

Spatial structure of event with GALO in area energy $> 10^{15}$ eV

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Abstract

In XREC to the chamber to complex installation “Adron-44”, located on height of 3340 meters above a sea level in mountains Tien Shan near Almaty some exotic events are registered. Among them two brightly expressed events with a halo – diffused shadow stain by the area a little cm^2 .

1. Introduction

The similar events were registered in mountain experiments Japan-Brazilian collaboration in Bolivia, in cooperation “Pamir”, in mountains Pamir, in the Chinese experiment on Jomolungma, in Japanese on Noricure etc. The main difference of our experiment from others is that the events with halo simultaneously were registered in nuclear emulsion, in a x-ray film and in ionization calorimeter.

2. Results

It has allowed to receive the detailed information on structure of downpours with accuracy from micron up to several meters and energy from neutral components up to complete energy. The detailed description of experiment, its using, processing of experimental data including comparison of downpours registered in XREC and in ionization calorimeter are given in work [1]. To the present time 28 expositions XREC together with ionization calorimeter by duration from 3 months till 1.5 years are carried out. The total operating time makes $540 \text{ m}^2 \text{ year}$. The registered interactions in an atmosphere with halo are named “Sholpan” and “Anna”. Some characteristics are given in the table.

In the first line of the table are specified of threshold energy of registration gamma - quanta. 100 % registration of

quanta for the above-stated families begins according to 0.8 and 1.2 TeV. In the second line the number of the quanta which have been found out in families is given. It is necessary to note, that for family “Sholpan” on distance of 1.4 meters from the center in ionization calorimeter, the supplied peak is observed which is well compared to family gamma - quanta in XREC with $\Sigma E_\gamma = 7.0 \text{ TeV}$. Thus, it is possible to name this interaction as two-jet event [2] or binocular [3]. In the fourth line the area of darkness with $\Delta > 0.4$ is given. Visible by an unaided eye darkness makes $\sim 400 \text{ mm}^2$. The complete measurement of energy on ionization calorimeter has become impossible because of limitation of a dynamic range of an electronic path. Stain of darkness of event “Sholpan” has the delta - figurative peak. In a circle of radius 7.22 mm there are $6.7 \cdot 10^7$ charged particles received by a method to scanning of a stain in a x-ray film. It is natural, that the amplifier with a dynamic range - 500 has come in saturation. Now in laboratory is created and patented the amplifier with a range $- 10^6$. Thus, the energy allocated in a neutral component is defined on XPEC, and allocated in adron on ionization calorimeter. The analysis of power spectra the secondary gamma - quanta which is included in structure halo shows, that the parameters of spectra at least on two order are softer than spectra gamma - quanta from usual families. Really, it is visible from the ninth line of the table, where the parameters of power spectra of examined events are given. For usual families this parameter is equal $a = 0.12$. The absence in researched interactions of leading particles, the abnormal large value of partial coefficient of elasticity $K_g \sim 0.9$ testifies about extremely large dissipation of

energy in this area of energy. To the present time there is no unequivocal interpretation of processes resulting in formation of so unusual events.

Besides as have shown results received on installation PIAS - "Adron", combining XREC with installation of EAS, in area $E \sim 10^{16}$ eV there is a sharp change of the characteristics of the elementary act of interaction [6]. As follows from experimental data of S.I. Nicolski group the indication is received, that at the given energy the sharp, almost threshold mitigation of spectra of secondary particles of trunks EAS is revealed.

