A COMPARATIVE ANALYSIS OF GAMMA AND HADRON FAMILIES AT THE SUPERHIGHT ENERGIES RECORDED IN EXPERIMENT "PAMIR"

Azimov S.A., Mulladjanov E.J., Nosov A.N., Nuritdinov H.
Talipov D.A., Halilov D.A., Yuldashbaev T.S.

Physical-Technical Inatitute of Academy of Sciences of the Uzbek SSR, USSR

In the paper a comparative analysis of hadron and gamma families were undergone the decascading procedure is made. Receive results are compared with different models of interactions. In hadron families with energies $\Sigma E_\gamma^h > 20$ TeV as well as in gamma families with energies $\Sigma E_\gamma > 70$ TeV increasing azimuthal anyzotropy in events with large ER is observed.

INTRODUCTION

It's of interest compare different characteristics of the gamma and hadron families at superhight energies. However, electromagnetic multiplication of the initial γ-quanta in the atmosphere has a great influence on observed characteristics of the γ-families decreasing sensitiveness these characteristics (especially longitudinal) to different models of strong interaction. Hadron families characteristics are free the influence of those effects.

The decascading procedure suggested in /I/ allow to reduce essentialy the influence of electromagnetic cascading multiplication of the initial γ-rays in the atmoaphere. All particles paires satisfied the condition $Z_{ik} < Z_o$ were combined in single group (initial quantum), where $Z_{ik}=R_{ik}(I/E_i+I/E_k)^{-I}$, R_{ik} -the mutual distance of particle pair in mm, E_i, E_k -their energies in TeV. The decascading parameter was set equal to Z_o=IO TeV·mm. Thus the observed γ_o-families are transformed in the initial γ_i-family. The comparison characteristics of the hadron-families (h-families) with such γ_i-families is a more corred procedure than comporison with observed families.

The experimental data about spatial characteristics of the γ_i and h-families compare with simulated families calculated on different assumptions about mechanism of the strong interaction. Different assumptions about chemical composition of the primary cosmic radiation exert essential influence on the results of such analysis. Consequently, in the paper an new selecting criteria of γ-families are formed by primary nuclei or protons is proposed.

We considered such spatial characteristics as $\bar{R}$ ($\bar{R} = \sum_{i=1}^{n_\gamma} R_i / n_\gamma$, R_i -distance of the γ-quanta from axis of family, n_γ -number particles of family) and α proposed in the

work /2/ for analyse the structure of the families.

$\alpha = \sum_{i \neq j}^{n} \cos 2\varepsilon_{ij}/(n(n-1))$, where ε_{ij} -the angle between the momentum projections of i-th and j-th particles in azimuthal XY-plane, perpendicular to the primary particles direction, n -number of particles in family.

The value α reachs magnitude $\alpha = 1$ for the completely complanar events and become minimal $\alpha_{min} = -1/(n-1)$ in the case of an isotropic, uniform distribution of azimuthal angles.

I. The characteristics of the hadron and gamma families

To analyse the spatial structure of γ-families it is impotant to have more complete information about particles with large transverse momenta. Consequently it's were investigated the experiment "Pamir" data obtained under conditions when film scanning and particle selection were realised within the radius R = 30 sm relatively the energy weighted center of γ-family. In the result were selected N=326 γ-families with energies $\Sigma E_\gamma = 60 \div 500$ TeV and number of particles $n_\gamma \geq 4$. The minimum energy of the γ-quants in the families was set $E_\gamma = 4$ TeV. Particle scanning and selection h-families were realised within the radius R=30 sm too. The minimum energy of the cascades in the h-families was set $E_\gamma^h = 4$ TeV. It were selected N=181 h-families with energies $E_\gamma^h = 20 \div 500$ TeV.

At the analysis of the hadron families on record by " "Pamir" carbon chamber, it is nesessary to take account the formation structured events that is the groups of spots with mutual distances less than ~ 1 mm in X-ray film. These narrow groups of spots corresponds to one hadron above the chamber and originate from spatial fluctuations in nuclear-electromagnetic cascad (NEC) in the chamber /3/.

In the paper the groups of the electron-photon cascades (EPC) with mutual distanse less than 1.7 mm are considered as one cascade is produced by only hadron.

In table presents data about $\langle \bar{R} \rangle$ and $\bar{\alpha}$ obtained from experiment and from CS -scaling and CSČj -models /4/.

TABLE

	EXPERIMENT		CALCULATION		
	γ_i-fam.	h-fam.	CS γ_i-fam.	CSČj γ_i-fam.	CSČj h-fam.
$\langle \bar{R} \rangle$	44.6 ± 2.1	45.3 ± 3.4	29.1 ± 1.3	42.1 ± 3.8	47.3 ± 4.8
$\bar{\alpha}$	0.19 ± 0.01	0.26 ± 0.02	0.11 ± 0.01	0.21 ± 0.02	0.28 ± 0.03

In CSČj-model the inelastic charge-exchange of leading charge pion into neutral one $\pi^\pm \to \pi^0 + \ldots$ and the jet production processes was taken into account. The generation cross

section of jets with large transverse momenta P_{tj} is calculated according to /5/. As one can see from table I only jet generation model is in good agriment with experiment.

