INDEX OF THE ENERGY SPECTRUM OF THE PENETRATING COMPONENT IN EXTENSIVE AIR SHOWERS WITH A SPECIFIED NUMBER OF PARTICLES

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THE energy spectrum of the penetrating component was studied in Tbilisi at 400 m elevation at the depths of 61, 127, and 162 meters water equivalent (m w.e.).

An array consisting of three Geiger-Müller counters, each with an area of 0.0257 m^2, placed on the earth surface in a circle with a radius of ~ 1 m, was used for shower selection. The surface part of the apparatus consisted further of four correlated hodoscopes, each with a total sensitive area of 0.3 m^2. One of the hodoscopes was placed under the selecting system, two were placed on the two sides at a distance of 10 m, and the fourth at a distance of 20 m in the direction perpendicular to the line joining the first three hodoscopes. The underground part consisted of two layers of counters, separated by 8 cm of lead. Each layer consisted of 30 counters, the total area being about 1 m^2. Coincidences between the two layers were recorded. The master pulse, formed by a triple coincidence of the counters of the selecting system, operated a cine camera which photographed a panel of neon bulbs connected to the underground array and all hodoscopes. The selecting system was also displayed on the panel. The shower size was determined graphically, using curves drawn according to the Nishimura-Kamata distribution for $s = 1.2$ (Ref. 1). The same method was used to determine the distance between the shower axis and the center of the selecting system.

The mean number of particles in the measured group of showers was equal to 2.9×10^5. The number of particles of each individual shower was determined with an accuracy of ± 50%.

The mean density of penetrating particles ρ_p was found using the formula

$$\rho_p = \frac{1}{s_1} \ln \frac{N}{N - N_p}, \tag{1}$$

where s_1 is the area of the underground group of counters, N is the number of recorded showers, and N_p is the number of counts of the underground array.

The obtained data are given in Table I.

A method of data reduction analogous to that used by Sakvarelidze[2] yields a slightly divergent spectrum with exponent larger than that obtained in Ref. 2. It should be taken into account that, in our estimate, the mean shower size detected in the experiment of Sakvarelidze was one order of magnitude smaller and that our selecting system favored showers falling within a smaller radius. The results of the present experiment and that of Sakvarelidze, although not in contradiction, cannot therefore be compared quantitatively.

TABLE I

Depth (m w.e.)	Number of counts of the selecting system	Number of counts of the underground array	Density of penetrating particles (m^{-2})	Effective distance (m)
61	262	101	0.49±0.07	16
127	519	93	0.20±0.02	27
162	856	115	0.15±0.02	29

Table I contains also the effective distances between the shower axis and the penetrating particle detector which was placed at different depths. It can be seen from the table that the effective distance increased slightly with the depth, which is due to the zenith-angle distribution of extensive air showers.

The following expression for the zenith-angle distribution, given by Greisen[1], was used in calculation of the effective distance:

$$J_\vartheta = J_0 \cos^{8.3} \vartheta. \tag{2}$$

The density of penetrating particles measured by us at the depth of 61 m w.e. below the selecting system was found to be equal to $(0.49 \pm 0.07)\ m^{-2}$. Within experimental errors, this in in agreement with the value $(0.55 \pm 0.06)\,m^{-2}$ obtained for the density of penetrating particles of a similar group of showers at the same depth, using the same relative position of the detecting system and the penetrating particle detector.[3] This makes it possible to use the results on lateral distribution obtained in Ref. 3:

$$\rho_p = (0.66 \pm 0.09) \exp[-(0.00058 \pm 0.00009) r^2]. \quad (3)$$

In consequence, a density of $(0.42 \pm 0.06)\ m^{-2}$ is found for the effective distance of 28 m.

The results for all three depths are then found to be consistent. These data, expressed in energy units which account for the atmospheric depth and refer to approximately equal effective distances, are given in Table II.

TABLE II

Depth (Bev)	Effective Distance (m)	Density of Penetrating Particles (m^{-2})
14.9	28	0.42±0.06
29.5	27	0.20±0.02
37.1	29	0.15±0.02

The energy spectrum of penetrating particles of an extensive air shower calculated from the above data for a mean distance of 28 m from the shower axis can be represented by a power law $\rho_p = AE^{-\gamma}$ with $\gamma = 1.09 \pm 0.21$.

In conclusion it should be noted that a tendency has been observed of a variation of the spectrum exponent with decreasing energy of the shower. Further experiments are being carried out to investigate this effect and to improve the degree of knowledge of the shape of the spectrum.

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[1] K. Greisen, Progress in Cosmic Ray Physics, Amsterdam, vol. III, 1956, pp. 1-141.

[2] I. I. Sakvarelidze, J. Exptl. Theoret. Phys. (U.S.S.R.) **30**, 458 (1956), Soviet Phys. JETP **3**, 361 (1956).

[3] E. L. Andronikashvili and M. F. Bibilashvili, J. Exptl. Theoret. Phys. (U.S.S.R) **32**, 403 (1957), Soviet Phys. JETP **5**, 341 (1957).

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TRANSITION EFFECT OF STARS IN A LEAD ABSORBER

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EXPERIMENTS carried out at mountain altitudes[1-3] and in the stratosphere[4,5] have established the existence of a transition effect of stars by means of photographic emulsions. However, such effect was found in other similar experiments.[6,7] Interest in this phenomenon was increased after a transition effect for stars was also found in a graphite absorber,[8] and in this way it was shown that the explanation of the transition effect in lead by means of the photon component of cosmic rays was not tenable.

In this note we present results of a control experiment undertaken in order to observe by means of photographic emulsions the transition effect for stars in lead absorbers.

Flat lead absorbers were placed one above another. Each layer of lead had an area of $40 \times 60\ cm^2$. The photographic films were placed horizontally singly at each depth of the lead absorber. The exposure was carried out at an altitude of 3100 m above sea level. The figure shows the results of the experiment. As may be seen from the graph the maximum of the transition effect amounts to 30%.

Since the transition effect is not found by all observers, it should be noted that at mountain altitudes its magnitude is not great (according to the data of various authors it amounts to 15 — 30%); at the same