nucleon-nucleon interactions with energies 70~700 Gev is not a very large (smaller than 50%).

2. The coefficient of inelasticity $K_{\pi 0}$ depends on the primary energy slightly.

3. Multiplicity of the secondaries increases with the increasing of the primary energy slowly.

Discussion

Ezawa, H.: Are there also two peaks of inelasticity just as the case reported by Dr. Murzin ?

Dobrotin, N. A.: I have no figure now and can tell nothing about individual cases, but the conclusion is that inelasticity is smaller than 50% in general at $10^{11}\sim10^{12}$ ev.

Menon, M. G. K.: The thickness of Cerenkov radiators is small compared to the area. The particles travel through the thickness in a vertical direction and the Cerenkov radiation is emitted at a small angle to their direction. If one takes the light out at the side then a very large number of reflections are needed before this occurs. This must result in inefficiency and further the light collected will depend on the position in the Cerenkov radiator through which the particles passed.

Dobrotin: It was checked by single μ-mesons and they found no change of the efficiency.

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III-6-7. The Composition of the Flux of the Cosmic Ray Nuclear-Active Particles of Momenta Higher than 1.8 Bev/c at the Altitude of 3250 m above Sea Level*

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The nature and the momentum spectra of the nuclear-active particles of cosmic radiation are investigated by means of magnet massspectrometer and five-layer gas proportional counters at the altitude of 3250 m above sea level. The results of the measurement of momenta and the ionization of the particles are given for the inferval of momenta 0,1-20 Bev/c.

In the flux of the nuclear-active particles of the cosmic radiation in the air is found that: the ratio $N_{\pi^+}/N_{\pi^-}=0,90\pm0,15$ in the interval of momenta 100-720 Mev/c; π-mesons are $\sim5\%$ of all the particles in the interval of momenta 0,1-22 Bev/c and not more than 10% of the particles of momenta $\geq1,8$ Bev/c.

In the works related to the investigation of the nature and the spectra of the particles produced by cosmic rays, strictly speaking, the nature and the energy of the "primary" particles in most cases remain unknown.

The use of the cosmic rays for the investigation of the particle interaction processes in an energy region higher than the one given by the accelerator requires the knowledge of

* This paper was read by T. L. Asatiani.

the composition of the cosmic ray particle flux.

At the height of the mountains in low energy region the flux of the star-producing particles consists mainly of nucleons. Pions of low energy produced in the stars, decay not far from the production point. In high energy region (~10 Bev) the pion decay range is of the order of nuclear range and therefore, the role of the pions in the generation process of secondary particles must grow by the increase of the energy.

The aim of this papar is to determine the relative number of pions in the flux of cosmic ray nuclear-active particles in the momentum region higher than 1.8 Bev/c.

§ 1. Arrangement

This work is carried out at the altitude of 3250 m above sea level (mountain Aragats, Armenia) by means of a magnetic mass—spectrometer.

In Fig. 1 is shown the cross sections of the arrangement in two mutual perpendicular projections. The arrangement consists of a massspectrometer (with a strength of magnetic field 6850 oe), an additional hodoscope system located above the spectrometer[1] five-layer thin wall gas proportional counter[2]. The construction of the arrangement allows to measure the momenta, the ionising power of the particles passing through the magnetic field and to determine the nature of their passage through the lead and copper filters located under the spectrometer.

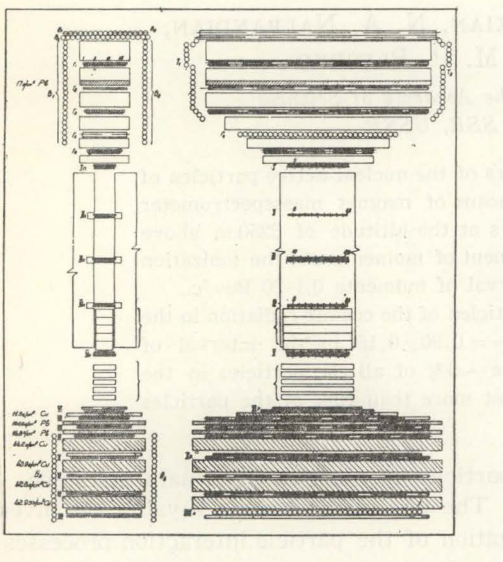

Fig. 1. The sketch of the arrangement in two mutual perpendicular projections.

