# Angular and Pseudorapidity Distributions of Relativistic Charged Particles Produced in the Interactions of $^{32}$S-Em at 200 AGeV

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## Introduction

Interactions of relativistic heavy nuclei have become a subject of interest among physicists working in high-energy physics. This is mainly due to the intensive search for quark–gluon plasma (QGP), which should be formed in the hot, high-density matter created in interactions of relativistic heavy ions.

Relativistic nuclear collisions offer us at present the only means to probe the high density and temperature domain in the laboratory. Through relativistic heavy-ion collisions we want to reach very high temperature over extended domains many times larger than the size of a single hadron. The excitement in reaching these conditions is also favoured by the recent developments in Quantum Chromodynamics (QCD) [1], which predicts that at sufficiently large baryon densities and high temperatures, nuclear matter is therefore expected to undergo a phase transition to a state called the Quark-Gluon Plasma (QGP) [2,3]. Besides this deconfinement, chiral symmetry is expected to be restored in a QGP, which means that the quark masses will approach zero.

The acceleration of heavy ion beams at RHIC, CERN, BNL and Bevatron LBL has offered an opportunity to explore new avenues in the field of High Energy Physics. With the availability of heavy ion beams at high energies it has become possible to detect the existence of phase transition from hadronic matter to Quark-Gluon Plasma (QGP). Multiparticle production is an important experimental phenomenon in high energy nucleus-nucleus collisions. One can use multiplicity, Pseudorapidity (Rapidity) to describe the characteristics of multiparticle production. In this paper angular distribution and pseudorapidity distributions of relativistic charged particles produced in $^{32}$S-Em at 200AGeV have been presented and compared with different projectiles at different energies.

## Experimental Techniques

In this experiment two stacks of Ilford G5 nuclear emulsion plates exposed horizontally to a $^{32}$S-beam at 200 AGeV from Supper Proton Synchrotron, SPS at CERN have been utilized for data collection. The scanning of the plates is performed with the help of Leica DM2500M microscope with a 10X objective and 10X ocular lens provided with semi-automatic scanning stages. The method of line scanning was used to collect the inelastic $^{32}$S-Em interactions. A sample of 330 primary interactions was collected for performing angular measurement.

The interactions collected from line scanning were scrutinized under an optical microscope (Semi-Automatic Computerized, Leica DM6000M) with a total magnification of 10*100 using 10X eyepiece and 100X oil immersion objective. The measuring system associated with it has 1μm resolution along X and Y axes and 0.5 μm resolution along the Z-axis.

For present data $\eta_{min}$ is –4.03473 and $\eta_{max}$ is 5.46032.

## Results And Discussions

### Angular Distributions of Relativistic Charged Particles:

The angular distributions of relativistic charged particles produced in the interactions of $^{32}$S-Em at 200 AGeV along with the data obtained by other workers [4,5] in the interactions of $^{28}$Si-Em at 14.6 AGeV and $^{28}$Si-Em, $^{12}$C-Em, α-Em and P-Em at 4.5 AGeV are shown in Fig.1. It has been observed that the angular distributions of relativistic hadrons are almost similar and prominent peaks are observed at smaller angles.

### Pseudorapidity Distributions:

One of the fundamental experimental distributions in high energy heavy-ion collisions is the pseudorapidity distributions of produced shower particles. The pseudorapidity, η, of a particle is defined as **$\eta = -\ln\tan\theta_s/2$,** where $\theta_s$ is the space angle of produced particles with respect to primary direction of the incident beam.

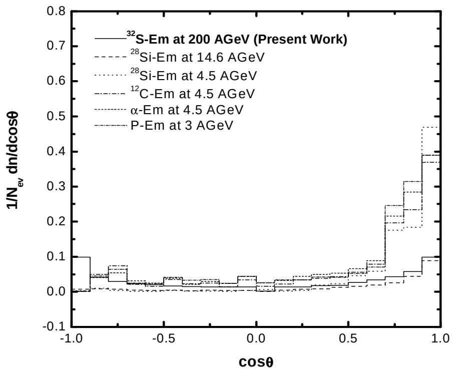


**Fig.1 Angular distribution of shower particles produced in various interactions at different energies.**

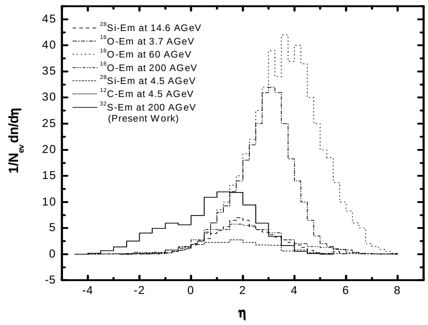


Fig. 2 Pseudorapidity distributions of shower charged particles produced at various energies

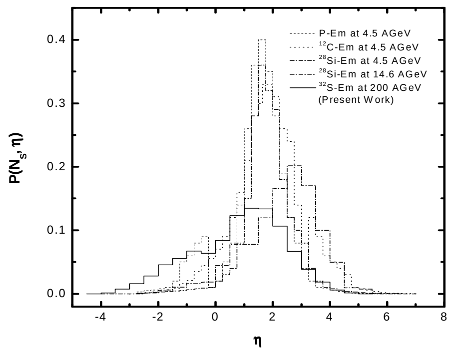


Fig.3 Variations of probability distributions of hadrons produced in various interactions at high energies.

The normalized pseudorapidity distributions (particle number densities in rapidity space) of the relativistic charged particles emitted in $^{32}$S-Em at 200 AGeV is shown in Fig.2. Also for the comparison the results obtained from the interactions of $^{28}$Si-Em at 14.6 and 4.5 AGeV and $^{12}$C-Em at 4.5 along with $^{16}$O-Em at 3.7,60 and 200 AGeV [4,6] respectively have been shown for the comparison. It has been found that the η distributions completely lie in the region of smaller values of η and also has been found to be independent of mass of incident beam whereas weak energy dependence has been found in this region. It has also been found that the distribution is broader for higher mass as well as beam energy. The height of the centroid increases many times in case of a nucleus-nucleus collisions with respect to the proton nucleus collisions [7].

The variation of probability distributions of relativistic charged shower particles produced per unit rapidity, **$P(N_s,\eta) = (1/N_s)(dn/d\eta)$** , with pseudorapidity, η, have been shown in Fig. 3 for the collisions of $^{32}$S-Em at 200 AGeV along with interactions [4] of $^{28}$Si-Em at 14.6A GeV $^{28}$Si-Em, $^{12}$C-Em and P-Em at 4.5A GeV respectively. The distributions are normalized for total number of hadrons produced in each sample. From this figure one may notice that the distributions are almost completely scaled for the entire region of η except for large η-values where a mild projectile dependence is seen. It may further be marked that the position and height of the centroid remains same in all the cases. Thus, one may conclude that the multiparticle production at all angles in the laboratory frame is same in nucleus-nucleus and hadron-nucleus collisions at different projectile energies.

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