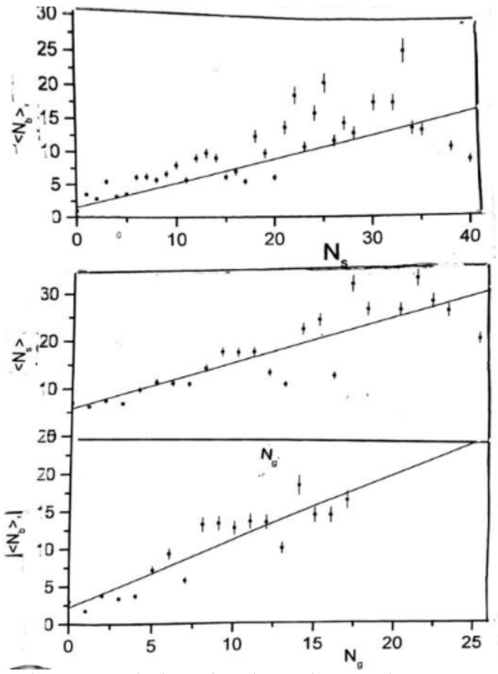

Fig.1 Correlations in Si-Em interactions

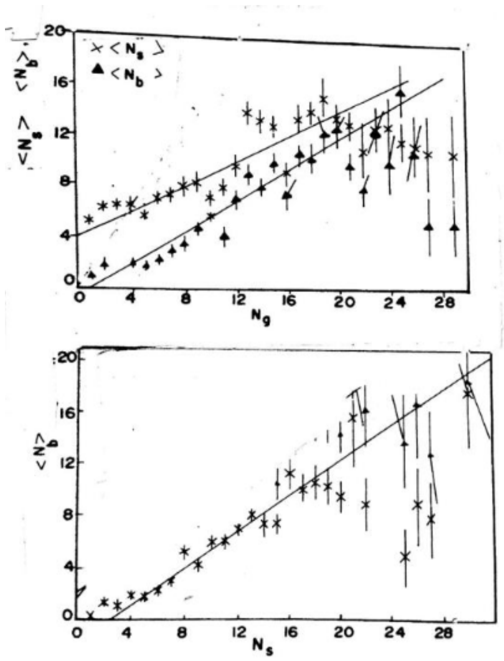

Fig.2 Correlations in 12C-Em collisions