Letters to the Editor

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Anomalous Rate of Nuclear Disintegration Effected by Cosmic Rays

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THE disintegration of atom nuclei by cosmic rays may be only rarely observed in the Wilson chamber, and the method of thickly coated photographic plates first proposed and worked out[1] at the Radium Institute of the Academy of Sciences of U.S.S.R. has proved to be more effective. Applying this method to a series of experiments,[2] we succeeded in observing many individual cases of nuclear disintegration. The rate of nuclear disintegration at sea level is about 8×10^{-3} an hour per 1 cm^2 of the photoplate area and shows a rapid increase depending on altitude and reaching, for example, at 7000 m, an amount 50 times as large, as that at sea level.[3] This paper records some preliminary data obtained in the case of an exceedingly high rate of nuclear disintegration we observed late in 1942.

The investigation was made in the following way: Thickly coated (70μ) plates with the emulsion sensitive to the charged particles analogous to the emulsion E_3 applied so far[1] were prepared for a series of tests to be carried out on November 19, 1942. The plates developed three days after their preparation (and not radiated at all) upon being examined under the microscope were found to contain an enormous quantity of forks, which because of a great range of particles had necessarily to be attributed to the nuclear disintegration from cosmic rays. This conclusion is also supported by the outward appearance of tracks, for the emulsion E_3 as it was formerly reported[3] possesses a property contributing by their appearance to the discrimination of tracks of mesotrons, protons, α-particles, and other particles capable of higher ionization. It was noted earlier[4] that the property of this emulsion allowed us to point out the possibility of registering mesotrons and of evaluating the mass of these particles. Yet in the plates developed on the day following their preparation, the number of similar disintegrations fully coincided with the above-mentioned "normal" rate for sea level. Further plate development (within different intervals up to $1\frac{1}{2}$ months) led to the observation of a greatly increased number of nuclear disintegrations. The examination of plates also showed the presence of a whole series of characteristic anomalies. Thus, for example, the former studies (carried out both at our Institute and in other laboratories) have shown that at sea level there prevail disintegrations involving three heavy charged particles, the number of ejected particles slowly increasing with the altitude; the quantity of single heavy tracks is much higher than that of forks. In our case the greatest percent of disintegrations is obtained from fourfold forks, and the quantity of single tracks is obviously smaller than that of disintegrations.[5] Side by side with single tracks and forks of a small number (2–5) of tracks one may observe (mostly on plates developed in December) an increased number of disintegrations with the ejection of many particles and characteristic showers consisting of a great quantity (up to some score) of heavy particles that are analogous to the shower of about 100 particles which was registered in 1938 on the plates sent up in an airplane to the altitude of 9000 m.[3, 6] An illustration thereof is given in a stereomicrophotograph of disintegration with the ejection of 20 heavy charged particles in Fig. 1 and an example of a shower of 50 particles (protons) in Fig. 2.

It is necessary, however, to point out the great fluctuations in the distribution of nuclear disintegrations on the plate area. For example, on some plates with the area of 10 mm^2 the magnitude of the rate amounts to the value 10^3 as high as that of the aforesaid "normal" value. Nevertheless, the greatest rate seems to have taken place during the period from November 23 till December 1. But it is only after a detailed and painstaking investigation of the plates under a microscope that we may come to a final conclusion.

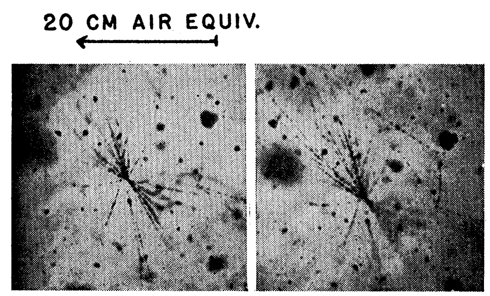

FIG. 1. Example of disintegration involving 20 heavy particles.

