Multiplicity and Pseudorapidity Distributions of relativistic charged particles in Pb-Pb Collisions at 158A GeV/c

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Introduction

One of the main goals to study the characteristics of multiparticle production in relativistic heavy-ion collisions is to understand the underlying dynamics involved in phase-transition of produced nuclear matter into final state hadrons. A further impetus to these studies has emerged after the promising chance of quark-gluon plasma (QGP) formation has emerged at RHIC and LHC. Under the conditions of extreme density and temperature; the heavy nuclei collisions at high enough energy serve as a unique tool to study the strongly interacting matter. The fluctuations in hadron multiplicity produced in heavy-ion collisions may provide some clues for the occurrence of phase-transition [1].

At relativistic high energies, nucleons of the colliding nuclei deposit a huge amount of energy in a very small region of space resulting in the very high energy density (of the order GeV/fm^3) for a very short duration of time [2]. The final state particles produced from the space-time evolution of such collisions carry important information about the mechanism of particle production. To analyze these type of collision processes, the investigation of charged secondary particles play a significant role [3].

In the experiments where nuclear emulsion is used, a special preference is given to singly charged particles having velocity more than 70 percent of the light velocity. The shower particles are such singly charged particles with the relative speed, $\beta \geq 0.7$. These particles are mostly the relativistic charged pions with a few kaons and protons. The ionization on the tracks of these particles is $g < 1.4g_o$; where g_o is the minimum ionization on the tracks of singly charged particles. It has been found more suitable to study the properties of only shower particles than an admixture of all the charged particles; because such an admixture also contains fragments from both the nuclei having totally different mass, energy and centrality dependence. Furthermore, the multiplicity of shower particles (N_S) is shown directly to be a parameter of the number of nucleons involved.

The pseudorapidity distribution can be obtained directly in the relativistic heavy-ion interactions. Thus it provides a viable method to study the process and mechanism of particle production. The emission angle (θ) for shower particles can be measured precisely, and it is usually presented in the terms of pseudorapidity variable $\eta = -\ln \tan(\theta/2)$. Pseudorapidity variable is considered as one of the vital kinematical variables and its distribution is very helpful in yielding the information related to the multiparticle production mechanism.

Brief Data Details

We have only considered the shower particles for our analysis. We have carried out an analysis of events produced in ^{208}Pb-^{208}Pb collisions at 158A GeV/c performed at CERN Super Proton Synchrotron (SPS). The number of events selected for the analysis is 58. The other details of the data can be found from the EMUO1 collaboration [4]. Due to its 4π solid angle coverage, the conventional emulsion technique has an advantage over other detectors. The full phase space acceptance in emulsions results in bias-free data while as the acceptance cone of other detectors is limited.

To carry out a comparative analysis, the simulated data is also considered. The 2000 events of Pb-Pb collision at 158A GeV/c have been simulated using event generator HIJING [5].

Results and Discussion

For a very large number of heavy-ion collisions, it becomes necessary to study the mean value of multiplicity both experimentally and theoretically. The mean value of multiplicities in relativistic charged particles produced in Pb-Pb collisions for both experimental and simulated data is presented in Table 1.

Data	Number of events(N)	<N_S>
Experimental	58	1120.55
HIJING	2000	668.85

Table 1: Mean multiplicities of relativistic charged particles.

The multiplicity (N_S) distribution of both the experimental and simulated data has been presented in Figure 1.

The pseudorapidity distribution variation for shower particles per unit rapidity is P(N,η) = (1/N)(dn/dη) is shown in Figure 2; where N represents the total number of events considered and dn represents the particle number in the pseudorapidity bin.

Conclusion

The multiplicity and the pseudorapidity distributions have been studied for the experimental and simulated data. It is observed from the distributions that the presence of high multiplicity events is proportionally more in experimental data as compared to the simulated data which results in lower value of <N_S> in the HIJING data. It may be due to the lesser statistics of considered experimental data.

The value of (1/N)(dn/dη) in η-distribution is lower for HIJING data (where N=2000) as compared to the experimental data (where N=58); again owing to the lower statistics available. However, the peak is around η=3.0 for both the experimental and simulated data. The shape of the η-distribution is similar to the distribution as reported by EMU01 collaboration [4].

Results on two-particle correlation in η-space will also be presented.

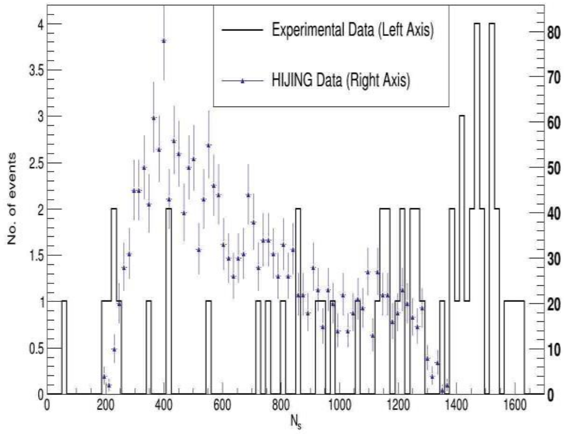

Figure 1: Multiplicity distribution of shower particles for both experimental and HIJING data.

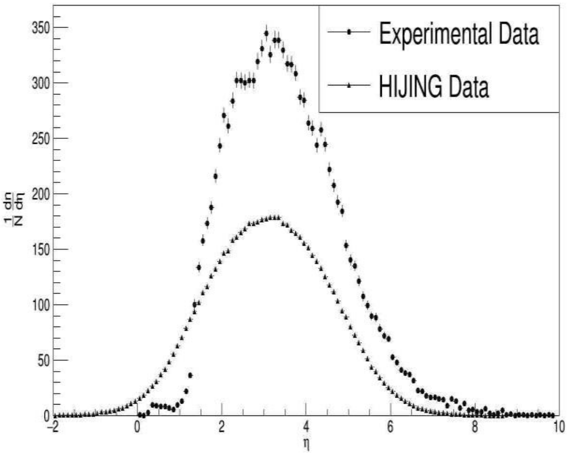

Figure 2: Pseudorapidity distribution of shower particles for both experimental and HIJING data.

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