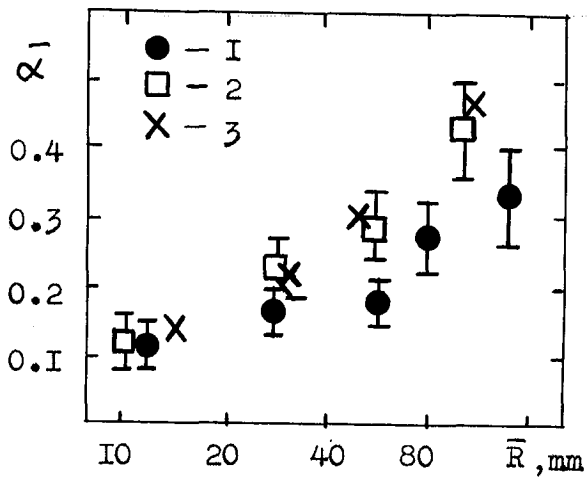

Fig. I

Fig.I presents data about the dependence of the value $\bar{\alpha}$ on the spatial parameter $\bar{R}$ of γ_i and hadron families (I – γ_i-families, 2 -h-families, 3 -h-families from CSCj-model). As one can see from figure I, the essential incrising of the azimuthal correlation in the range of the large values $\bar{R} > 50$ mm of the hadron and γ_i-families is observed. These results are in a good agriment with the jet production model while CS-model is led to smaller values $\bar{\alpha}$, $\bar{R}$, than in experiment.

2. Gamma-families originated from nucleus-nucleus (AA) and proton-nucleus (PA) interactions

In the paper the selecting criteria of that families obtained from the analysis of the γ-families simulated on the basis MSF-model /6/.

The criterion: $\bar{R} > 40$ mm and $\alpha < 0.2$ for selection of γ-families, originated from nucleus-nucleus interactions (AA-families) is proposed, as for as AA-families are more wide (the majority of the families have the value $\bar{R} > 40$ mm) and isotropic in the azimuthal plane than PA-families. That criterion select 65% AA- and 35% PA- of simulated families with energy ΣE_γ=70-500 TeV, contained EPC with energies $E_\gamma \geqslant 2$ TeV, lying within the radius R=30 sm from family center.

The using such criterion to experimental data showed, the fraction AA-families at the observation level is I5±4%. This value is agree with assumption about normal chemical composition of the primary cosmic radiation at energies $E_o \geqslant 10^{15}$ eV.

Other proposed criterion: $d = n_o / n_i$ where n_o and n_i – number of the observed and initial γ-quants in the families. According to MSF-model, families with $d \geqslant 1.6$ originated from protons (the admixture of AA-families compose ~9%), and events with $d \leqslant 1.2$ originated mainly from nucleus-

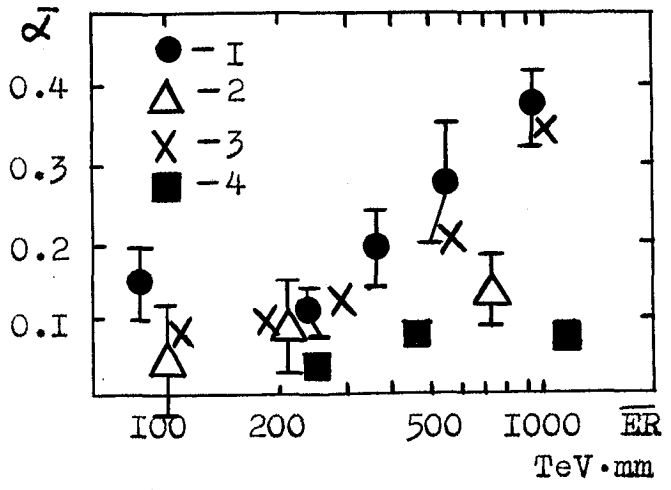

Fig. 2

nucleus collisions (among them 70% AA- and 30% PA-families).

At the Fig.2 data about the dependence azimuthal correlations from value $\overline{ER}$ (E -energy R -distance of the γ -quanta from axis of family, I -experimental families with $d \geqslant I.6$, 2 -experimental families with $d \leqslant I.2$, 3 -CSČj-model, 4 -MSF-model for events with $d \leqslant I.2$) is presented.

How one can see from Fig.2, effect of the azimuthal correlations increasing in the range of the large values $\overline{R}$ and $\overline{ER}$ connected with proton-nucleus interactions and described by CSČj-model. On the other hand for the nucleus-nucleus interactions the increasing azimuthal correlations is not observed.

REFERENCES

I. L.T.Baradzey, Yu.A.Smorodin, E.A.Solopov Preprint FIAN N I03, I974
2. S.A.Azimov, T.S.Yuldashbaev et.el. Zeszyty Naukove Universitety Lodzkiego, Lodz I977, z.60, s.II, p.28I
3. G.G.Leptuh et.el. Proc. of International Symposium on Cosmic Rays and Particle Physics, Tokyo, March I9-23, I984, p.26I
4. S.A.Azimov, E.J.Mulladjanov, H.Nuritdinov, D.A.Talipov, D.A.Halilov, T.S.Yuldashbaev Proc. I8-th ICRC, Bangalor, India I983, v.5, p.458
5. L.V.Gribov, E.M.Levin, M.G.Ryskin Phys.Lett. I2IB, 65, I983
6. R.A.Mukhamedshin Proc. I7-th ICRC, Paris I98I, v.5, p.343