where φ_0 (ρ) is the coordinate portion of the deuteron wave function.

The second term in expression (3) is calculated in the following manner:

$$\sum_{\mathbf{f}} (f^2 / M + \varepsilon_0) \mid M_m \mid^2 \qquad (5)$$

$$= \frac{2g^2}{M^2} \sum_{\mathbf{f}} \langle \Phi_m^* \sigma_1 \mathbf{k} F_i \Psi_{\mathbf{f}} \rangle \langle \Psi_{\mathbf{f}}^* (H_1 \sigma \mathbf{k} F_i - \sigma_1 \mathbf{k} F_i H) \Phi_m \rangle,$$

where H is the Hamiltonian of the interaction of the two nucleons. Its general form (without taking the tensor forces into account) is as follows:

$$H = \mathbf{f}^2 / M + {}^1/_4 U_t(\rho)(\sigma_1\sigma_2 + 3) \qquad (6)$$

$$- {}^1/_4 U_s(\rho)(\sigma_1\sigma_2 - 1)$$

$$+ \{{}^1/_4 \tilde{U}_t(\rho)(\sigma_1\sigma_2 + 3) - {}^1/_4 \tilde{U}_s(\rho)(\sigma_1\sigma_2 - 1)\} P_{12}.$$

Here f^2 / M is the kinetic-energy operator, U_t and U_s are the potential energies in the triplet and singlet states, $\tilde{U}_t$ and $\tilde{U}_s$ the exchange energies, and P_{12} is the particle commutation operator.

Calculating the sum (5) with the aid of the Hamiltonian (6), and inserting the result into (1), leads to the following dispersion relationships.*

For deuterons polarized parallel (anti-parallel to the incident beam:

$$D_{\pm 1}(\omega) - D_{\pm 1}(\mu) \qquad (7')$$

$$= g^2 \left(\frac{\mu}{2M}\right)^2 \frac{2}{M} \frac{k^2}{\omega^2 - \tilde{\omega}^2} \left[1 + \frac{8M}{\mu^2} \int \varphi_0^2 \sin^2 \frac{\tilde{k}\rho}{2} \tilde{U}_t \, d\rho\right]$$

$$+ \frac{k^2}{2\pi^2} \int_{\mu}^{\infty} \frac{\omega' \sigma_{\pm 1}(\omega') \, d\omega'}{k' (\omega'^2 - \omega^2)}$$

For deuterons polarized perpendicular to the incident beam:

$$D_0(\omega) - D_0(\mu) \qquad (7'')$$

$$= g^2 \left(\frac{\mu}{2M}\right)^2 \frac{2}{M} \frac{k^2}{\omega^2 - \tilde{\omega}^2} \left[1 + \frac{4M}{\mu^2} \int \varphi_0^2 \cos^2 \frac{\tilde{k}\rho}{2} \{\tilde{U}_s - U_s + \tilde{U}_t + U_t\} \, d\rho\right]$$

$$+ \frac{k^2}{2\pi^2} \int_{\mu}^{\infty} \frac{\omega' \sigma_0(\omega') \, d\omega'}{k' (\omega'^2 - \omega^2)}.$$

The dispersion relations obtained for the scattering of pions by deuterons contain, in addition to the constant g, also certain effective values of the potential interaction energy of two nucleons in different states and these values affect substantially the value of the singularity term for deuterons, polarized perpendicularly to the incident beam.

The authors express their gratitude to Academician L. D. Landau for valuable comments.

*Let us call attention to the fact that we obtained (7′) and (7″) without using the actual form of the coordinate part of the wave function of the deuteron.

