

Peculiarities of gamma-quanta distribution at 20 Tev energy

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The angular distribution of protons from the fragmentational region was analyzed. The gamma-quanta families were generated in a dense target by cosmic ray particles at 20 Tev energy. There were found the families which had dense groups (spikes) of gamma-quanta where the rapidity density was 3 times more than the average value determined for all registered families. The experimental data were compared with the results of artificial families simulation.

The fluctuations of particles density in the rapidity scale which were discovered in accelerator experiment [1] were discussed before when gamma-quanta families were studied in cosmic ray experiments [2]. It becomes interesting to study these fluctuations again because the mechanism of their appearance is connected with the effect of quark retention which leads to length restriction of gluons emission [3]. Thus, in the paper [4] there was discovered a structure of the angular correlations of charged secondaries in the inelastic proton-proton interactions at 400 Gev which gives new information about quark retention character.

The data concerning cosmic particles interaction were received by means of the installation consisting of the 9 m² ionization calorimeter and X-ray and emulsion chamber (XREC) of the same area, which was disposed just on the ionization calorimeter. At 11 m above the ionization calorimeter there was the paraffine target of 60 m² area and of 15 g/cm² thickness.

The photosensitive layers of XREC consisted of X-ray film RT-6 and nuclear emulsion R-2T. The registration energy threshold for gamma-quanta for about 100% detection efficiency was equal to $1.5 \cdot 10^{12}$ ev for X-ray films and $0.5 \cdot 10^{12}$ for nuclear emulsion.

The comparison of electron-nuclear cascades in the ionization calorimeter with dark spots in the X-ray film and emulsion chamber was made using coordinates of an entrance point of a high energy particle, zenith and azimuth angles and neutral pions energies measured by the ionization calorimeter and the XREC.

On ionization calorimeter and XREC give incomplete information about each individual interaction: not all secondaries are registered by XREC, besides, it is impossible to separate particles from first and second interactions. The limited spatial resolution of a calorimeter leads to confluence of electron-nuclear cascades initiated by near particles. Thus, the peculiarities of the experiment don't exclude the possibility of systematic distortion of some hadron-nucleons interaction characteristics. To reveal these systematic distortions there were made simulations of electron-nuclear and electromagnetic cascades applicable to the experimental conditions [5].

It was considered three-dimensional picture of electron-nuclear and electromagnetic cascade development for the case when cosmic particles went through layers of substance having different atomic weights, densities, cascade units and interaction mean free paths. The height was taken as 5200 m above sea level for simulation of artificial interactions. For this height there is known the experimental data concerning the composition and energy spectra of hadrons and electrons. In the simulations of hadron-nuclear interactions there was used the model which was based on an extrapolation of accelerator data into more than 10^{13} ev energy region. The model assumed scaling conservation in the fragmentational region.

The experimental statistics was 203 families of gamma-quanta initiated by particles at the mean energy which was equaled to 20 Tev. The mean number of gamma-quanta with energies above registration threshold was equaled to: $\langle N_p \rangle = 6.5$. The dense gamma-quanta jets (spikes) were looked for among the families with the number of gamma-quanta $N_p \geq 4$

Photon groups were taken for spikes when $N_{\mu} > 4$ and the densities on the rapidity scale were $N/\Delta\eta \geq 9$. Such spikes were found in 123 families.

Fig.1 gives the rapidity-distribution of the family photons against the spike rapidity. It can be seen that photons in spikes are in rather narrow rapidity interval. The width of the peak at half-height is equaled to: $\Delta\eta = 0.5$.

Fig.2 shows the number of spikes distribution against gamma-quanta density per rapidity unit.

Fig.3 shows the spike-distribution against the number of photons in the spikes (K).

Fig.4 gives the distribution of the families against emission angles of jets in center-of-mass system. The emission angles in CMS range from 1° to 15° , the most probable value being $5-6^{\circ}$.

The estimations of the process of gamma-quanta generation with high density on rapidity scale are, probably, underrated because there were not taken into account the possible double-modal distributions of gamma-quanta in the families with high multiplicity.

Bibliography.

1. Rushbrooke J.G. Preprint CERN-EP/84-39, (1984).
2. Amanov K.A. et al., ICRC papers, Paris, v.5, p.307, (1981).
3. Dremin I.M., Nuclear Physics, v.37, p.649, (1983).
4. Dremin I.M. et al., Letters to JETP, v.40, p.320, (1985).
5. Ermakov P.M., Shorin B.F., Preprint HEPI, n.84-16, p.I-22, Alma-Ata, (1984).