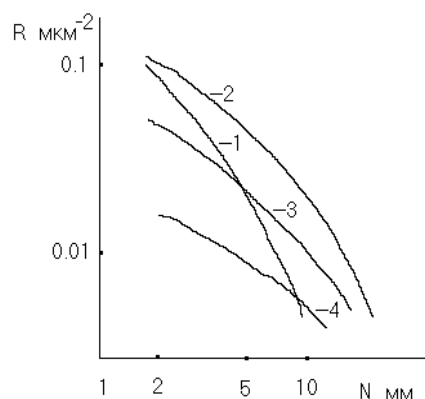
The threshold infringement of scaling, consisting in disappearance of fragmentary area of secondary particles, can mean presence of new channels of multiple birth at energy above $5 \cdot 10^{15}$ eV. The given factor unequivocally results to the uncompleted measurement about half of energy of a primary particle at the expense of its dissipation in an atmosphere. Thus, firmly established "break" of a spectrum in the field of energy $E = 3 \cdot 10^{15}$ eV, found out in works executed by a technique EAS, can be connected with the uncompleted measurement of energy.

Uncertainty in a question of formation of families the scale - quantum with halo has induced us to study of these events.

In event "Sholpan" the axial symmetry of darkness density is observed, besides the direct measurement of tracks on nuclear emulsion allows to study spatial distribution of the charged particles in halo.

On the fig.1 the spatial distribution of density of the charged particles (under figure 1) is submitted depending on radius in the given event. Here are given accounting distribution on R received in group "Pamir" [5].

The account was carried out on the scaling model (independence of section and spectra from E_0) for primary protons. The curves, given in figure, were calculated for protons with energy of $3 \cdot 10^{16}$ eV (figure -3) and $5 \cdot 10^{15}$ eV (figure -4). The accounting distributions are similar under the form and in area $R > 1$ mm are characterized by dependence $n \sim R^{-0.3}$.



In the same figure the results of account interpreting formation of halo EPC, born by primary gamma - quanta [4], (figure 4) are submitted. From figure it is visible, that experimental curve-1, is described by dependence $n \sim R^{-1}$ and differs from accounting curves.

Thus, the significant difference in cross distribution on density of the charged particles and parameters of power spectra in events with halo and without halo is one of the certificates on possible(probable) change of the characteristics of interactions in energy area $10^{15} - 10^{16}$ eV. Besides it is necessary to note the following: in an accounting part of work [4] is shown, that in events of a type halo density of particles in 4 times more, and the sizes approximately in as much time are less (at the same energy), than in usual. Such events at energy $> 10^{15}$ are approximately half. Large installations for registration EAS now are created: in Russia by the size 1000 km^2 and in USA $\sim 10000 \text{ km}^2$ with distances between detector items $0,5 - 5,0$ km. It is natural, that in such discrete installations the most part of exotic events which are mentioned above will be missed in consequence of the most interesting information on possible features of interactions in area $E 10$ eV can be irrevocably lost.

References

1. Eremenko U. A. Study leading neutral pions. Alma-Ata, Изд. "Science". (1988).
2. Такубаев Z.S., Sadygov T.H. Изв. АС КазССР. Сер.физ.-мат. N4. С. 15. (1977).
3. Bellandi J and Cardoso I and et al. 16-th ICRC. Kyoto, Japan. V7, p. 350. (1979).
4. Managadze A.K., Fedorova G.F. Препринт 91-23/227. НИИЯФ МГУ Moscow. (1991).

5. Baiburina THIS YEAR, Borisov AMPERE-SECOND. Etc. Тр. ФИААН USSR. Т. 154. С. 3. (1984).
6. Adamov D.S., Arabkin V. V. Etc. Изв. АН of Russia. Сер.физ. N4, с.15. (1993).

Table 1.

N	Characteristic of events	Sholpan	Anna
1	Threshold energy on nucl. plate.. TeV	0,3	0,5
2	Quantity(amount) of quanta found out on nucl. plate	497	177
3	Total energy of quanta on nucl. plate. PeB	0,69	0,32
4	Area of darkness in XREC with $\Delta > 0.4$. mm ²	163,7	126,3
5	Energy determined on XREC PeV	4,2	3,24
6	Area of a downpour on ionization calorimeter. m ²	50	42
7	Area of a downpour in ionization calorimeter. in iron.	0,8	0,7
8	Energy adron components, in . ionization calorimeter, PeV	0,20	0,16
9	Parameter of a power spectrum.	0,0002	0,0008