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Fragmentation in S^{32}–AgBr interaction at 200 GeV/n – evaporation model revisited

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Abstract : This paper presents new data target fragment model in S^{32}-AgBr interaction at 200 GeV/n The data do not favour evaporation model instead a preferential backward emission of black track is indicated by the data

Keywords Nucleus-nucleus interaction, evaporation model, backward emission

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The extended state of matter can be studied with the help of relativistics heavy ion collision under extreme of energy density and temperature reachable otherwise in hot early universe, or in certain astrophysical situations of strong gravitational collapse. In particular, such collision can possibly create regions of deconfined matter so highly energetic that the normal forces that confine quarks and gluons in an individual hadron are overcome, and the matter in the interaction region in the form of an extended quark-gluon -plasma. There has been considerable speculations on the types of exotic matter which may be formed in central relativistic heavy ion collisions. At high baryon density the conjectures are : pion condensation, Lee -wick nuclear matter, delta isomer, quark matter and at high temperature one might encounter a temperature limit.

We are interested to get very high temperature over extended domain many times larger than the size of a single hadron. Quantum chromodynamics (QCD) suggests the color confinement prevails under normal circumstances, but at sufficiently high density and/or temperature deconfinement should occur, leading to a new phase of matter the quark gluon plasma (QGP).

One of the signature of QGP formation is larger non-statistical fluctuation among produced pions. Recently a large number of works [1] have been reported whose fluctuation study has been done for the pions in psudorapidity space. In this paper we have studied for the dynamical fluctuation in the azimuthal angle distribution of pions produced as a result of nucleus nucleus interaction at ultra-relativistic energy.

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When there is a formation of quark gluon plasma during the collision, it will rapidly destroy itself through instabilities, expansion and cooling. One should search for specific signals which could be associated with its transient presence of the plasma. The very important thing is to decide the fluctuation of some parameters on an event-to-event basis.

Recently, many works of the nuclear fragmentation in collision of ion at relativistic energy have been reported. To study the 'black tracks' is still interesting because the actual dynamics of target evaporated low energy particle is not known. Most of the works have concentrated of the nuclear flow of targets and happened to be the richest source of information of nuclear reaction of state and reaction dynamics[2-10]. In this present analysis the black tracks are identified as target evaporation particles in a model referred to as 'the evaporation model' [11]. According to this evaporation model, the particles corresponding to 'shower' and 'gray' tracks, in an excited state, left the hot residual nucleus and are started to emit form the nucleus immediately after the instant of impact. The emission of particle is relatively slow. In order to escape from this residual nucleus a particle must await a favorable statistical fluctuation, as a result of random collision between the nucleons within the nucleus, which takes the particle close to the nuclear boundary, traveling in outward direction. After evaporation of this particle a second particle brought to the favorable condition for evaporation and so on, until the excitation energy of the residual nucleus is so small that transition of the ground state is likely to be affected by the emission of the γ rays. In the rest system of the nucleus in this model, the direction of the emission of the evaporation particles are distributed isotropically. The evaporation model is based on the assumption that statistical equilibrium has been established in the decaying system and that the life time of the system is much longer than the time taken to distribute the energy among the nucleons within the nucleus. However the concept of the evaporation model has not been universally accepted. Barkas[12] suggested different mechanism to explain the emission heavy fragments from excited nuclei. The emission of slow target associated particle indicates the existence of non equilibrium nature as supported by different experimental data while Dalkhazhaev *et al* revealed the indication of nonequilibrium process in spectrum of slow particles in interaction of 70A GeV protons and 9.4A GeV deuterons with different emulsion nuclei. Taking the experimental data for proton-emulsion experiment at incident energy 67 to 400 A GeV, Takibaev and Adamovich [13] observed the dominance of non statistical fluctuations over the statistical part of angular distribution of 'black' particles. In this work we present new data on black tracks produced in S^{32} -AgBr interaction at 200 GeV/n. The data do not favor evaporation model.

