Comparison of the curves for 4.2 and 2.45° K shows a sharpening of the resonance at lower temperatures. Such a sharpening was found earlier in lead[8] and is related to a noticeable increase in the relaxation time t. The dc resistance of the indium specimen does, indeed, decrease several fold as the temperature is reduced from 4.2 to 2.5° K.

Measurement of the field dependence of surface resistance of zinc and aluminium at liquid helium temperatures showed that at 9300 Mcs there is a slow decrease with increasing magnetic field. The absence of resonance effects in zinc and aluminum is apparently related to the breakdown of the conditions under which cyclotron resonance is observable ($\omega t \gg 1$).

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ENERGY OF THE ELECTRON-PHOTON COMPONENT OF EXTENSIVE AIR SHOWERS

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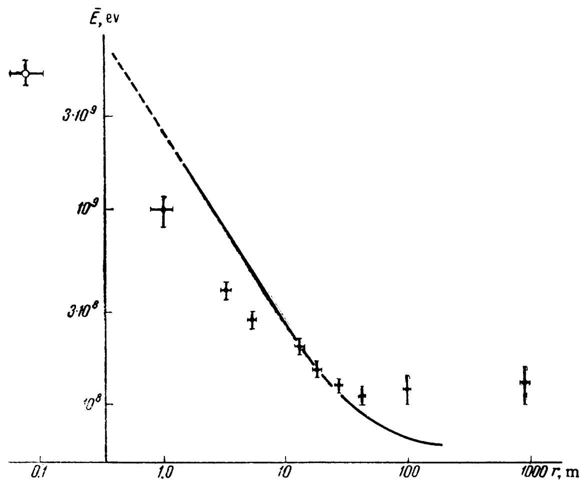
In a previous article[1] we reported the results of measurements of the energy of the electron-photon component in the central region of extensive air showers (EAS). In the present investigation, measurements of the energy carried by the electron-photon component at lateral distances from 0.1 to 1000 m were made at sea level using the array for the comprehensive study of EAS. Practically the whole energy of the electron-photon component was thus measured directly, since the above-mentioned distance range contains about 90% of the total number of shower particles. The total energy of the electron-photon component is, on the average, proportional to the total number N of particles in the shower. The value of the energy of the electron-photon component is equal to $E_{e-p} = (2.7 \pm 0.3)\,\beta N$, where β is the critical energy for air. The energy flux distribution in the central region of EAS is given in reference 1. At distances $100\,\mathrm{m} \le r \le 1000\,\mathrm{m}$, the distribution function of the energy flux can be represented in the form $\rho_E(r) \sim r^{-(2.6\pm0.2)}$.

Data on the mean energy of the particles of the electron-photon component have been obtained. The value of the mean energy per electron at various distances from the shower axis is given in Fig. 1.*



In the central region of the showers, for $0.1\,\mathrm{m} \le r \le 30\,\mathrm{m}$, the mean energy can be described by the function $\bar{E} = 10^9 r^{-(0.6\pm0.1)}$ ev, where r is in meters. At distances of 100 — 1000 m, the mean energy is constant and equal to $\bar{E} = (1.2 \pm 0.15) \times 10^8$ ev. A comparison with the theoretical curve obtained on the basis of the cascade theory for s = 1 by Kamata and Nishimura[3] (the curve is shown in the figure) reveals a considerable discrepancy between experimental and theoretical results. The observed increase in the mean energy with decreasing distance from the shower axis is smaller than the calculated one. At the same time, the measured mean energy at the shower periphery is higher than the theoretical value. A less-pronounced variation of the mean energy with the distance in the central region of the showers can be explained by the effect of nuclear scattering, as shown by experimental data on the nuclear-active component at sea level.[4] The higher energy of particles at larger distances ($r \geq 500$ m) is explained by the fact that, at these distances, some of the electrons originate in the μ-meson decay.

A detailed presentation and discussion of the results will be published.

