where T_0 is the initial energy of the μ^--meson and m is the mass of the electron.

In the second case it is assumed that the following condition is satisfied:*

$$2\pi Z/137 \gg \beta_1, \beta, \beta_+, \beta_-; \; 2\pi/137 \ll \beta_\pm, \tag{2}$$

where β_0, β, β_+ and β_- are correspondingly the velocities of the μ-mesons and the pair particles with respect to the nucleus, $\beta_\pm$ is the relative velocity of the particles of the pair.

In this approximation the total cross section for the production of electron-positron pairs by μ^--mesons on nuclei is:

$$\sigma = 8\pi^3\left(\frac{Z}{137}\right)^6\left(\frac{e^2}{m}\right)^2\frac{m}{T_0}\left(\frac{T_0-2m}{2m}\right)^2 \left\{\eta^4\left(\frac{1}{4!}-\frac{1}{2\eta^2}\right)\mathrm{Ei}(-\eta)+I(\eta)\exp(-\eta)\right\}\exp\left\{-\frac{\pi Z}{137}\left(\frac{2\mu}{T_0}\right)^{1/2}\right\}. \tag{3}$$

Here: μ is the mass of the μ-meson,

$$I(\eta)=\sum_{k=0}^{1}\frac{(-1)^k\eta^k}{2\ldots(2-k)}-\sum_{k=0}^{3}\frac{(-1)^k\eta^k}{4\ldots(4-k)}; \quad \eta=\frac{\pi Z}{137}\left(\frac{T_0-2m}{2m}\right)^{-1/2}.$$

The function $\mathrm{Ei}(-\eta)$ is the exponential integral, the values of which are tabulated in Ref. 6.

The second case corresponds to the Born approximation for the pair particles:

$$2\pi Z/137 \ll \beta_+, \beta_-, \beta_\pm; \; 2\pi Z/137 \gg \beta_0, \beta. \tag{4}$$

In this approximation the total effective cross section for pair production is

$$\sigma=\frac{\pi^2}{6}\left(\frac{Z}{137}\right)^4\left(\frac{e^2}{m}\right)^2\frac{m}{T_0}\left(\frac{T_0-2m}{2m}\right)^3\cdot\exp\left\{-\frac{\pi Z}{137}\left(\frac{2\mu}{T_0}\right)^{1/2}\right\}. \tag{5}$$

The formulas in (3) and (5) do not go over directly to Eq. (11) of Ref. 5 which pertains to a region of considerably higher energies. We may note, however, that the exponential factor in Eq. (11) of Ref. 5 becomes approximately the same as the exponential factor in Eqs. (3) and (5) when $T_0 \to 2m$.

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*Here and in the following we will not specifically state the condition

$$2\pi/137 \ll \beta_{e-\mu}$$

[where $\beta_{e-\mu}$ is the relative velocity of the scattered μ-meson and electron (positron)] since it is easily satisfied.

SOFT COMPONENT IN AN ELECTRON-NUCLEAR SHOWER AT ENERGIES OF 10^{14} EV

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In an earlier note[1] we presented a short report concerning an investigation in an emulsion of the angle-energy characteristics of the rare case of a nuclear interaction between an α-particle with an energy of $(8^{+3}_{-4}) \times 10^{13}$ ev and a nucleon. The observation conditions were such that it was also possible to develop the electron-photon component in the emulsion over a region of two cascade lengths.

TABLE I

Space-Energy distribution of electron pairs.

	$\vartheta_x \leqslant 0.6 \cdot 10^{-3}$		$0.6 \cdot 10^{-3} < \vartheta_x \leqslant 5 \cdot 10^{-3}$		
$h\nu$, Bev	>500	70—500	>500	70—500	9—70
$t \leqslant 0.6$	1	3	0	0	3
$0.6 < t \leqslant 1.1$	2	3	0	0	1
$1.1 < t \leqslant 1.6$	1	1	0	0	0
$1.6 < t \leqslant 2.1$	0	0	0	0	0

TABLE II

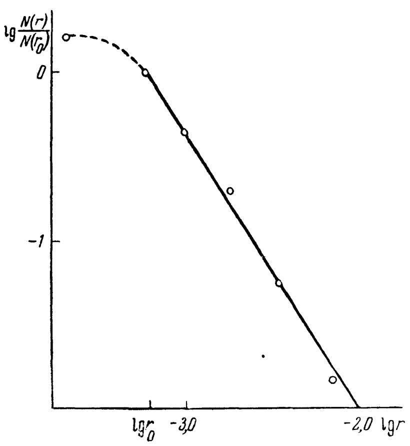
Space distribution of electrons.

$\vartheta \cdot 10^3$ (at $t=2$)	n_e	$t(\vartheta \leqslant 5 \times 10^{-3})$	n_e
<0.2	8	0.5	14
0.2 —0.4	15	1.0	43
0.4 —0.6	11	1.5	90
0.6 —1.25	29	2.0	149
1.25—2.5	32		
2.5 —5	34		

The results of the study of the soft component can be given in the form of a space-energy distribution of the non-bremsstrahlung electron-positron pairs (Table I) and an electron space distribution (Table II and figure). In this analysis the quantities which characterize the spatial distribution have been chosen as the distance t along the axis of the cascade (expressed in cascade units) and the deflection angles of the pairs and the particles with respect to the same axis in space ϑ or in projection on the plane of the emulsion ϑ_x. The photon energies $h\nu$ were determined from the opening angle of the components of the pair α in accordance with the formula given in Ref. 1 in which use was made of the relations between the energy $h\nu$ and the mean-square value of the angle α.

The distribution of electrons along the axis of the cascade (Table II, right half) makes it possible, using the usual cascade curves, to verify the energy estimates given in Table I.

As is apparent from the figure, the spatial distribution of particles of the soft component in the direction perpendicular to the axis of the shower at a depth $t = 2$, can be approximated by the power function $f(r) \sim r^{-\gamma}$ where $\gamma = 1.62 \pm 0.05$, $r = t\vartheta$ (solid line in the figure).



Electron spatial distribution at a depth $t = 2 (r = t\vartheta$, r_0 is an arbitrary point).

An analysis of the data given in Tables I and II and in the figure leads to the following conclusions: (1) the total number of photons is approximately equal to the number of penetrating particles emitted within the forward cone (in the c.m. system) within the limits of the statistical errors; (2) the energy flux carried by the photons is approximately 0.1 (with an error of approximately 0.05) of the energy of one nucleon of the primary particle; twice the mean energy carried by one photon is approximately equal to the mean energy of one penetrating particle if it is assumed (cf. Ref. 1) that the mean energy associated with the transverse momentum component of the mesons is $1.5\ \mu c$; (3) the concentration of photons and associated energy flux close to the axis of the shower is considerably higher than that which would be expected on the basis of the angular distribution measurements and the transverse momentum of the penetrating particles of the shower.

It is extremely probable that the last feature of the soft component of the shower is related, at least to some degree, to fluctuations, in view of the fact that the major part of the energy flux is carried by a small number (1 — 2) of π^0-mesons. It is also possible that part of the effect is due to differences in the efficiency for pair detection at different distances from the axis of the shower and the "addition" of a small number of pairs of bremsstrahlung origin.

There is still one other possible origin of this effect; this is the presence of an additional proton source in the form of bremsstrahlung produced (cf. for example, Ref. 2) as a consequence of the rapid deceleration of the quickly-moving electric charge of the primary particle.

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