Simultaneous Penetrating Particles in the Cosmic Radiation

Some experiments were made to examine whether showers with two or more penetrating particles could be found in cosmic radiation.

The apparatus used has been described in a previous paper.[1] It consisted of a fourfold coincidence set provided with a Neher-Harper circuit; its coincidence time was of 7×10^{-7} min. The counters used were of 100 cm^2 area and were filled with hydrogen and argon at a total pressure of 15 mm of mercury. Their efficiency, measured according to the method of Street and Woodward, was 100 percent.

The arrangement of the counters consisted of two sets of telescopes in coincidence (Fig. 1), each counting only rays which produce coincidences through a layer of lead 16 cm thick.

The results of the measurements (made at an altitude of 800 m above sea level), are given in Table I. The observed average frequency of the showers was 15 times greater than the random fourfold coincidences. (The greatest contribution to the "zero-effect," which was very carefully studied, comes from the random coincidences between the two telescopes.) Such showers cannot be produced by a "knock-on" process in the lead, as follows from the arrangement I. The above results show therefore the existence of showers of two or more simultaneous penetrating particles.

Further studies on the number of penetrating particles in a shower and on the extension of those showers are in course, and results already obtained lead us to think that the observed particles are associated with the penetrating cores of the extensive showers discovered by Auger and his co-workers.

The existence of simultaneous penetrating particles is of remarkable interest chiefly if such particles are mesotrons. A quantum theory of such showers has been recently proposed by one of us.[2] Drs. M. Schoenberg[3] and M. D. de Souza Santos have indepently discussed the absorption processes of the mesotron producing radiation in the high atmosphere and have pointed out that in order to explain the high absorption of this radiation in the upper region of the atmosphere and the penetrating power of the mesons, it is necessary to assume that at least two mesotrons are simultaneously created (which makes improbable the inverse process.)

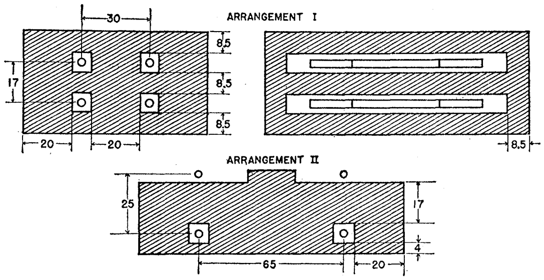

FIG. 1. Arrangement of counters. Linear dimensions are in centimeters.

TABLE I.* *Number of coincidences per minute for arrangements I and II at an altitude of 800 meters.*

ARRANGEMENT	NUMBER OF COINCIDENCES	TIME IN MINUTES	COINCIDENCES PER MINUTE $\times10^4$	ERROR $\times10^4$
I	54	17,400	31	3
II	46	18,700	25	3

* Frequency of random fourfold coincidences: $2\cdot10^{-4}$ min.$^{-1}$.

A further report of these measurements will be published elsewhere.

G. WATAGHIN
M. D. DE SOUZA SANTOS
P. A. POMPEIA

Department of Physics,
São Paulo University,
São Paulo, Brazil,
December 8, 1939.

---

[1] Annaes da Academia Brasileira de Sciencias. T. XI, p. 1.
[2] La Ricerca Scient., in the press.
[3] Annaes da Academia Brasileira de Sciencias, in the press.

A New Proof of the Instability of the Mesotron

Clay[1] has recently published a series of measurements concerning the Pb absorption of cosmic rays coming at an angle of 60° to the zenith. These measurements are striking in that for the first 30 cm a lack of absorption is found, while beyond 30 cm the absorption coefficient is less than for the vertical radiation. We have repeated this measurement with a coincidence system between four pairs of 3-×-30-cm^2 counters arranged at such a distance as to permit the insertion of 86 cm of Pb between them. The results are just the same as those of Clay, and they are given in Fig. 1, curve (a). The measurements with zero cm of Pb have not been taken because the electronic component which appears in them does not interest us in this case. We think that this peculiarity can be explained by the instability of the mesotron.

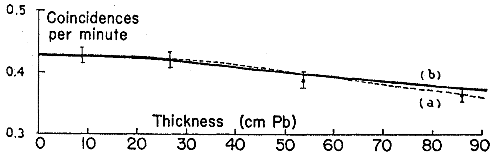

FIG. 1. Absorption in lead of cosmic rays which make an angle of 60° with the zenith.

With the usual hypotheses in regard to the production of mesotrons in the high atmosphere, the conclusion[2] is easily arrived at that the probability for a mesotron to reach the pressure H (expressed in g/cm^2) with the vertical direction without being disintegrated in the air, is:

$$P_0(H,W)=\left[\frac{(W_0-aH)100}{(W_0-100a)H}\right]^{A/W_0},$$

where W is the energy of the mesotron, a the loss of energy per g/cm^2 of air, $W_0=W+aH$ the initial energy of the mesotron, and $A=(mc/\tau\delta)10^3$ (τ = mean life of the mesotron, δ = the specific gravity of the air, m = mass of the mesotron).

For a mesotron having a direction of 60° with respect