*For the distance of 0.1 m, we have used the data of Strugal'skiĭ.[2]

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ON ANOMALOUS EQUATIONS FOR SPIN ½ PARTICLES

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A paper of L. A. Shelepin[1] argues that anomalous equations (obtained by one of us[2]) for particles with spin $\frac{1}{2}$ and with several rest masses are reducible. We want to call attention to the erroneousness of this assertion and to show where the mistake is in reference 1.

The proof of the reducibility of the anomalous equations was constructed by Shelepin on the basis of a theorem which asserts that if the Lorentz transformation matrix S for the wave function ψ which satisfies the equation

$$(\beta_\mu \partial^\mu - i\varkappa)\psi = 0, \tag{1}$$

can be written as a direct product

$$S = S' \times S'', \tag{2}$$

where S′ and S″ represent the Lorentz transformations corresponding to the functions ψ' and ψ'' satisfying the equations

$$(\beta'_\mu \partial^\mu - i\varkappa)\psi' = 0, \qquad (\beta''_\mu \partial^\mu - i\varkappa)\psi'' = 0, \tag{3}$$

then the algebra $U(\beta)$ is given by the direct product $U(\beta) = U(\beta') \times U(\beta'')$.

The proof of this theorem in reference 1 is not complete. This assertion can be graphically demonstrated by repeating the proof by some other method, that is by using infinitesimal rotations instead of general Lorentz transformations. In this case the matrix S can be written in the familiar form $S = 1 + \frac{1}{2}\epsilon_{\mu\nu}I^{\mu\nu}$ (we have similar expressions also for S′ and S″). Equation (2) then has the form

$$I_{\mu\nu} = I'_{\mu\nu} \times 1'' + 1' \times I''_{\mu\nu}. \tag{4}$$

From the requirement of the invariance of (1) and (3) under Lorentz transformations, the well-known relations for the matrices β_μ, β'_μ, and β''_μ result

$$[\beta_\mu I_{\nu\sigma}] = g_{\mu\nu}\beta_\sigma - g_{\mu\sigma}\beta_\nu, \tag{5}$$

$$[\beta'_\mu I'_{\nu\sigma}] = g_{\mu\nu}\beta'_\sigma - g_{\mu\sigma}\beta'_\nu, \qquad [\beta''_\mu I''_{\nu\sigma}] = g_{\mu\nu}\beta''_\sigma - g_{\mu\sigma}\beta''_\nu. \tag{6}$$

If we now represent the matrices β_μ in the covariant form

$$\beta_\mu = c_0(\beta'_\mu \times 1'') + c_1(\beta'_\nu \times \beta''_\mu \beta''_\nu) + \cdots + d_0(1' \times \beta''_\mu) + \cdots, \tag{7}$$

that is, symbolically $\beta = u(\beta') \times u(\beta'')$, where $u(\beta')$ and $u(\beta'')$ are general elements of the algebra $U(\beta')$ and $U(\beta'')$, then equation (5) will be identically satisfied on the basis of relations (4), (5), and (7). The proof of the quoted theorem in reference 1 is finished up by finding the solutions of Eq. (7) which satisfy Eq. (5) identically. However, this is not sufficient for a proof: it actually should be shown that the solution in the form of Eq. (7) represents a unique solution for the given operators $I_{\mu\nu}$. We have here a situation very similar to that in tensor algebra. As is well known, one can in the latter satisfy the transformation law for a second rank tensor by constructing a quantity equal to the product of two vectors. However, it does not follow from this that every tensor of the second rank can be described by the product of two vectors.

If such a proof did exist, then anomalous equations for particles with spin $\frac{1}{2}$ and with two or more rest masses could be completely reduced. Since, however, these equations do not decouple, they represent the case where the solutions of (5) do not have the form of (7).

In the anomalous equations $(\beta_\mu \partial^\mu - ik)\varphi = 0$, satisfying all the physical requirements, the