

UNIVERSIDADE DE SÃO PAULO
FACULDADE DE FILOSOFIA, CIÊNCIAS E LETRAS
Departamento de Física

São Paulo (Brasil) de de 19.....

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*Letter to the Editor
of the Physical Review*

SHOWERS OF PENETRATING PARTICLES.

and

Paulus Aulus Pompeia, Marcello Damy de Souza Santos / Gleb Wataghin. (A)

In previous papers a report was given ~~on~~ measurements which put in evidence the existence of showers containing at least ~~new~~ ^{two} particles penetrating each not less than 17 cm. of lead and the size of the penetrating core which is of the order of ~~1.2~~ sq. m.

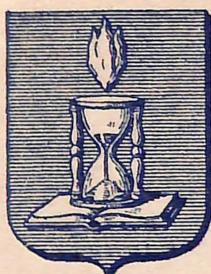
~~On this paper, further measurements are reported~~

A closer examination shows that in order to put in evidence the existence of associated penetrating particles the experimental arrangement must exclude the possibility of being the shower produced by only one mesotrons accompanied by some ~~soft~~ secondary radiation (photons, knock-on electrons and cascade-showers).

For instance the average number of particles (~ 15) which arrive at the depth of the lowest counter in the arrangement III gives only the total number of penetrating and soft particles, at this depth.

In this paper, further measurements are reported. In order to examine the possible association of the observed showers with the extensive showers, discovered by Auger and his collaborators, we have used a five-fold coincidence set, in an arrangement in which four counters were arranged in two telescopes at a distance of 30 cm. and surrounded by lead as in arrangement I, and the fifth was placed at a distance of 280 cm from the others. The observed frequency was of $8 \cdot 10^{-4} \text{ min}^{-1}$, showing that some soft radiation is associated with the penetrating core. This frequency shows that the effect observed by us is responsible for some of the extensive showers.

Other experiments and results are indicated in fig. ~~in~~. The results of measurements IV and V show that a part of the rays responsible for the five-fold coincidences at a distance of 30 cm between the two telescopes, is absorbed by 24 cm of lead. By a narrower arrangement of type VI-X, there is no noticeable absorption and the observed frequency is about 3 times greater than the frequency of 5-fold coincidences in IV (more than 10 times greater than in V) where 20 cm of Pb are placed between the telescopes. It could be objected



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that some knock on shower [or burst] originated by one mesotron going through the lead sheet above the counters, can produce such coincidences (especially if we take into account the experimentally established absorption coefficient of soft γ rays in lead). This assumption could also explain the difference in absorption effect observed in the arrangements IV - V and in VI - X.

~~a part of the experiments themselves~~ such phenomena ~~could be~~ ^{possibly} responsible for similar explanations could be perhaps proposed to the experimental results reported by Janossy, (6) Josephson, (7) and Regener & Rossi (8).

A definite evidence for an association of at least two penetrating particles ~~is~~ given by arrangements of type V or I, II, III, of previous papers, where the distance between two telescopes, each shielded from all sides with at least 20 cm of lead was increased until 120 cm.

It seems noteworthy that in the experiments X, XI, XII the observed frequencies are not different by an order of magnitude, so that it seems likely that the observed showers are produced by vertical rays and contain several penetrating particles. (The lowest counter was at the depth of 55 cm Pb in the vertical direction). In a similar arrangement of 3-fold coincidences with a diminished distance between the two lower counters (only 8 cm Pb interposed) we observed 13 coincidences in 14500 mm. During the whole series of measurements we observed only one 4-fold coincidence of type I.

We conclude that there is evidence for the existence ^{underground} (underground) of showers containing at least two particles going through more than 20 cm Pb. A ~~very~~ easy calculation shows that it is highly improbable that soft γ radiation, which accompanies always the penetrating component underground can be responsible for these showers.

Further studies concerning the nature of the shower-producing rays are in progress.

* and the almost certain theoretical result of the meson theory⁽⁵⁾ (Booth Wilson, Kenner, Hance, Coker) which predict high energy radiation losses for high energy mesons.
(Coker and Hance, Booth Wilson)



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In this paper are reported further measurements made with a 6-fold coincidence set (3) with a coincidence time of $3 \cdot 10^{-8}$ mm using the multivibrator circuit developped by one of us (3). Some of the arrangements used (fig.I) were chosen in order to avoid knock-on showers and the secondary effects of the soft-radiation which usually accompanies the penetrating rays.

First we have tried to get evidence of a possible association of the observed showers with the extensive showers discovered by Auger and his co-workers. A five-fold coincidence set ~~with a coincidence time of $3 \cdot 10^{-8}$ mm~~ was used: four counters were arranged in two telescopes at a distance of 30 cm from each other and surrounded by lead (arrangement I); the fifth counter was placed at a distance of 280 cm from the others.

The observed frequency was of $8 \cdot 10^{-4}$ mm⁻¹ showing that some soft radiation is associated to the penetrating core; we can therefore conclude that the mesons showers are responsible of some of the extensive showers (4).

Other experiments on the nature of the penetrating showers are given in fig. I.

~~and other~~ ~~with a coincidence time of $3 \cdot 10^{-8}$ min~~

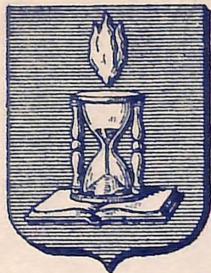
In this paper, further measurements [are reported] made with a ^{fold} coincidence set using the multivibrator circuit developed by one of us (+), ^{Some of} the arrangements used (fig 1) were ~~chosen~~ chosen in order to avoid knock-on showers and the secondary effects of the soft-radiation which usually accompanies the penetrating rays.

First we have tried to get evidence of a possible association of the observed showers with Auger's and the extensive showers discovered by Jüger and his co-workers. A five-fold coincidence set (°) with a coincidence time of $3 \cdot 10^{-8}$ min, was used: four counters were arranged in two telescopes at a distance of 30 cm and surrounded by lead (arrangement I); the fifth counter was placed at a distance of 280 cm from the others.

The observed frequency was of $8 \cdot 10^{-4}$ min⁻¹ showing that some soft radiation is associated to the penetrating core; ~~this~~ we can therefore conclude that the ~~soft~~ mesion showers are responsible for of some of the extensive showers (S).

Other experiments on the nature of the penetrating showers are indicated given in fig I.

10^8 min⁻¹



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