STRUCTURED EVENTS IN "PAMIR" CARBON X-RAY CHAMBERS

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ABSTRACT

Results of experimental and theoretical investigations of Structured **Events or** Narrow Groups of Hadrons in "Pamir" carbon chambers are presented.
It is shown that these events are formed by the usual fluctuations in in-chamber development of NEC initiated by a single hadron from the atmosphere.

1.Introduction. In the present article the revised data on Structured Events or Narrow Groups of Hadrons[1,2]are presented along with the final results of their Monte-Carlo simulation.

A Structured Event(SE) is a group of density spots on X-ray film in Hadron(H)-block of carbon emulsion chamber with mutual distances between spots in the interval (0.1 - 1.0) mm and energy registered in each spot $E_h^{(\gamma)} \geq 2$ Tev.

Anomalously small distances in SE link these events with the so-called "Chiron"-type events and "mini-clusters" registered by Brazil-Japan Collaboration[3,4]and with the certain ones observed by Pamir Collaboration[5,6].Usually, these phenomena are interpreted as an indication on an existance of narrow groups of particles in the atmosphere.However,to insist in this hypothesis the thorough investigation of all possibilities to obtain the observed events by the known physical processes is needed.This work has been performed for SE case and has led to the conclusion of SE origin triviality.

2.Properties of experimental Structured Events. From the data of 2 x 46 m² area of two-storey "Pamir-77/78" C-chamber(60 cm of C and 5 cm of Pb in each H-block) as much as 85 SE have been selected.Since SE as a rule are consisted of two density spots the properties of two-spot SE are presented here:

a)The fraction of SE of the total number of registered hadrons with $E_h^{(\gamma)} \geq 4$ Tev is:

$$\langle F \rangle = (8 \pm 2)\ \%, \qquad (1)$$

while the ratio of SE fraction in lower H-block to the one in upper H-block is:

$$\langle Q \rangle = 1.3 \pm 0.3. \qquad (2)$$

b)The spatial distribution within SE,i.e. the distribution of distances between spots in SE,is very narrow,concentrates at the lower edge of allowed interval and vanishes at 0.5 mm. The first two momenta of the distribution are:

$$\langle R \rangle = (0.21\ ^{+0.03}_{-0.01})\ \text{mm}, \quad \sigma = 0.10\ \text{mm}. \qquad (3)$$

Spatial distributions in both H-blocks are almost identical.

c) Energy-weighted spatial distribution in SE has the following mean value:

$$\langle E_h^{(\gamma)} R \rangle = (0.38 \pm 0.03)\ \text{Tev.mm}. \qquad (4)$$

d) The average energy of SE as a whole is:

$$\langle \sum_1^2 E_h^{(\gamma)} \rangle = (9.1 \pm 0.5)\ \text{Tev}. \qquad (5)$$

3. Out-of-chamber sources of Structured Events. Usually, to estimate the average height of parent interaction the $\langle ER \rangle$ characteristics of events under investigation is used along with the average transverse momentum of gammas produced in nuclear interaction ($\langle P_T^{\gamma} \rangle = 0.2$ Gev/c). In case of SE one obtains the following:

$$\langle H \rangle = 0.4\ \text{Tev.mm} / 0.2\ \text{Gev} = 2\ \text{m}, \qquad (6)$$

i.e. a source of SE seems to be above the chamber.

Investigations of possible out-of-chamber sources of SE have excluded them because in addition to the smallness of SE fluxes from these sources the experimental approximate equivalence of SE fractions in both H-blocks and narrowness of SE spatial distribution are not reproduced. For example, Monte-Carlo simulation of NEC in the atmosphere in the framework of quasiscaling model of strong interaction has resulted to almost uniform distribution of distances between hadrons in narrow groups of particles at the installation level:

$$\langle R \rangle = (0.61 \pm 0.06)\ \text{mm}, \quad \sigma = 0.30\ \text{mm}, \qquad (7)$$

which is in the striking discrepancy with the experiment.

4. Sources of SE inside the chamber. As the average height of the usual nuclear interaction in the chamber is estimated to be equal to ≈ 40 cm above the observation level, i.e. above the level of X-ray films under investigation, it is possible to estimate the average transverse momentum of gamma-rays in interactions giving rise to SE:

$$\langle P_T^{\gamma} \rangle = 0.4\ \text{Tev.mm} / 400\ \text{mm} = 1\ \text{Gev}, \qquad (8)$$

which is five times higher than usually accepted value.

However, simulation of high-P_T processes in the chamber have yield the negligible flux of SE [1]. This is due to the smallness of high-P_T processes cross-section, the smallness of transverse jet average energy and high energy threshold of X-ray film.

