Characteristic Study of Pions Production ^{84}Kr-Emulsion Interaction at ~ 1GeV/n

N. Marimuthu[1, 2], V. Singh[1]*, S. S. R. Inbanathan[2]*

[1] *Physics Department, Institute of science, Banaras Hindu University, Varanasi-221 005, INDIA*

[2] *Research and Post Graduate Department of Physics, The American College, Madurai-625 002, INDIA*

* *Email: venkaz@yahoo.com, stepheninbanathan@gmail.com*

Introduction

Over the last few years the investigation of nucleus - nucleus (A-A) and hadrons - nucleus (h-A) collisions at relativistic high energy regions has received considerable interest on both front experimental and theoretically [1]. If ion is heavy, may revels the novel phenomena such as new phase of matter called Quark-Gluon Plasma (QGP), which is still debatable [2]. It is known that pions are interesting tool for the investigations of such phenomena in case of light and heavy ion collisions. They are mainly produced from the decay of the Δ - particles [4]. Most of the energies spent in the particle creation during heavy ion collision particularly pions productions. Nuclear emulsion detectors (NED) have been extensively used in accelerator and cosmic ray research because of their excellent particle detection, 4π steradian acceptance angle, high spatial resolution and large ionization sensitivity [1]. High energy pions i.e. GeV/n are considered to be valuable to understand the formation of hot and dense nuclear matter during collisions. However, due to the strong interactions of pions ($N_\pi^\pm$), the sensitivity of pions productions are still under the debate [4]. The investigation of pions production provides us information about reaction region and to understand the dynamics of the collisions properties. Subject of the present work is devoted to the investigation of charged pions, which are emitted from the interaction of $^{84}Kr_{36}$ projectile with NED's targets at around 1 GeV/n. we have significantly investigated the multiplicity and probability distribution of charged pions. We have also studied the dependence of $<N_\pi^\pm>$ on the target mass number.

Experimental details

In the present experiment, highly sensitive nuclear emulsion stack of NIKFI BR-2 was exposed horizontally to $^{84}Kr_{36}$ beams with kinetic energy around 1 GeV/n at the Gesellschaft fur Schwerionenforschung (GSI), Darmstadt (Germany). Pellicles of the emulsion have dimensions of 9.8×9.8×0.06 cm^3. The pellicles were scanned with oil immersion objective lens of 100× along with 15× eye-pieces [1, 3]. Present study is based on the 615 inelastic primary events collected from the ^{84}Kr- Em interactions with nuclear emulsion targets.

Results and discussion

Multiplicity distribution of the emitted charged pions ($N_\pi^\pm$) in ^{84}Kr- Em interactions with different target nuclei is shown in figure 1. From figure 1, one can see that the distribution shapes of the emitted charged pions are varying with the different targets of emulsion nuclei and also the distribution getting wider with increasing the size of the target.

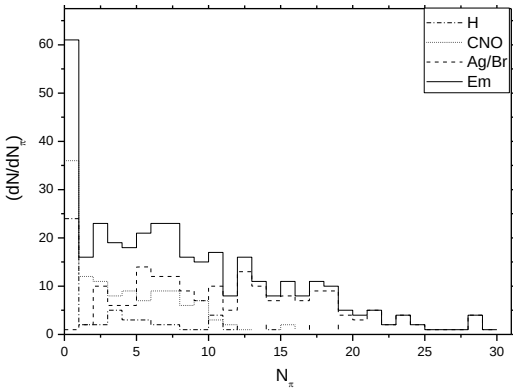

Figure 1: Multiplicity distribution of emitted charged pions ($N_\pi^\pm$) in ^{84}Kr-Em interactions at around 1 GeV/n.

It is also being observed from figure 1 that the produced charged pions in the heavier target nuclei i.e. Ag/Br relatively higher than the lower mass number targets such as H, CNO nuclei. It does indicate that, pions production is most favorable for the symmetric collisions, where projectile and target have almost identical mass number. The maximum values of the emitted charged pions $(N_\pi^{\pm})_{max}$ is 19, 20 and 30 for H, CNO and Ag/Br target groups.

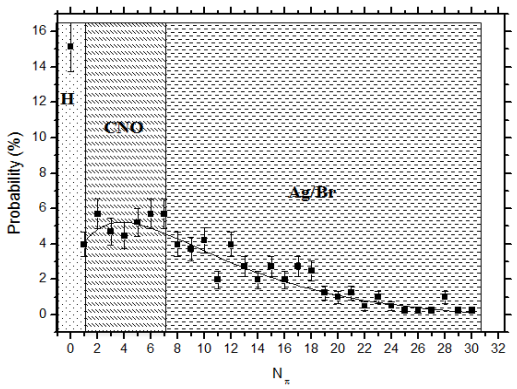

Figure 2: Probability distribution of emitted charged pions ($N_\pi^{\pm}$) in ^{84}Kr-Em interactions at around 1 GeV/n.

Probability distribution of the produced charged pions from ^{84}Kr - Em interaction has been shown in figure 2. The distribution fitted with exponential decay function with 1.6 χ^2/DOF value. The different pions production regions are roughly marked in figure 2, which apparently belongs to be the different target groups of the emulsion nuclei. The probability distribution of emitted charged pions are extends up to 30 in an event.

We have also studied the average multiplicity of emitted charged pions ($<N_\pi^{\pm}>$) with average target mass number (A_T) in ^{84}Kr-Em interactions at around 1 GeV/n. It may see from figure 3 that the emitted average numbers of pions $<N_\pi^{\pm}>$ are linearly increases with increasing the target mass number. The data points are fitted with eq. (1),

$$<N_\pi> = a(A_T)^b. \quad (1)$$

Where A_T represents that average target mass number based on the number of heavily ionizing charged particle in ^{84}Kr-Emulsion interactions.

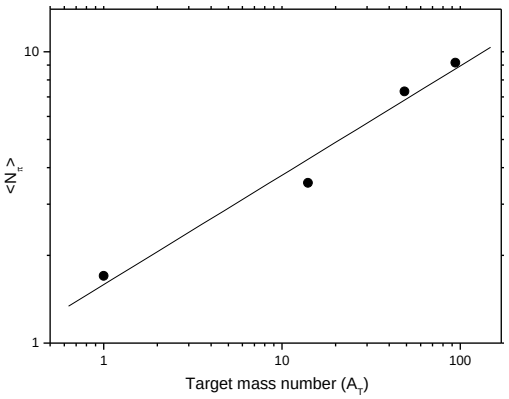

Figure 3: The average multiplicity of emitted charged pions ($<N_\pi^{\pm}>$) on target mass number (A_T) in ^{84}Kr-Em interactions at around 1 GeV per nucleon.

The best fitted parameters found to be a = 0.20±0.06 and b = 0.37±0.04. By comparing our fitting parameter with other projectiles ^{24}Mg (a = -0.06±0.03, b=0.49±0.02) and ^{28}Si (a= - 0.26± 0.05, b = 0.63±0.04). From figure 3, one can understand that the charged pion production is not only depends on the projectile mass number and incident kinetic energy, but also strongly depends on the target mass number.

Conclusion

Multiplicity distribution shapes of charged pions are varying with different targets of emulsion nuclei. Pions are emitted from the heavier target nuclei relatively higher than lower mass target in NED. The mean multiplicities of produced pions $<N_\pi^{\pm}>$ are dependent on projectile and target mass number as well as the incident energy.

Acknowledgement

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