A stack of G5 nuclear emulsion plates horizontally exposed to ^{32}S beam, having an average beam energy of 200 GeV/n at CERN SPS has been used in this case[14]. Leitz metalloplan microscope provided with semiatomic scanning stage are used to scan the plates, using objectives 10 x in conduction with a 10 x ocular lens. The scanning is done by independent observers to increase the scanning efficiency which turns out to be 98%. Criteria to select the events are :

(i) The beam track did not exceed 3^0 from the mean beam direction of the pellicle.

(ii) Events having interactions within 20 µm from the top or bottom surface of the pellicle rejected.

(iii) The incident beam tracks are followed in the backward direction to ensure that selected events did not include secondary interactions, the latter events are removed from the sample.

All the tracks are classified as usual

(i) The target fragments with ionization > 1.4 I_0 (I_0 is the plateau ionization) either black or grey tracks. The black tracks with range < 3mm represent target evaporation particles the light nuclei evaporated from the target)of β < 0.3,single or multiply charged particles

(ii) the gray tracks with a range ≥ mm and having velocity 0.7 ≥ β ≥ 0.3 are mainly images of fast target recoil protons of the energy range up to 400 MeV.

(iii) The relativistic shower tracks with ionization's < 1.4 I_0 are mainly produced by pions and are not generally confined within the emulsion pellicle. They are believed to carry important information about the nuclear reaction dynamics.

(iv) The projectile fragments form a different class of tracks with constant ionization, long range and small emission angle.

To ensure the target in the emulsion to be Ag/Br, only such events are chosen in which the number of heavily ionizing tracks exceed eight. The heavily ionizing particles of types (i) and (ii) belong to the target nucleus and those of type (iv) to the projectile nucleus, particles of type (iii) are produced in the final state of interaction.

Following the above selection procedure we have chosen 250 events of ^{32}S-AgBr interactions at 200 AGeV. The spatial angle of emission (θ), in the laboratory frame, of all black tracks is measured by taking the space coordinates,(X, Y, Z) of a point on the track, another point on the incident beam and the production point by oil immersion objective (100x in conjunction with a 10x ocular lens). The azimuthal angles ϕ of all black tracks are also calculated from these coordinate.

^{32}S-AgBr interaction at 200 GeV/n data have been presented in a two dimensional ($1 + \cos\theta$) and ϕ plot (Figure 1). Scale

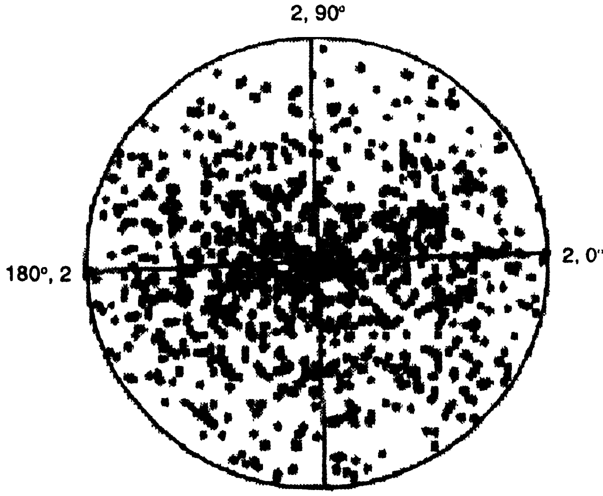

Figure 1. ($1 + \cos\theta$) $- \phi$ plot of emission angle ($0 \leq (1+\cos\theta) \leq 2$) and ϕ = 0° to 360° of target fragments from ^{32}S – AgBr interactions at 200 GeV/n

has been shifted properly for the convenience of plot. The following conclusions can be drawn from the data :

(i) The data indicate an overall azimuthal symmetry.

(ii) The plot hints at a clustering of target fragments in ϕ direction between 270^0 and 0^0 at emission angular zone 180^0.

Similar type of observations were obtained in case of ^{16}O-AgBr interaction at 60 GeV/n[15]

This analysis is interesting because it speaks against the evaporation model which speculates an isotropic angular distribution. Further, the data indicates a preferential emission of target fragment in the backward direction. The angular distribution of target fragment produced in ultra high energy nuclear collision can possibly throw some light in the emission mechanism of target fragment.

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