AN APPROACH FOR THE STUDY OF MULTIPLICITY CORRELATIONS AND FLUCTUATIONS IN RELATIVISTIC HEAVY ION COLLISIONS

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Abstract : In this paper an attempt has been made to study the multiplicity correlations of produced charged particles in the interaction of 28Si + Emulsion collisions at an energy 409 GeV (28 × 14.6 GeV per nucleons). This analysis is based on the maximum fluctuation of the charged particle density in narrow pseudorapidity intervals of experimental data and compared with the simulated Monte Carlo data in η and ϕ phase spaces. The study reveals the existence of dynamical multipions correlation in the pseudorapidity interval 0.1–1 for both the data sets.

Keywords : Relativistic heavy ion collisions, Multiplicity correlations and fluctuations.

Introduction : The existence of multiparticle phenomena provides valuable informations about the processes involved in nuclear collisions at ultrarelativistic energies. Global features such as multiplicity and pseudorapidity fluctuations of relativistic charged particles can be described to a good approximation by various models [1, 2] based on multipions production in hadron-hadron, hadronnucleus and nucleus-nucleus collisions at very high energies. The event-by-event study of produced charged particles gives an idea that these particles are assumed to be emitted in a correlated way [3]. The reason for such type of correlation behavior, suggested by various theoretical physicists [4, 5], might be due to the production of resonance phenomena and the formation of a newly state of matter called quark gluon plasma (QGP) [6]. The study of the experimental results reveals the formation of clusterization, which may be the main cause of such correlation effect. In view of this, the study of correlation and clusterization of relativistic charged particles in such processes is used as a tool to extract vital information.

Experimental Details : Two Stacks of FUJI - type nuclear emulsion, exposed horizontally of28Si beam at energy 14.6 AGeV from the Alternating Gradient Synchrotron at Brookhaven National Laboratory (BNL AGS) have been utilized for data collection. A NIKON (LABOPHOT and Tc-BIOPHOT, Japan made)microscopewith a 40 Xobjective and 10 Xeyepieces provided with a semi-automatic scanning stage was used to scan the plates. Each plate was scanned by two independent observers to increase the scanning efficiency. The final measurements were done using an oil immersion 100 Xobjective. The measuring system fitted with it has 1 µmresolution along the X and Y axes and 0.5 µm resolutionalong the Z-axis. The angle of emission of a particle is determined by finding the space angle (θ_{s}) of the corresponding tracks with respect to the primary by the relation:

$$\theta_{s} = \cos^{-1} [\cos \theta_{p} \times \cos \theta_{d}], \text{ where } (\theta_{p}) \text{ is }$$

projected angle and (θ_d) is dip angle.In order to study the correlations and fluctuations in relativistic nuclear collisions in different phase spaces, the measurement of azimuthal angle is taken into account. This is the angle between the projections of secondary track in the Y-Z plane with respect to Yaxis. The azimuthal angle, ϕ , is determined by the following relation:

$$\phi = \cos^{-1} [\cos \theta_d \sin \theta_p / \sin \theta_s].$$

The other relevant details of the present experiments can be seen in our earlier publications [7 - 9].

Results And Discussions : In order to analyze the dynamical fluctuations in the pseudorapidity distributions of η -phase space and azimuthal angle ϕ -phase space, the following method has been used. The pseudorapidity of all the relativistic charged particles is arranged in increasing or decreasing order for particular events as well as for whole data. For each event η -values are examined with a fixed rapidity intervals, $\Delta\eta$, over the full range of η -values and the number of relativistic shower particles in each η -window of interval, $\Delta\eta$, are determined. The maximum particle density, ρ_{max} , is defined by [6, 10, 11]: $\rho_{max} = \Delta n_{max} / \Delta \eta$ in each η -window, where

 $\Delta n_{\rm max}$ is the maximum number of particles in each event within rapidity intervals, $\Delta \eta$. Similar procedure has been adopted in case of uncorrelated events generated by Monte Carlo simulation [12]. It is characterized to obtain the dynamical correlations of fluctuations.

The normalized distributions, $(1/N_{ev} dn/d\rho_{max})$ as a function of ρ_{max} for various fixed $\Delta\eta$ values, $\Delta\eta =$ 0.1, 0.4, 0.7 and 1.0 are depicted in Figs. 1 (a-d) for the interactions of 14.6A GeV/c ²⁸Si nuclei with nuclear emulsion in η -space and ϕ -space, respectively.