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Translated by J. G. Adashko
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Influence of the Earth's Magnetic Field on the Space-Distribution of Particles in Extensive Air Showers

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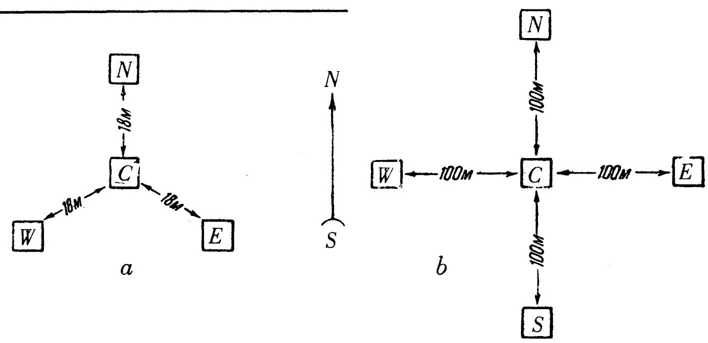
THE space-distribution of charged particles in the extensive air showers of cosmic rays has been studied in a number of experiments[1-4]. In none of the computations used, despite their high statistical accuracy, has the influence of the earth's magnetic field been taken into account. The theoretical estimates made[5] have shown that the distortion of axial symmetry in the space-distribution of the electron component of the extensive air shower, produced by the action of the earth's magnetic field, does not exceed the statistical limits of experimental errors. Nevertheless, the results of the experimental investigation given in Ref. 6 aroused doubts as to whether the disregard of the influence of the earth's magnetic field on the space-distribution of shower particles is justified. This disregard, by the way, was considered permissible in Ref. 2.

Subsequently, we made a supplementary analysis of the experimental data given in Ref. 2. These related to a study completed in the summer of 1952 at an elevation of 3860 m (Pamir). The relative position of a part of the experimental set-up with respect to the earth's magnetic field is shown in diagram *a*. The letters *C, N, E, W* (central, north, east, west) indicate groups of counters connected to a hodoscope (counter-telescope). The cases under consideration were those in which the axis of the extensive air shower passed at a distance of not more than 5 m from the center of the set-up *C*. The influence of the earth's magnetic field on the space-distribution of shower particles can be described by the relationship

$$\Delta = 2(p_L - p_M)/(p_L + p_M).$$

Here p_M is the mean flux density of the charged particles above the hodoscopic group of counters *N*, p_L is the mean flux density of the particles above the groups *W, E*. For the average distance ~ 18 m from the shower axis the value Δ_{18} equals 0.00 ± 0.03 and, therefore, the disregard of the influence of the earth's magnetic field on the space-distribution of shower particles in study[2] is fully justified.

In the summer of 1955, working at an elevation of 3860 m (Pamir), we continued our investigation of the influence of the earth's magnetic field on the space-distribution of shower particles. The layout of the set-up is shown in diagram *b*. At the center of the set-up, *C* was a controlling counter group consisting of three counters placed under a shield of lead 6 cm thick, and another counter 3 m away from the shielded counters. The counters were included in the circuit of a fourfold coincidence arrangement. As shown in Ref. 1, such a control system serves chiefly as a means of registering the cores of the extensive air showers. Counters of different areas, connected to a large hodoscopic device, made it possible to determine the flux density of the particles at the center of the set-up for each registered shower. Similar hodoscopic groups were used at a distance of 100 m to the north, south, east and west of the center of the set-up (*N, S, E* and *W*, respectively).



The primary energy of the showers studied in the most recent investigation differed little from the primary energy of the showers studied in 1952[2], and amounted to $\sim 10^{14} - 10^{15}$ ev. A study of more than 800 extensive air showers whose axes were not more than 10 m away from the center of the set-up enabled us to establish the value of Δ for distances of 100 m from the shower axis, namely, $\Delta_{100} = 0.12 \pm 0.03$. In the case under discussion, the symbol p_M was used to denote the mean flux density of the particles at points *N* and *S*.

Our experimental data pertaining to the influence of the earth's magnetic field on the space-distribution of charged particles in the extensive showers agree with the findings given in Ref. 7 by Norman, who failed to trace the forementioned influence in the central part of the shower. At the same time, however, it is difficult to reconcile our findings with the results obtained by Chaloupka and Petrzilka in their investigation[6], where the value of Δ for distances ~ 30 m is greater than or equal to 0.35 ± 0.15.

