CHARGE COMPOSITION AND ENERGY SPECTRUM OF COSMIC RAY PRIMARY PARTICLES FOR ENERGIES HIGHER THAN I TEV

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ABSTRACT

Onboard the "Cosmos-I543" satellite an experiment was performed to investigate the charge composition and primary cosmic ray energy spectrum for energies higher than I TeV. Preliminary experimental data are reported.

I. Introduction. Investigation of the energy spectrum of various groups of primary cosmic ray nuclei in the high and superhigh energy regions is one of the most important problems of cosmic ray physics and astrophysics. In the energy range I-IO GeV per nucleon the situation is rather clear [I], while in the range of E > IOO GeV per nucleon the problem is not solved yet [2] . To perform investigations in this energy region we have elaborated a special apparatus [3] and carried out in I984 the experiment beyond the atmosphere.

2. Methods. We used as energy detector the ionization calorimeter with the total thickness of absorber 5.5 paths for proton interaction. It consisted of 8 steel plates each IO cm thick and located above 8 scintillators. Each scintillator was attached to a lightguide and viewed by a PMT-84. The calorimeter is situated below the aluminium target about 8 cm thick, two lead absorbers 3 cm and 2 cm

thick, and two rows of scintillators employed to estimate the energy of electromagnetic cascades generated in the target.

Above the installation two types of Cerenkov charge detectors are located. The first-type detector consists of II directed action counters. Each counter comprises a radiator in optical contact with a PMT-49 and measures charges in the range of $I \leq Z \lesssim 5 \div 7$. Above this detector the second one is located, which composed of four counters to measure charges in the range of $3 \lesssim Z \lesssim 60$. Every counter consists of a radiator enclosed in a light-proof box and is viewed by a PMT-49. An accuracy of determination of Z under onground conditions is about 4%.

The device comprised the total of I99 amplitude analysers serving 95 detectors. The device's construction, characteristics, stability, and energy consumption are described in detail in [3] .

3. Results. The device was exposed in an almost circular orbit with a mean removal from the Earth of 330 km and an inclination angle of 62.8^{0}. It was oriented along three axes with the longitudinal axis being vertical.

The main mode for the device to put into operation required a signal in the directed action Cerenkov detector excited by a particle of $Z \geqslant I$, the total energy release in the calorimeter being $\gtrsim$ I.5 TeV at energy release $\gtrsim$ 35 GeV at least in eight absorbers. The rate of event registration remained constant during the whole experiment. The performed analysis showed that all the experimental apparatus work had been stable.

Up to date a small fraction of the data obtained has been processed, and the material presented below is mainly qualitative.

Figs. I and 2 show the examples of registered events. Two projections of the device and the avalanche position in the calorimeter are shown. The height of rectangles is proportional to the particle number in the corresponding scintillator. In the topr part of the position of the operated charge detectors is shown. The first event was initiated by a proton with energy I5 TeV and the second one by a neon nucleus of energy 20 TeV.