The mean square error of the determination of momenta of 2 and 20 Bev/c is 10% and 80% respectively.

The ionizing power of each particle is determined by mean square error ±14% by means of a gas counter.

The thickness of the materials above the arrangement (the cover of the room) is not more than 5 g/cm² of wood and 1 g/cm² of iron.

§ 2. The separation of the nuclear-active particles in the air from the electrons, muons, and particles produced in the arrangement

The exclusion of the electrons.

To reduce the background of the electrons, a lead plate of a thickness of 17 g/cm² (Fig. 1) is placed above the row Γ_2 of the hodoscope system.

A hodoscope system surrounding the first three filters (11,5 g/cm² Cu, 16,65 g/cm² Pb, 16,8 g/cm² Pb; i.e. 0.82+3.2+3.24 shower units) has been served as a detector for electrons, passing through the field. To exclude the electrons, all the particles which produce showers in these three filters, the products of which do not pass the next copper filter (44.2 g/cm²) has been excluded from the consideration.

The exclusion of the particles produced in the arrangement.

All the particles produced by the neutral radiation or in the stars inside the hodoscope system mounted above the magnet, has been excluded from the work.

The exclusion of muons.

The problem of separating nuclear-active particles from muons has been investigated by G. V. Khrimian[3]. She has shown that the nonionization stoppings, scatterings, surpassing the double mean square magnitude of the multiple scattering and the "large" showers (of $n \geq 5$, $m \geq 2$)*, are produced ex-

* The stars observed in the hodoscope system, are characterised by the numbers m and n, where m is the number of the rows (between which the filters are located), through which have been passed not less than two star particles, n is the number of the observed secondary particles of the stars[3].

Table I. Number of Positive and Negative "Primary" Particles of Momenta 1,8–22 $\frac{\text{Bev}}{\text{c}}$ from the Runs "A" and "B".

Nature of the interaction of the "primaries" in the filters	Products passed the row XIII, large stars (m≧2; n≧5)		Remained events (Products did not pass the row XIII)		All types of the interaction	
1	2		3*)		4*)	
"Primary sign"	+	−	+	−	+	−
Run A	5	1	188(38)	3	193(43)	4(1)
Run B	15	0	13(3)	2(1)	23(8)	2(1)
A+B	20	1	201(41)	5(1)	221(61)	6(2)

*) In the columns 3 and 4 the number of large stars (type m≥2; n≥5) are given in brackets.

clusively by the nuclear-active particles.

It is impossible to distinguish the other types of interactions of the nuclear-active particles from the electron showers, produced by muons. Using the method suggested in (3) we have separated the nuclear-active particles from muons (events of large angle scattering are not included in the work, because much labour would be expended for their selection).

§ 3. The nature and the momentum spectra of the nuclear-active particles at the altitude of 3250 m above sea level

The results of two runs are included in the present paper: a) run "A" (coincidence I+II+III+IV+V−XIII), the arrangement has registrated mainly the particles absorbed with their secondary products in the filters. b) run "B" (coincidence I+II+III+IV+V), the arrangement has registrated all the particles.

Table I is a list of a detailed data from both runs about the nature of the passage of negative and positive "primary" particles through the filters of the arrangement. The given data shows that the ratio N_+/N_- within statistic errors is the same for the primary particles, producing large stars with penetrating products and for the particles creating other types of nuclear interactions. This means that the nature of the nuclear interactions of pions and protons in the momentum region of 1.8–20 Bev/c is the same and, therefore, one may use the data of both runs to determine the relative number of pions in the atmosphere flux of the cosmic rays.

In Fig. 2a are shown the momentum spectra of the positive and negative particles of momenta ≥1.8 Bev/c observed in the run "A". In Fig. 2b is shown the analogous spectra from the run "B". Except the particles given in Figs. 2a and 2b have been observed 5 particles of momenta >22 Bev/c the charge sign of which is not possible to determine.

According to the given data, in both runs, in the interval of momenta higher than 1.8 Bev/c, totally 232 particles has been observed, of which 6 are negative, 221 positive and 5 of unknown sign of charge.

Thus, in the momentum region 1.8–22 Bev/c, where 95–98% of the particles of momenta ≥1.8 Bev/c is concentrated, the number of the negative particles is ≈3% of all the particles.