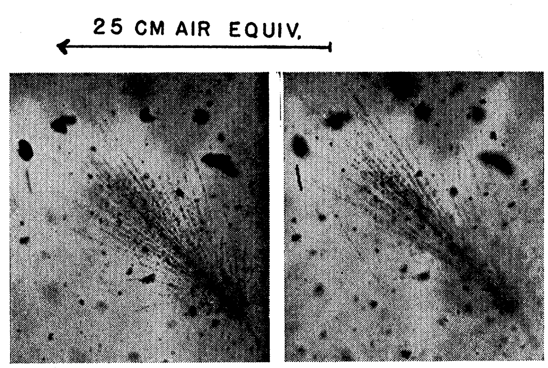

FIG. 2. A shower of 50 particles (protons).

The question becomes complicated due to the presence of an abnormal concentration of forks in the proximity of big showers—the fact noted at an earlier[6] period and graphically seen when drawing a topographic map of the distribution of nuclear disintegrations.[3] Doubtlessly the reason that called forth this anomalous phenomenon is a rough increase of the intensiveness of those components of cosmic radiation that are responsible for nuclear disintegrations. Considering this, it is of great interest to find out whether the increase is a general one and how long it will last (it may be the result of a cosmic catastrophe and thus a similar anomaly could be observed in other places of the globe), or whether it is a local one stipulated, for instance, by the passage of some superpowerful torrent of cosmic particles or, finally, whether it is a result of a combination of both alternatives.

We may hope that a further detailed statistical investigation of plates will bring some answer to these questions.

[1] L. Myssowsky and P. Tschishow, Zeits. f. Physik **44**, 408 (1927); A. Jdanov, J. de phys. et rad. **6**, 233 (1935).
[2] See M. Shapiro, Rev. Mod. Phys. **13**, 58 (1941) for a summary.
[3] A. Jdanov, Bull. Acad. Sci. U.S.S.R. **4**, 266 (1940); Comptes rendus Acad. Sci. U.S.S.R. **28**, 109 (1940).
[4] A. Filippov, A. Jdanov, and I. Gurevich, Comptes rendus Acad. Sci. U.S.S.R. **18**, 181 (1938); J. Phys. U.S.S.R. **1**, 51 (1939); A. Jdanov, Comptes rendus Acad. Sci. U.S.S.R. **20**, 645 (1938); **22**, 163 (1939).
[5] If one takes into consideration only those disintegrations and single tracks where the range is more than 10 cm of air equivalent.
[6] A. Jdanov, Nature **143**, 682 (1939).

The Method of Shower Anticoincidences for Measuring the Meson Component of Cosmic Radiation

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THE meson intensity measured in counter experiments where absorbers are used to filter out the soft electronic component refers only to fast mesons. The slow mesons which get cut out by the absorber can so far be estimated only indirectly, as, for instance, by the method adopted by Auger[1] and Greisen.[2] There is evidence, however, that the proportion of slow mesons increases rapidly with altitude, and it would be of great advantage if there were a direct method for measuring the total meson intensity. Bhabha[3] has recently suggested on grounds of reducing the weight of lead carried by balloons measuring the meson intensity in the stratosphere that the production of secondaries by the electronic component can be used to advantage in cutting them out. But this principle could be used for the more important purpose of bringing for the first time the slow mesons in the field of direct experimental observations. While a great proportion of cosmic-ray electrons in the atmosphere are already associated with other ionizing particles, the number so associated can be increased by a lead plate of thickness corresponding to the maximum of the Rossi curve. By means of an anticoincidence arrangement working along with a vertical counter telescope, it is possible to exclude events in which associated particles arrive in the telescope. This can be done with side anticounters arranged as shown in Fig. 1*a*, but here the main cone of measured radiation is not utilized for detecting the showers and those that are generated in the lead above on account of their narrow angular spread might avoid detection. The actual arrangement used is shown in Fig. 1*b*, where the sets of counter II and III are used to register the showers. A shower coincidence II, III gives rise to an antipulse which is fed to the coincidences of the main telescope formed by counters I, IV. The lead placed in position X is to increase the associated soft particles, and the lead placed in position Y is to study the absorption of the radiation without interfering with the efficiency of shower anticoincidences. The basic circuit used has been shown in Fig. 1*c*.