To check whether SE can be produced in hadron interactions inside the chamber the direct problem of NEC simulation in C-chamber has been solved along with the inverse problem of event processing,measurement and energy restoration[2].

Each simulated event is presented at the observation level in the form of secondary electron number density distribution(two-dimensional histogram,80 x 80 channels).Note, that this allows a study of density spot microstructure on X-ray films in Hadron-block.

As regions of low density are not visible on film due to the latter low sensitivity it is obvious that only peaks of the distribution can be seen as density spots.Investigation of these distributions in simulated events in Gamma- and Hadron-block has shown the difference in their shapes: gamma-initiated events are of one-peaked narrow distribution whereas hadron-initiated ones result in rather wide comlicated structure of electron number density distribution.It is evident that if two or more sufficiently well separated peaks(local maxima) of the latter distribution are above the certain threshold the event is seen as SE on X-ray film.

To select the required SE among the simulated ones a special method has been developed for the computer-search of local maxima which are candidates for separate density spots.The experimental procedure of optical density measurement by means of microphotometer with round diaphragm has been also simulated.Only peaks of electron number density distributions with corresponding energies above the accepted threshold value have been considered.

<u>5.Results.</u> The following properties of simulated SE have been obtained to be compared with similar ones in Sect.2:

$$\langle F \rangle = (20 \pm 4)\ \%,$$

$$\langle R \rangle = (0.23 \pm^{0.03}_{0.01})\ \text{mm}, \qquad (9)$$

$$\langle E_h^{(\gamma)} R \rangle = (0.39 \pm 0.03)\ \text{Tev.mm},$$

$$\langle \Sigma E_h^{(\gamma)} \rangle = (10.6 \pm 0.6)\ \text{Tev}.$$

As it can be seen the experimental and theoretical values are in good agreement.The excess in SE fraction in simulated events is related to its high sensitivity to handling parameters whereas it has been found the spatial and energy properties to be rather stable.

The interesting result is that the average energy of hadron interacted in the chamber and resulted in non-structured(usual)spot with $E_h^{(\gamma)} \geq 4$ Tev is just the same as the average energy of hadron that generates SE.It means that SE are quiet normal events with $E_h^{(\gamma)} \geq 4$ Tev and the selection of SE at the experiment does not biased energies of hadrons fallen on the installation from the atmosphere.

6. Discussion. Now the question is why simple estimates based on $\langle ER \rangle$ and $\langle P_T^{\gamma} \rangle \langle H \rangle$ relation have failed so drastically?

To study sources of this contradiction the genealogies of the certain number of simulated events have been analysed, i.e.it has been examined where from particles which form distant spots are originated.The investigation has shown that spots at distances greater than 0.1 mm from event's center are formed by rather low-energy particles from NEC nuclear interactions in the upper part of the chamber.All other particles in NEC give rise to more energetic central spot.When measuring optical density of distant spot the corresponding particle energy is overestimated due to overlapping effect.This effect was investigated in Gamma-block 7 where it was shown that "tails" of neighbouring electron-photon cascades(EPC) overlapped thus "amplifying" corresponding optical densities.In H-block the effect is stronger due to high multiplicity and narrowness of NEC secondary particles at film level.Overlapped EPCs of these particles form high "pedestal" for distant low-energy particle and lead to to visible distant spot.

The second,rather trivial,source of simple formula(8) failure is that it can not be used in case of cascade. That is why in case of in-chamber NEC the average P_T was once more overestimated.

7. Conclusion. The investigation performed have shown that SE as a whole corresponds to a single hadron from the atmoshere.Distant spots in SE are formed by the usual fluctuations in in-chamber NEC development.Corresponding energies are overestimated due to overlapping effect.

It is recommended to treat SE as single "hadron" and to determine its energy by measuring optical density of SE as a whole by means of diaphragm of highest radius.

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References.

1. Khizanishvili,L.A. et al,(1983),Proc.18th ICRC,Bangalor, vol.11,p.133.
2. Leptukh,G.G. et al,(1984),Proc.Intern.Symp.on Cosm.Rays and Particle Physics,Tokyo,p.414.
3. Hasegava,S,(1984),ibid,p.319.
4. Tamada,M,(1984),ibid,p.352.
5. Bielawska,H. et al,(1984),ibid,p.360.
6. Bayburina,S.G. et al,(1984),ibid,p.426.
7. Denisova,V.G.,Managadze,A.K.,(1984),Lebedev P.N.Phys. Inst. preprint No.20.