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INTERNATIONAL CONFERENCE ON COSMIC RAYS AND THE EARTH STORM Part III

III-4-8. An Experiment to Determine the Heights of Origin of Mu-Mesons in Extensive Air Showers

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In 1958 an experiment was performed at Culham, England by de Beer, Cranshaw and Parham to determine the heights of origin of mu-mesons in extensive air showers. A preliminary report on this work was given at the Moscow Conference in 1959 whilst a full report has been submitted to "The Philosophical Magazine". Unfortunately this work was terminated prematurely at the end of 1958 because of the closing down of the Culham air shower array. It was then decided to continue observations on the heights of origin of mu-mesons in air showers at the University of Potchefstroom, South Africa.

An air shower array consisting of five 1 sq. metre liquid scintillators has been put into operation to detect showers containing more than 10^6 particles. In addition there are 3 spark counter mu-meson telescopes which measure the directions of mu-mesons which have penetrated them. The relative positions of the scintillators and the telescopes are shown in Fig. 1. For showers falling inside the ring of outer scintillators, the core positions can be determined with an accuracy of ± 10 metres. In order to calculate the size and position of a shower, the lateral structure as determined by the M.I.T. group is used. Showers which cannot be solved by using this lateral distribution are rare. A typical good solution is shown in Fig. 2. The largest shower detected so far contained 3.5×10^7 particles.

The method of calibration of the scintillators is probably rather unusual. The scintillation counters have been designed to give good uniformity of response but as a result the efficiency is low and thus the ordinary methods of calibration could not be used. Our method of calibration is as follows: Small air showers were selected by means of a temporary array of Geiger counters. These showers fell on one of the scintillation counters which gave pulses proportional to the density of particles which have penetrated it. Very close to this scintillator were 20 Geiger counters. From the number of discharged Geiger counters the true density

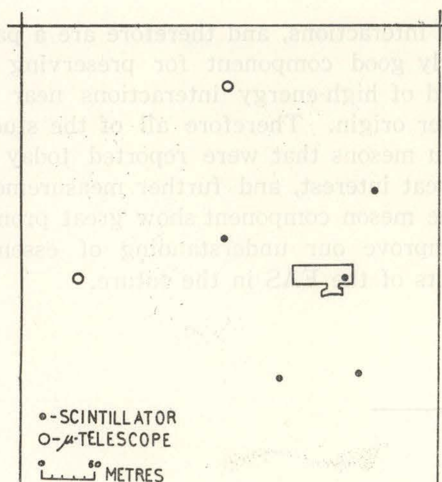

Fig. 1.

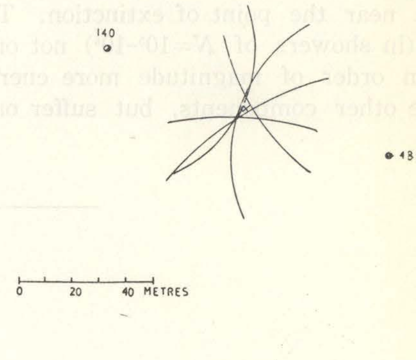

Fig. 2.

* This paper was read by P. H. Stoker.

of particles was deduced. In this way the factor of proportionality between pulse size and particle density was determined accurately. Subsequently the scintillator pulses were fed through a discriminator which registered a count every time more than 19 particles have traversed the scintillator simultaneously. The possibility of a random noise count is eliminated by demanding a coincidence with a tray of 6 G26 Geiger counters. The discriminator thus records the rate of showers containing more than 19 particles. This rate was determined accurately for the calibrated scintillator. Once this rate of showers with more than 19 particles was known, all the gains of the other scintillator channels were adjusted to give the same rate of showers above the 19 particle discrimination level of the first calibrated system. This rate with which a scintillator records showers of a certain mean size serves as a continuous future check on its calibration since the rate of showers is very constant, *i.e.* apart from a small variation with atmospheric pressure.

The mu-meson telescopes are similar to the one described at the Moscow Conference except that only 3 triggered spark counters are used in each telescope. The vertical distance between successive counter is 40cms. A layer of lead above each spark counter shields it from electrons. The accuracy with which the direction of a mu-meson can be obtained is about 0.2 degrees by 0.2 degrees. No results are available yet.

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III-4-9. Concluding Comments After EAS Ordinary Session 1

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In concluding this session I wish to call attention to the fact that in air showers of 10^4–10^7 particles the mesons carry the dominant amount of energy. The remaining electrons, photons and nuclear active particles are debris left over after many interactions, and are near the point of extinction. The mesons (in showers of $N=10^5$–10^6) not only carry an order of magnitude more energy than the other components, but suffer only weak interactions, and therefore are a particularly good component for preserving the record of high-energy interactions near the shower origin. Therefore all of the studies of mu mesons that were reported today are of great interest, and further measurements of the meson component show great promise to improve our understanding of essential aspects of the EAS in the future.