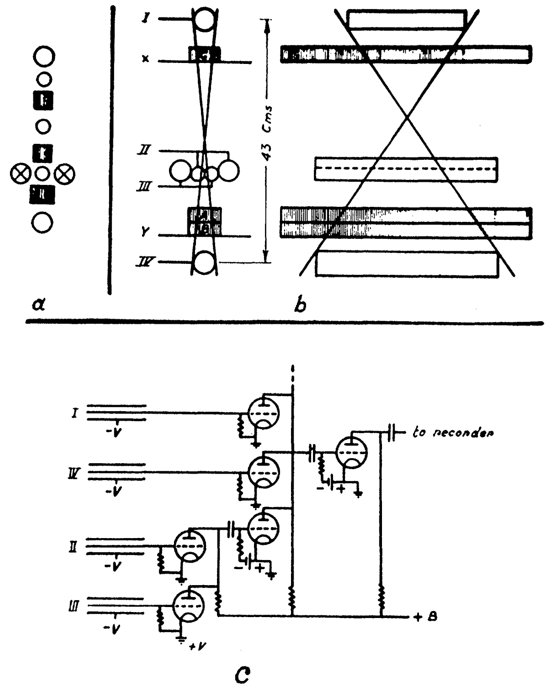

FIG. 1. *a*. Arrangement showing anticounters outside the main cone of measured radiation. *b*. Arrangement used for measuring shower anticoincidences. *c*. Basic circuit for registering shower anticoincidences.

Preliminary results obtained with this arrangement of the total intensity given by coincidences I, IV and the meson intensity given by shower anticoincidences I, IV-(II, III) at various altitudes up to 13,900 ft. in Kashmere illustrate the working of the arrangement. Figure 2 shows the absorption curve at two altitudes of these two counting rates with lead placed at positions X and Y. The difference between the two curves diminishes rapidly with increasing thickness of lead absorber as the electronic component gets progressively absorbed; and while the slope of the total intensity curve increases with diminishing thickness of lead, the slope of the meson intensity curve varies in an opposite direction. The tendency of the shower anticoincidence curve to become horizontal for zero thickness of lead is a striking indication of the fact that it measures chiefly the meson intensity. The altitude intensity curves from readings at 4 elevations in Kashmere at geomagnetic

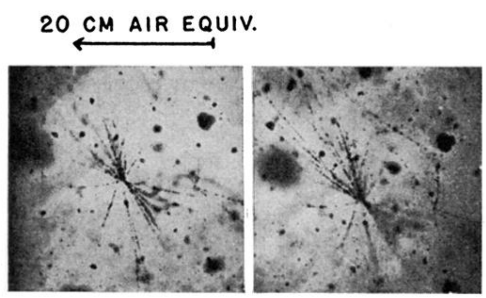

FIG. 1. Example of disintegration involving 20 heavy particles.

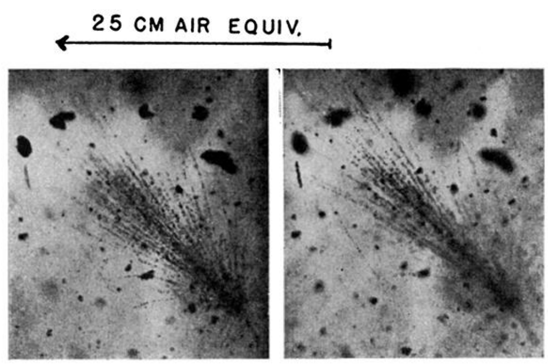

FIG. 2. A shower of 50 particles (protons).