$$\frac{1}{N_{\text{spike}}} \frac{dN_{\text{spike}}}{d\eta}$$

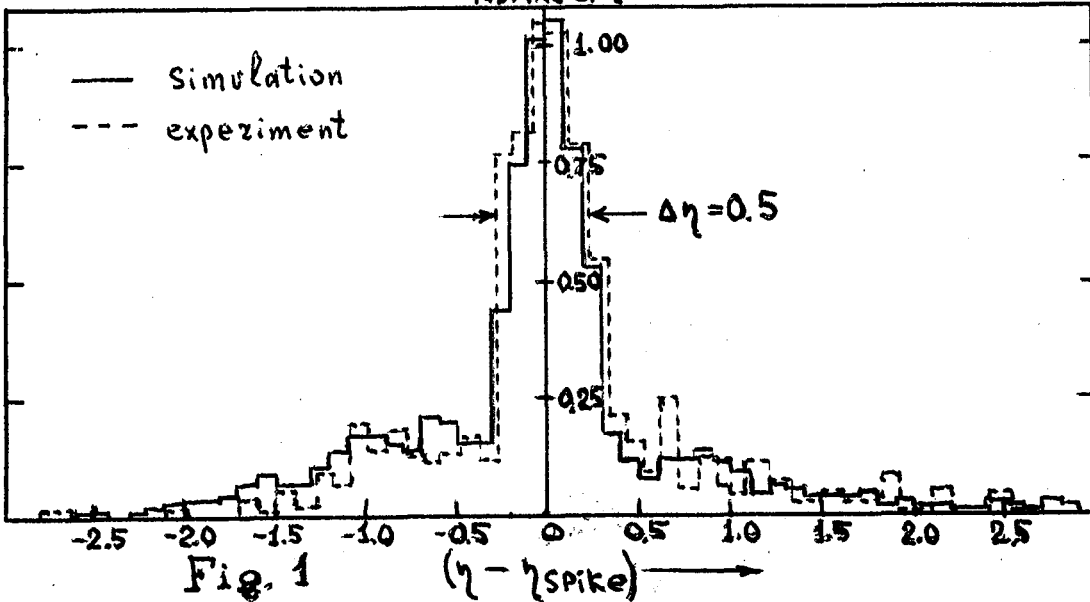


Fig. 1

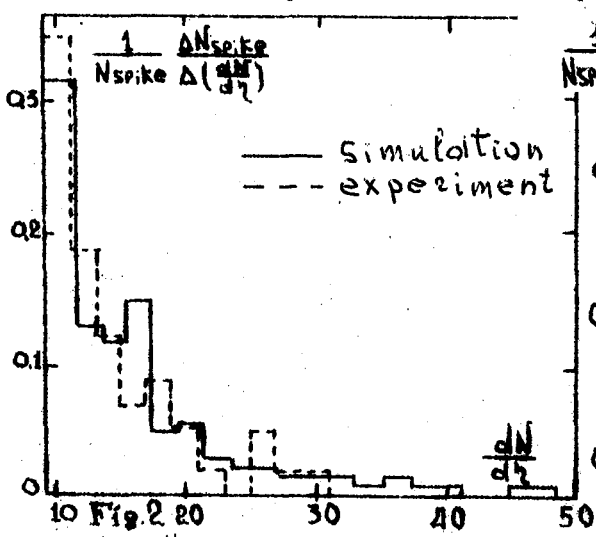


Fig. 2

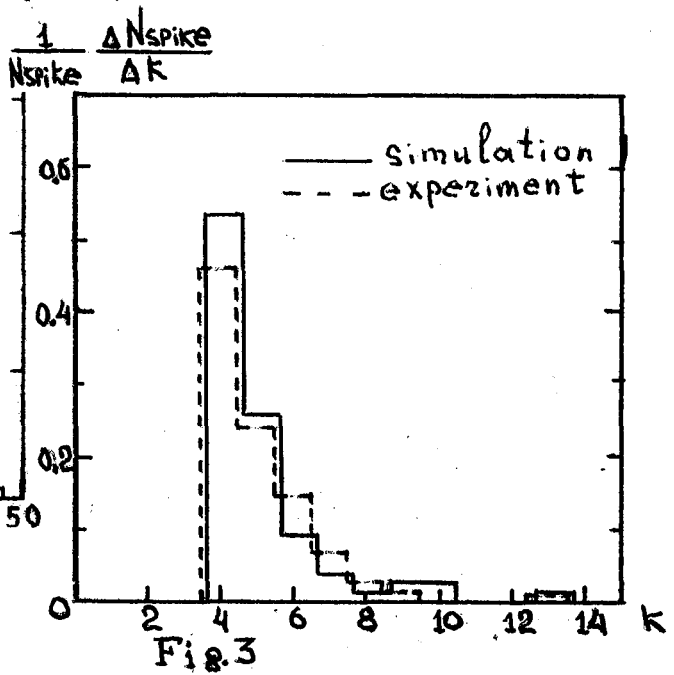


Fig. 3

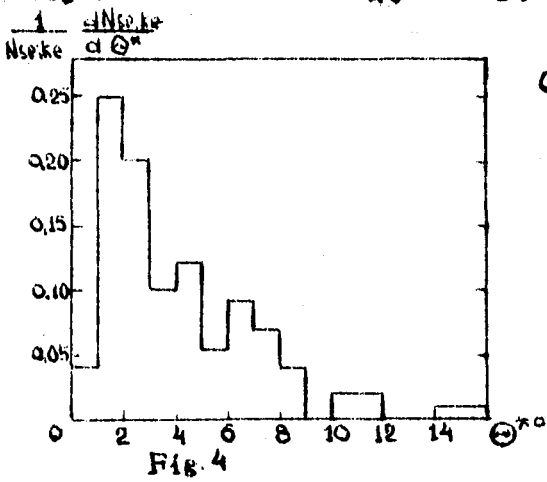


Fig. 4