Shower and Grey Production in Forward-Backward Hemisphere in the Interaction of ^{84}Kr with Emulsion at 1 A GeV

M. K. Singh[1],* V. Kumar[1], B. Kumari[1], K. Attri[1], U. Rawat[1], S. Karmakar[1], P. K. Khandai[2], D. Singh[3], and V. Singh[4]

[1] *Department of Physics, Institute of Applied Sciences and Humanities, GLA University, Mathura, 281406, India.*

[2] *Department of Physics, Ewing Christian College, Allahabad, 211003, India.*

[3] *Department of Physics, Gujarat Arts and Science College, Ellisbridge, Ahmedabad, Gujarat, 380006, India. and*

[4] *Department of Physics, School of Physical and Chemical Sciences, CUSB, Gaya, 824236, India.*

The focus of this investigation has been on shower and grey particle emission characteristics that result from the interaction of ^{84}Kr + Em at 1 A GeV. We have shown from this investigation that the shower and grey particle emission behaviors exhibit distinct characteristics. The likelihood of shower particles emitting is greater in the forward hemisphere than that of grey particles, whereas the likelihood of grey particles emitting is higher in the backward hemisphere than that of shower particles.

Introduction

The nuclear emulsion detector (NED) has played a unique role in the study of heavy ion interaction from the early days of experimental nuclear and particle physics [1]. Today, NED is still in use due of its unique properties. Its tiny size, maximum location resolution, and 4π observation capacity are among these. The heavy ion interaction compound approach has a unique target fragmentation mechanism [2]. The interaction of two nuclei at relativistic energy can be explained with help of PS model [3]. The schematic diagram of PS model is shown in figure 1 [3]. The emission feature of shower and grey particles that appeared in the forward-backward hemisphere, together with their association with the target fragment, have been investigated in this work. Events that manifested at an angle θ less than 90^0 are classified as forward hemisphere events, whereas events that manifested in an angle θ more than 90^0 are classified as backward hemisphere events. In this instance, we employed the events arising from the interaction of ^{84}Kr nuclei and emulsion nuclei at a 1 GeV per nucleon.

*Electronic address: manoj.singh@gla.ac.in

Experimental Details

In this observation, we utilized NED with dimensions of 9.8 × 9.8 × 0.06 cm^3. They were exposed at Germany's GSI in Darmstadt. The NED is known to have minor amounts of S and I along with a mixture of H, O, C, N, Ag, and Br. We have employed two widely used line and volume scanning techniques to identify the physics events from NED plates using the Olympus binocular transmitted light microscope BH-2 [1-3]. All events are divided into several groups, such as shower, black, and grey particles, depending on the features of each class [4]. The mixture of black and grey particles is denoted by N_h and is referred to as heavily ionized charged particles.

Result and Discussion

The particles' forward-backward multiplicity correlations, which arise from the interaction of two nuclei at relativistic energy, provide information necessary to create a sufficient description of the heavy ion collision systematics. Figure 2 illustrates the association between shower and grey particles that developed in the forward hemisphere in the interaction of ^{84}Kr with emulsion as a function of N_h. Figure 2 illustrates that shower particles have a larger emission probability than grey particles, which are emitted in the

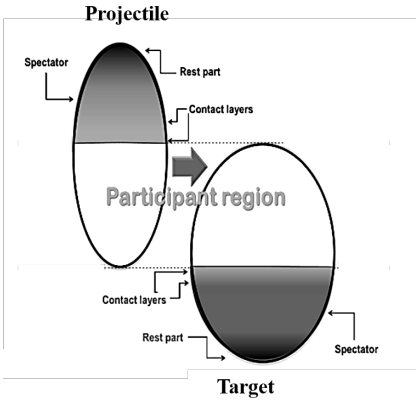

FIG. 1: The schematic diagram of PS model [3].

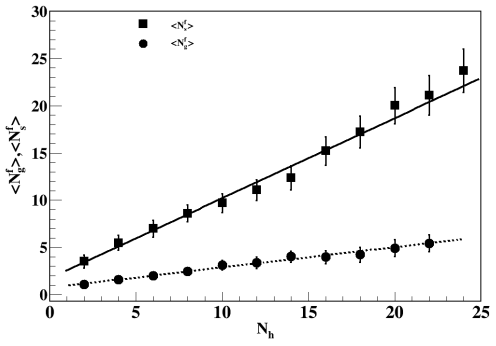

FIG. 2: Forward mean multiplicity of shower and grey particles as a function of N_h for the events occurred in the ^{84}Kr's interactions with emulsion.

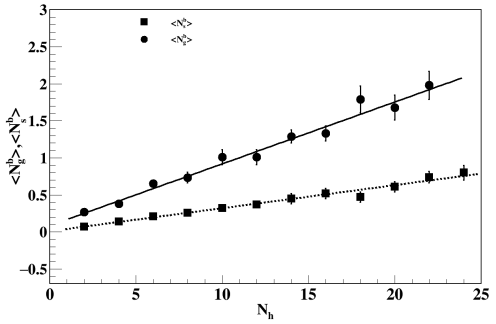

FIG. 3: Backward mean multiplicity of shower and grey particles as a function of N_h for the events occurred in the ^{84}Kr's interactions with emulsion.

forward hemisphere. The grey particle and shower emission behaviors similarly exhibit a linear relationship with N_h. Figure 3 illustrates how shower and grey particles correlated in the backward hemisphere in the interaction of ^{84}Kr with emulsion as a function of N_h. Figure 3 illustrates that the likelihood of emitting grey particles is greater than that of shower particles emitted in a reverse direction. In backward hemisphere, the shower and grey particle emission behaviors both exhibit a linear relationship with N_h, similar as in the case of forward hemisphere. This is due to the fact that shower particles, which have higher energy, emerge from the participant region, whereas grey particles, which are nearto the participant region, emerge from the contact region and have less energy than shower particles. For this reason, shower particle emission probability is higher in the forward hemisphere than that of grey particle emission.

Conclusion

The results of the present study demonstrate that the mean multiplicities of the shower and grey particles exhibit a linear relationship with N_h, and that the shower particle's emission probability is greater in the forward hemisphere and lower in the backward hemisphere than that of the grey particles.

Acknowledgments

The emulsion detector was implemented by the entire technical staff of GSI Darmstadt, Germany, for which the authors are grateful.

References

[1] B. Kumari et al., *J. Kor. Phys. Soc.*, **84**, 829 (2024).
[2] Kajal et al., *Int. J. Mod. Phys. E*, **31(8)**, 2250073 (2022).
[3] M. K. Singh et al., *Ind. J. Phys.*, **85**, 1523 (2011).
[4] M. K. Singh et al., *Ind. J. Phys.*, **84**, 1257 (2010).