Study of the intermediate mass fragments produced in ^{84}Kr emulsion interactions at 1 GeV per nucleon

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Introduction

In the last decade, after the prediction of new phase of matter known as QGP, investigations of final state particles produced in nucleus-nucleus or nucleon-nucleus interactions at relativistic high energy is an active research area with vast discovery potential [1, 2].The various concepts of nuclear physics are extrapolated with study of heavy-ion collisions, since the heavy-ion collisions provide information on the deep properties of nuclear matter [3]. The compactness of size, high resolution, 4π detection capability and large range of ionization sensitivity makes the nuclear emulsion detector as a unique and simple detector till date [3]. The high resolution of nuclear emulsion detetors make it useful for the detection of short-lived particles such as τ lepton and mesons etc [3].

According to the participant-spectator model the interacting system can be divided into three main regions: (i) target spectator region, (ii) projectile spectator region and (iii) participant region. The black and grey particles are coming from the target spectator region and projectile fragments are coming from the projectile spectator region having charge Z ≥ 1 while shower particles are coming from the participant region [3]. In the complex scheme of high-energy heavy-ion reactions with multibaryon system, the projectile fragmentation is a relatively well isolated process [3]. The results of our systematic study on intermediate mass fragments produced in the interaction of ^{84}Kr as a projectile with nuclear emulsion as a target at 1 GeV per nucleon are presented in this report.

Experimental Details

The nuclear emulsion plates used in the present study were irradiated horizontally at Gesellschaft fur Schwerionenforschung (GSI) Darmstadt, Germany. These nuclear emulsion plates contains of hydrogen, carbon, nitrogen, oxygen, silver and bromine with a small percentage of sulfur and iodine [3]. In order to obtain the primary interactions, there are two standard scanning methods used to scan the emulsion plates, one of them is the line scanning method and other is volume scanning method [3]. In line scanning method the tracks are followed along their length till they interact with one of the photographic emulsion material or escape the emulsion plates, and in the volume scanning method the emulsion plates are scanned strip by strip [3] and event information are collected. These events have been examined and analyzed with the help of an Olympus BR-2 binocular optical microscope, having total magnification of 2250× and measuring accuracy of 1μm. The emitted charged particles from the primary interaction are known as the secondary charged particles and are divided into three main categories, (i) *Shower particle* (N_s): These particles have normalized grain density $g^* < 1.4$ and relative velocity $\beta > 0.7$. The number of such particle represents the degree of destruction, depends

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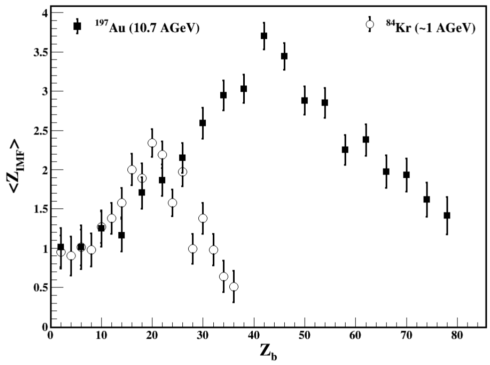

FIG. 1: The average multiplicity of intermediate mass fragments as a function of Z_b for the interactions of $^{197}Au - Em$ [4] and $^{84}Kr - Em$ [Present work]

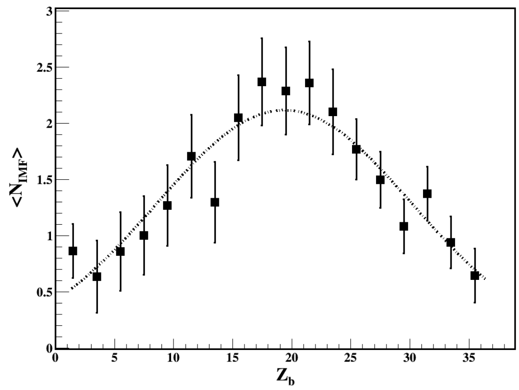

FIG. 2: The multiplicity distribution of $< N_{IMF} >$ as a function of Z_b for the interactions of $^{84}Kr - Em$

on collision geometry and impact parameter of the events, (ii) *Black particle* (N_b): These particles have normalized grain density $g^* >$ 6.8, range L $<$ 3 mm and relative velocity $\beta <$ 0.3. These particles are slow evaporated target fragments, (iii) *Grey particle* (N_g): These particles having normalized grain density 1.4 $< g^* <$ 6.8, range L $>$ 3 mm and relative velocity 0.3$> \beta <$ 0.7.These particles are fast evaporated target fragments. The number of heavily ionizing charged particles ($N_h = N_b + N_g$) depends upon the target breakup. The projectile fragments are classified according to their charges into three main categories, single charge projectile fragments ($N_{z=1}$), double charge projectile fragments ($N_{z=2}$) and multiply charge projectile fragments ($N_{z>2}$) respectively [3].

Result and Discussions

In this article we present our study on the intermediate mass fragments produced in the interaction of the ^{84}Kr with nuclear emulsion at arround 1 GeV per nucleon. The average multiplicity of intermediate mass fragments as a function of Z_b is shown in figure 1. From figure 1 it is clear that both peak locations and overall distribution are shifting to lower value for low energy data and vice versa, due to the production of the higher charge fragments [2]. Therefor it is clear that distribution of $< N_{IMF} >$ is depends on the incident energy, which is also supported by the earlier works [4, 5]. Figure 2, shows the correlation between the average multiplicity of intermediate mass fragments and bound system charge Z_b for the interactions of ^{84}Kr-Em. This study show that the mechanism of fragmentation of the spectator part of the projectile nucleus also have strong relation with target fragments [4, 5].

Acknowledgments

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