

III-4-4. Nuclear-Active Particles in Showers with Different
Number of Particles

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The change of the dependence of nuclear-active (n.a.) particles number on the total number of shower particles N at $N \sim 2 \cdot 10^5$ discovered in the work (1) has turned out to be one of the first experimental points of the change of elementary act characteristics at $E_0 \sim 3 \cdot 10^{14}$ ev. The region where a slight dependence of a total number of n.a. particles on a shower size is observed can be considered as an intermediate region between the showers with $N < 10^4$ and $N > 10^5$ which differ one from another according to a relative number of n.a. particles.

The measurements of a number of n.a. particles in the extensive air showers with different number of particles were carried out at the altitude of 3333 m above the sea level in 1960-1961. The experimental set selecting the showers with different number of particles is given in Fig. 1. Six counters of σ area each were placed at the centre of this set (I in Fig. 1), 3 counters of the same area were placed in every point (2-7). All the E.A.S. producing six-fold coincidence of discharges in point I and not accompanied with three-fold coincidence in one of the

points from 2 to 7 were recorded. Such events are connected with the hitting of a shower axis near the set centre. Six such sets with different area counters worked simultaneously. The spectrum of registered showers is given in Fig. 2.

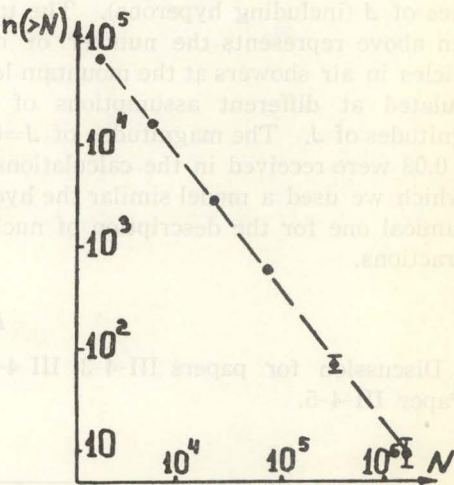


Fig. 2.

N. a. particles detectors were placed in the set centre and at the distance of 12 m from the set centre for the observation of n.a. particles. They were counters with BF_3 submerged in paraffin and covered with lead filters of different thickness. Some preliminary results for showers with $N \simeq 10^4$ and $N \simeq 10^5$ are shown in the table given below. In order to confront the data of this experiment with calculations and paper (2), we supposed that the lateral distribution of n.a.

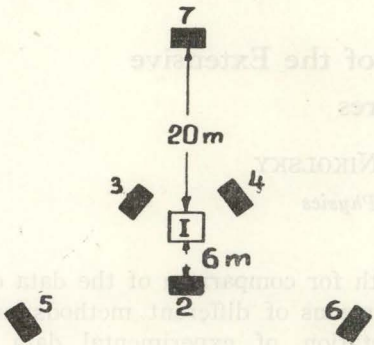


Fig. 1.

This paper was combined with III-4-3 and III-4-6 and presented by G. T. Zatsepin.

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N	experiments		calculations			
	paper (1)	present	$\Delta=0,27$	$\Delta=0,08$	$\Delta=f(E)$	$\Delta=0$
10^4	200 ± 50	150 ± 50	260	32	95	20
10^5	400 ± 100	500 ± 200	1690	237	770	

particles corresponded the paper (1), and the energy spectrum in the region $10^9 \sim 5 \cdot 10^9$ ev looked like $dE/E^{1.8}$.

A number of n.a. particles which was in agreement with an experiment was received in calculations (2). The fraction of secondary nucleons and antinucleons (Δ) among all the secondary particles, produced in the elementary act, considered to be equal 0.27. The latter seems to be a little bit higher in comparison with the majority of experimental data. However, if a great deal of observed characteristics of showers can be received by a method of calculation at some other values of Δ , a number of n.a. particles in air showers is determined mainly by the values of Δ (including hyperons). The table given above represents the number of n.a. particles in air showers at the mountain level calculated at different assumptions of the magnitudes of Δ . The magnitudes of $\Delta=0.27$ and 0.08 were received in the calculations (2) in which we used a model similar the hydrodynamical one for the description of nuclear interactions.

The calculation was carried out at $\Delta=f(E)$ with the account of the experimental data testifying the decrease of the energy fraction transferred to π -mesons at the increase of the interactive particle energy. For the region $10^{10} \text{ ev} \leq E \leq 10^{12} \text{ ev}$ and then it increases monotonously and at the level $E_0=10^{15} \text{ ev}$ it becomes 0.27. At $\Delta=0$ all the secondary particles are π -mesons. A free path for the nuclear interaction was taken as 75 g/cm^2 in every calculation mentioned above.

The comparison of calculated magnitudes with experimental data allows to draw a conclusion that at the collisions of particles with the energy $10^{10} \sim 10^{12} \text{ ev}$ an average fraction of nucleons, antinucleons and hyperons among all the secondary particles produced in elementary acts is large ($>10\%$).

References

- 1) S. I. Nikolsky, Yu. N. Vavilov, V. V. Batov, DAN, USSR, III, (1956) 71.
- 2) S. I. Nikolsky, A. A. Pomansky—Proc. International Conf. II, 1960.

Discussion

Discussion for papers III-4-3, III-4-4 and III-4-5 is combined and given after the Paper III-4-5.

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III-4-5. Energy Composition of the Extensive Air Shower Cores

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Measurements of an average value of energy of electron-photon (e-ph) and nuclear active (n.a.) components near an axis of the air shower were carried out by us earlier¹⁾.

* This paper was combined with III-4-3 and III-4-4 and presented by G. T. Zatsepin.

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But both for comparison of the data carried out by means of different methods and for interpretation of experimental data, it is necessary to know distribution of the shower characteristics near the average value. The measurements of fluctuations of energy flux were carried out at the Pamirs (3860 m, 650 g/cm^2) in the autumn of 1959. The de-