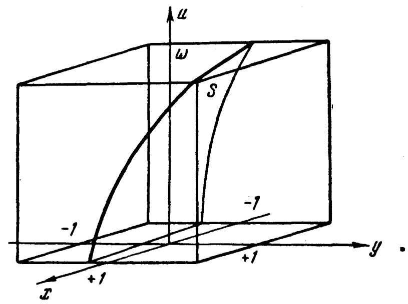

FIG. 2

values of F result from different values of the parameters α and w. In the general case ($0 \leq \alpha \leq 1$) we get:

$$0 < w < 1 \quad : \quad F = 1 - w^2 (1 + 2\alpha) / 5,$$

$$1 < w < 1/\alpha : \quad F = [\alpha^2 - 2 + 10w^2 - 20\alpha w^3 + 15\alpha^2 w^4 - 4\alpha^3 w^5] / 10w^3 (1 - \alpha)^2,$$

$$1/\alpha < w < \infty: \quad F = (1 + \alpha)^2 / 10\alpha^2 w^3.$$

As is easily seen these formulae simplify considerably in the limiting situations $\alpha = 0$ and $\alpha = 1$.

We express our sincere gratitude to Prof. I. Ia. Pomeranchuk and L. A. Ter-Martirosian for interesting and productive discussions.

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2 M. L. Goldberger, Phys. Rev. 74, 1269 (1948).

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The Spatial Distribution of the Penetrating Component of Wide Atmospheric Showers

E. L. ANDRONIKASHVILI AND
M. F. BIBILASHVILI
Physical Institute, Academy of Sciences, Georgia SSR

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STUDIES have been carried out on the spatial distribution of the penetrating component of wide atmospheric showers at an altitude of 400 meters above sea level in a tunnel underneath 26.6 meters of earth (65.5 meters of water equivalent, m. w. e).

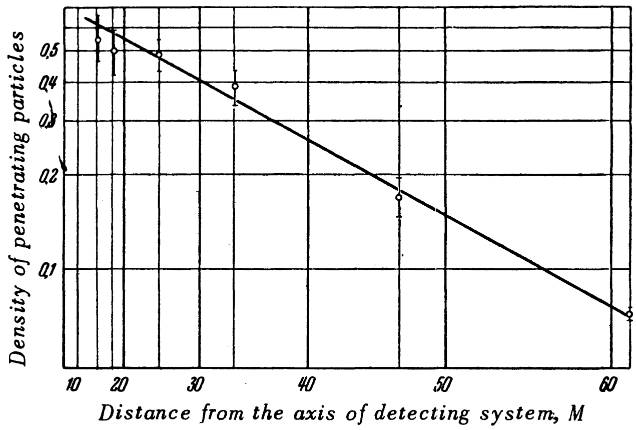
The measurements of the density of penetrating particles were carried out at distances of 0, 10, 20, 30, 45, and 60 meters from a vertical axis passing through the center of the detecting system. The shower detection was carried out using two core selectors similar to those used in previous work.[1] In addition, the apparatus contained correlating hodoscopic systems which served to determine the total number of particles and the point of passage of the core of the wide atmospheric shower. There was also an underground apparatus registering the particles in the penetrating component. The showers were recorded with the help of a movie camera. This set-up was most efficient for showers containing between 10^5 and 5×10^5 particles. During 2156 hours of running data were obtained on the spatial distribution of the penetrating component of showers with this number of particles and these are presented in the Table.

Distance from the axis of detecting system	Time of observation, hours	No. of showers registered	Rate of counting, Days^{-1}	Calculated density of penetrating particles, *Particles/m^2*
0	276.0	72	6.25	0.55 ± 0.065
10	250.0	61	5.9	0.51 ± 0.078
20	244.0	58	5.7	0.49 ± 0.064
30	246.0	48	4.7	0.39 ± 0.056
45	395.0	38	2.3	0.17 ± 0.027
60	745.0	31	1.0	0.07 ± 0.013

The experimental data obtained are represented satisfactorily, within statistical error, by a Gaussian of the form:

$$\rho(r) = 0,61 \exp[-0,00059r^2]. \qquad (1)$$

We note, however, that in carrying out the measurements we did not take into consideration the angular distribution of the cores of the wide atmospheric showers and the inaccuracy in determining the position of passage of this core. Consideration of the two distributions shows that the axes



Spatial distribution of the penetrating component of wide atmospheric showers having a total number of particles in the interval between 10^5 and 5×10^5.

of the wide atmospheric showers are inclined relative to the underground system and this is especially important for measurements in the central parts of the shower. The spatial distribution of the density of the penetrating particles (per m^2) is constructed from the corrected data presented in the Figure. It obeys a Gaussian law on the form:

$$\rho(r) = (0.66 \pm 0.09) \exp[-(0.00058 \pm 0.00009)\, r^2]. \tag{2}$$

The total number of penetrating particles calculated on the basis of distribution (2) turns out to be $(3.5 \pm 1.1) \times 10^3$ particles.

Consideration of the minimum energy needed to get a depth of 65.5 m. w. e. leads to a value of 5×10^{13} ev carried by the penetrating component. The soft component of these same showers at sea level carries an energy of 3×10^{13} ev. Thus 60 to 70% of the energy reaching sea level as electronic-photonic component penetrates to a depth of 65.5 m. w. e. Considering the energy carried by penetrating particles that are absorbed in the ground up to 65.5 m. w. e. we conclude that at least 75% of the energy of wide atmospheric showers at sea level is concentrated in their penetrating component.

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1 Cocconi, Cocconi-Tongiorgi and Greisen, Phys. Rev. 76, 1020 (1949).

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