The asymmetrical effect, revealed in our experiments, in the distribution of the flux density of the charged particles at a distance ~ 100 m from the axis of the extensive air shower is equivalent to a 6-10% enlargement of the shower radius in the W-E direction at the stated distance from the axis, which is approximately twice as high as the figure arrived at in the theoretical estimates in Ref. 5. In our opinion, the use of the theoretical values offered by Cocconi[5] results in a lower figure because in his computations the latter fails to take into account the regular deflection of low energy electrons (< 100 mev) in the air layer adjacent to the observation level. An approximate evaluation of the deflection of these electrons, which are prevalent at great distances from the shower axis, eliminates the discrepancy between the theoretical estimates given in Ref. 5 and the results of our investigations.

In conclusion, the authors express their gratitude to V. M. Seleznev, V. V. Krugovykh, I. F. Maklakova and other co-workers.

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On a Certain Regularity of Decaying Unstable Particles

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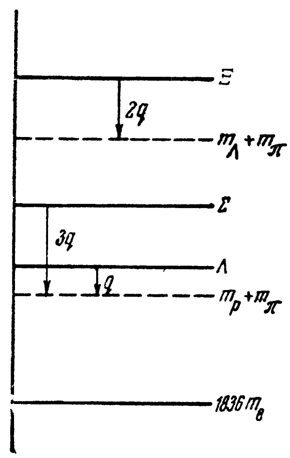
AT the present time the following values of the masses of stable and unstable particles have been firmly established as universal (in electron masses): $m_\nu = m_\gamma = 0$; $m_e = 1$; $m_\mu = 207$; $m_\pi = 274$; $m_K = 966 \pm 3$; $m_p = 1836$; $m_\Lambda = 2181 \pm 1$; $m_\Sigma = 2327 \pm 3$; $m_\Xi = 2585 \pm 15$.

From among these particles, μ, π, K, Λ, Σ and Ξ are unstable. The values of the decay energy Q, experimentally observed or computed from the known masses of the particles and from decay schemes, are given below (in mev):

$\pi^0 \to 2\gamma$	$Q = 135$	$n = 3.8$
$\mu \to e + 2\nu$	$Q = 106$	$n = 3.0$
$\pi \to \mu + \nu$	$Q = 34.5$	$n = 1.0$
$K \to 3\pi$	$Q = 75.0 \pm 1.5$	$n = 2.1$
$K \to 2\pi$	$Q = 214 \pm 5$	$n = 6.0$
$K \to \mu + \nu$	$Q \sim 389$	$n = 11.0$
$K \to \mu + \pi^0 + \nu$	$Q \sim 248$	$n = 7.0$
$\Lambda^0 \to p + \pi^-$	$Q = 37.0 \pm 1.0$	$n = 1.0$
$\Sigma \to n + \pi$	$Q = 111.0 \pm 3$	$n = 3.1$
$\Xi \to \Lambda^0 + \pi$	$Q = 66 \pm 6$	$n = 1.9$

The third column contains the quantity $m = Q/q$, where $q = 35.5$ mev $= 69.5\ m_e$. All values of n are quite close to integers. An exception is noted only in several cases, when the decay leads only to stable particles (for example, neutron or π^0).

The kinetic energy liberated in the decay of unstable particles is thus a multiple of 35.5 mev. The experimentally observed energy-level scheme for hyperons* is shown in the diagram.



If the above statements are correct and if new unstable particles exist, they should be located among the mass numbers M satisfying the relationship

$$M - (m_p + nm_\pi) = n_1 q$$

for particles heavier than protons, or the relationship

$$M - nm_\pi = n_1 q$$

for mesons heavier than the pion. In these equations n and n_1 are integers.

It is interesting to note that the number of electron masses entering into q is very close to the value $1/2\ \alpha = 68.5$.