Fig. 3 characterises the separation of both proton and helium

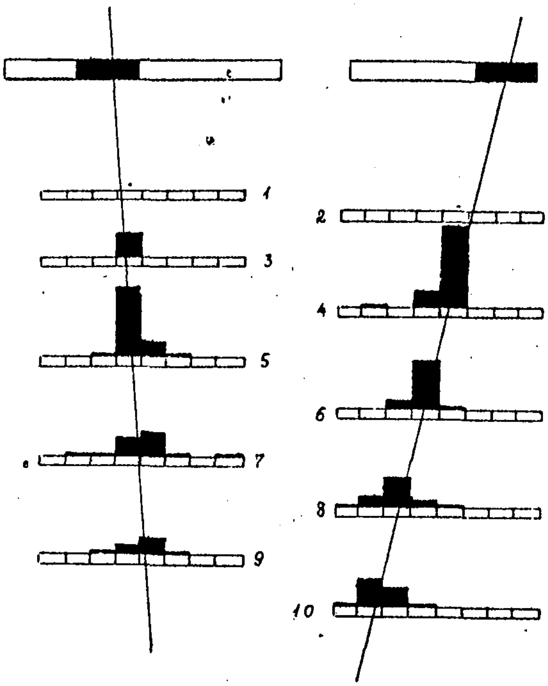

Fig. I

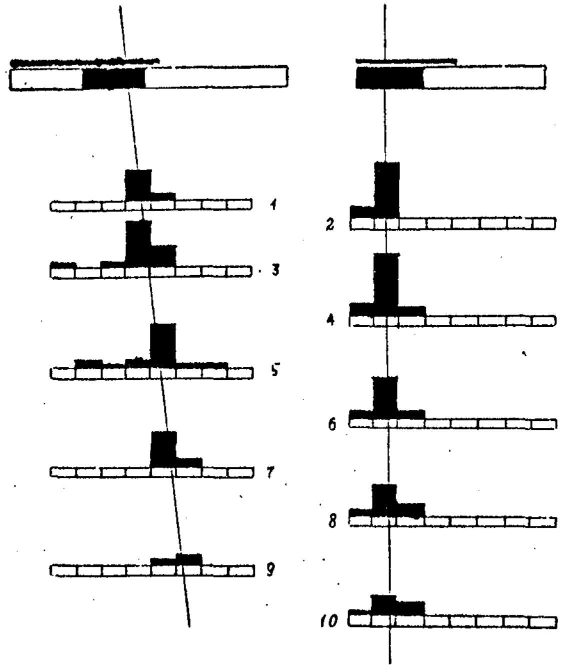

Fig. 2

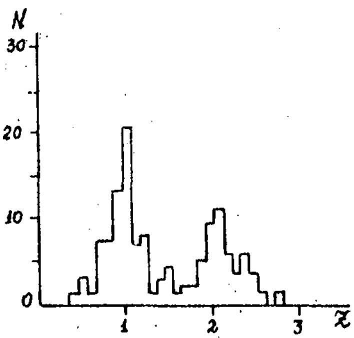

Fig. 3

of both proton and helium nuclei by the d directed action charge detectors. The ratio of particles with Z = 2 and Z = I (0.6-0.7) is close to that of at low energies.

The charge distribution at Z $\geq$ 5 obtained with the aid of the upper detector is shown in Fig.4, alongside with the expected distribution, provided that the distribution on Z is the same as that of the lower energies, and the amplitude distribution at fixed Z is characterized by the rms spread $\sigma \approx$ 4%. An examination of Fig. 4 shows that at Z$\geq$5 the nucleus charge composition is, within error limits, the same as that of at low energies.

Fig. 5 presents the differential spectrum of nuclei with Z$\geq$2. At low energies the spectrum is limited by $E_{thr} \approx$ I.0 ÷ ÷ I.5 TeV, and at higher energies γ = 2.50 $\pm$0 .25.

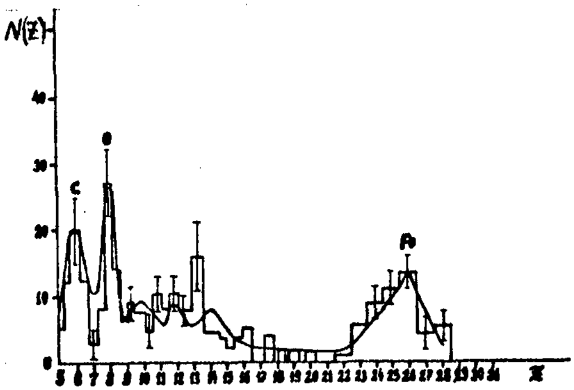

Fig. 4

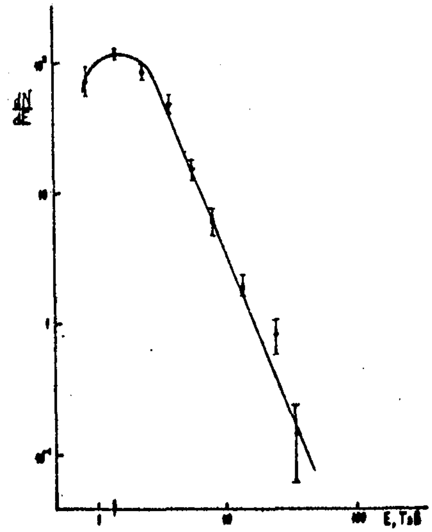

Fig. 5

<u>Conclusions</u>. It shoud be noted that the above presented experimental data do not indicate any abrupt variations of the spectrum and charge composition, however, they require further clarification. The presented distributions were plotted for all the events processed, while the threshold energies and the possibilities of particle registration may be a function of Z.

<u>References</u>

I. Juliusson, E., (I983), Proc. I8 ICRC, v.I2, II7
2. Linsley, J., (I983), Proc. I8 ICRC , v.I2, I35
3. Vernov, S.N. et al., (I98I), Proc. I7 ICRC, v.8, 49.