In the momentum region up to 720 Mev/c, where the identification of the particles is possible by momentum and ionization[4),5)], we have studied the ratio N_{π^+}/N_{π^-}. By means of the arrangement used in the given work (Fig. 1) it has been obtained $N_{\pi^+}/N_{\pi^-}=17/15$. According to the data of our experiment "without generators[4)]" $N_{\pi^+}/N_{\pi^-}=47/56$.* Thus, the ratio in the air $N_{\pi^+}/N_{\pi^-}=0.90\pm0.15$.

If in the momentum region higher than 1.8 Bev/c the ratio does not noticeably differ from the one observed in the interval up to 720 Mev/c, then from the data given in Fig. 2a and 2b follows, that the pions are (6±2) % of all the nuclear-active particles in the momentum interval 1.8–22 Bev/c.

If one assumes that all the 5 particles of unknown sign of charge are to be also pions, than in the momentum region higher than 1.8 Bev/c the maximum number of pions

* Published for the first time.

would not be more than 10% of the flux of cosmic ray nuclear-active particles at the altitude of 3250 m above sea level.

Direct experimental data for the relative number of pions of the nuclear-active particles in atmosphere is not given till now. There are only given data for the relative number of protons in the flux of cosmic rays[6] and the spectrum of pions calculated on the basis of the experimental spectrum of muons, assuming that all muons are the decay products of air pions[7].

For the determination of the ratio N_P/N_μ or N_π/N_μ from our data it is necessary to determine the absolute numbers of protons and muons. In the spectrum (Fig. 2) and Table I are given the protons and pions stopped or creating stars in the filters. The remained protons penetrating the filters without interaction or producing small stars have been excluded by an anticoincident electronic circuit and a selection method of nuclear-active particles. To determine the part of the excluded protons, it has been studied the nature of the passage through the filters of the arrangement of the particles of momenta higher than 1.8 Bev/c produced by neutrons or in large ($n \geq 5$, $m \geq 2$) stars in the run below 25 cm of Pb[5]. It has been obtained that the probability of the registration of protons of momenta higher than 1.8 Bev/c is $\alpha = 0.22 \pm 0.09$. On the basis of the given data we have obtained $N_P/N_\mu = 0.11 \pm 0.05$; $N_\pi/N_\mu = 0.007 \pm 0.003$. Within the limits of errors the obtained values are in consistence with the data of the paper[6] $N_P/N_\mu = 0.061 \pm 0.003$ and with the calculations[7] $N_\pi/N_\mu = 0.0035$ (for momenta 2–4 Bev/c).

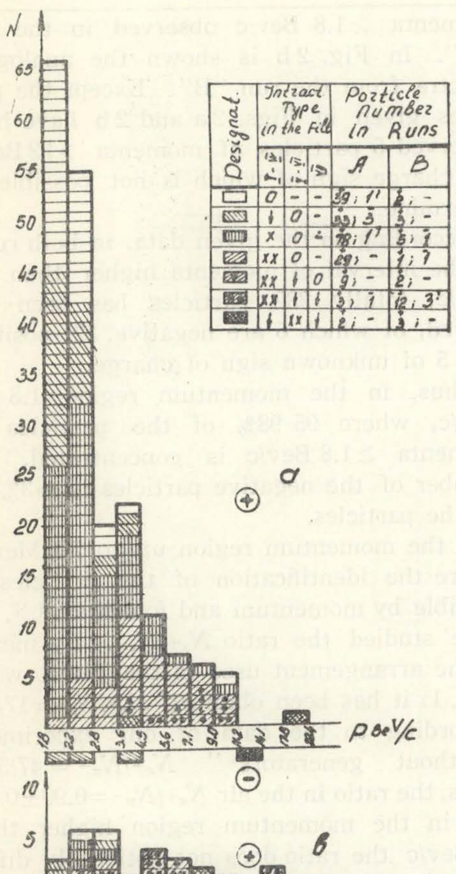

Fig. 2. The momentum spectra of the cosmic ray nuclear-active particles at the altitude of 3250 m above sea level: "a" is the spectrum of the particles observed in run "A". "b" is the spectrum of the particles observed in run "B". O-is the stopping. ↓-is the passage without interaction. ×-is the production of a weak star. ××-is the production of a large star ($m \geq 2$; $n \geq 5$) ? means particles, the sign of which is not determined (momenta > 22(Bev/c)).

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