ABSORPTION OF NUCLEAR-ACTIVE COSMIC RAY PARTICLES IN AIR

G. BOZOKI, E. FENYVES, T. SANDOR,* O. BALEA, M. BATAGUI, E. FRIEDLANDER,†
B. BETEV, S. KAVLAKOV, and L. MITRANI‡

Submitted to JETP editor May 4, 1961

J. Exptl. Theoret. Phys. (U.S.S.R.) **41**, 1043-1045 (October, 1961)

Absorption of nuclear-active cosmic-ray particles in air was studied by the coincidence method at 80, 410, 950, and 2925 m above sea level. The μ-meson background was determined by measuring the underground flux. The absorption mean free path for nuclear-active particles in air is found to be $\lambda_a = (119 \pm 1)$ g/cm^2. The mean energy of the investigated nuclear-active particles estimated from the magnitude of their flux is ~ 30 Bev.

THE absorption of the nuclear-active component of cosmic radiation was investigated by measuring its flux at different altitudes above sea level (Bucharest—80 m, Budapest—410 m, Busteni—950 m, Stalin's Peak—2925 m). The experimental setup was an array of counters connected for coincidence and placed in a lead block (Fig. 1). This registered the electron-nuclear showers produced by the nuclear-active particles in the lead. A layer of lead 10 cm thick was placed between the upper (1 — 4) and the lower (5 — 8) counters while 5 cm of lead was placed between the lower counters. The counters were covered on the top and on the sides by 15 cm of lead. The counter diameter was 4 cm and the effective length 80 cm. The lower counters 5 — 7 and 6 — 8 were connected in parallel pairs and the frequency of the sixfold coincidences (1, 2, 3, 4, 5 — 7, 6 — 8) was measured.

Since the muon background at low altitudes is considerable compared with the overall frequency of coincidences due to nuclear-active particles, we have determined the frequency of the background events by underground measurements. The investigations were carried out in Budapest 8 m below ground (17 m water equivalent). At this depth, the nuclear-active component is practically completely absorbed and thus the sixfold coincidences obtained can be caused only by the muons.

By measuring the intensity of the muon component underground and on the earth's surface at different heights above sea level, we can determine the background produced by the muons in different places, so that corrections can be made for the frequency of the measured coincidences.

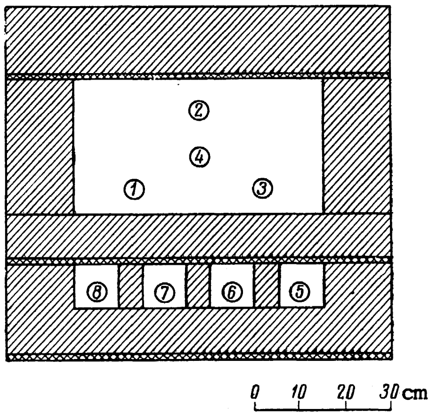

FIG. 1. Diagram of experimental apparatus.

The measurement results are shown in the table and in Fig. 2. It is clearly seen from Fig. 2 that the absorption curve deviates insignificantly from exponential.

The free path for absorption in air was determined directly from the measurements, with allowance for the background, by the maximum-likelihood method [1]

$$\lambda_a = 119 \pm 1 \text{ g/cm}^2.$$

This value agrees well with the results of Tinlot [2] (118 ± 2 g/cm^2), Hodson [3] (118 ± 1.1 g/cm^2), Azimov, Vishnevskii, and Khil'ko [4] (123 ± 6 g/cm^2), Schultz [5] (125 ± 5 g/cm^2), George and Jason [6] (114 ± 10 g/cm^2), Ryzhkova and Sarycheva, [7] and also with other results obtained with similar experimental arrays. All obtained approximately 120 g/cm^2 for the absorption free path in air.

The mean energy of the registered nuclear-active particles can be estimated from the frequency of the coincidences by assuming that the energy spectrum follows a power law and that the

*Central Physics Research Institute of the Hungarian Academy of Sciences, Budapest.

†Institute of Nuclear Physics, Bucharest Rumania.

‡Physics Institute with Atomic Scientific-Experimental Base, Sofia, Bulgaria.

Location	Depth, g/cm²	Frequency of coincidences	
		without correction	with correction
Bucharest (80 m)	1009	1.17±0.02	1.00±0.04
Budapest (410 m)	969	1.73±0.03	1.55±0.04
Busteni (950 m)	907	2.57±0.03	2.37±0.04
Stalin's Peak (2925 m)	703	13.96±0.10	13.67±0.11

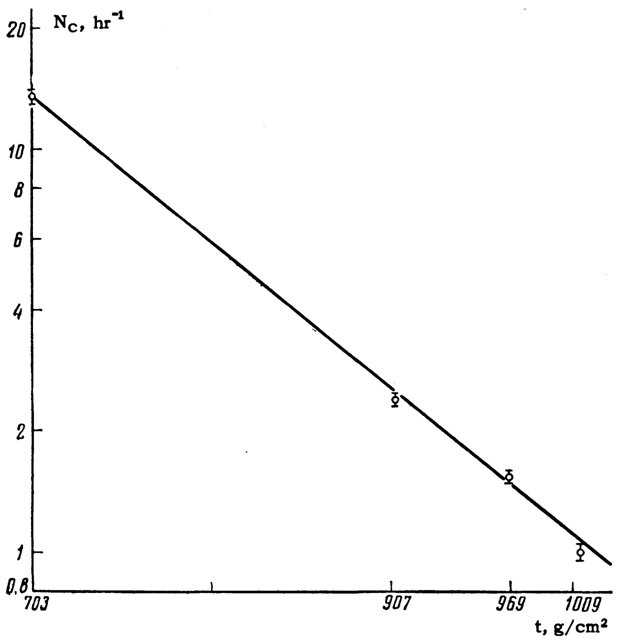

FIG. 2. Frequency of coincidences N_c (with correction for background) as a function of the depth t in the atmosphere.

probability of operation of the apparatus approaches a step function with zero value below a certain limiting energy E_0 and constant value K (determined by the geometry of the apparatus) at energies greater than E_0. Using the spectrum obtained by Bridge and Rediker [8] we find that the mean energy of the nuclear-active particles is roughly 30 Bev.

The authors are grateful to Professors L. Janossy, G. Nadzhakov, and I. Auslaender for deep interest and valuable advice during the experiments, to N. Akhababyan, I. H. Ionn, J. Koch, G. Thaler, K. Ziegelman, and J. Schnirer for wiring and operating the apparatus, and to E. Rupp for help with the calculations.

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Translated by J. G. Adashko
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