Size-Spectrum of Extensive Air Showers
of the Cosmic Radiation.

I. – Response of a Single Scintillator to Extensive Air Showers (*).

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Summary. — Previously determined experimental and theoretical expressions for the lateral distribution of particles in extensive air showers are used to predict the response of a single scintillator to these showers. The integral rate of particles traversing the scintillator is found in terms of the integral rate of showers; the average size of shower resulting in a given number of particles through the scintillator is calculated; the effect of the zenith-angle distribution of the shower axes is also investigated.

1. – Introduction.

The extensive air showers of the cosmic radiation are of two-fold interest. First, there is the intrinsic value of the showers themselves in their complicated structure and development. Secondly, there is the expectation of deducing knowledge of the primary cosmic radiation, as it is incident upon the outer atmosphere of the earth, from the behavior and occurrence of the extensive air showers; such knowledge can then be used as a basis for speculations of cosmological importance. One of the more important and basic characteristics of the extensive air showers is the frequency of occurrence of the showers as a function of the total number of particles in the shower. A size-spectrum of this kind is of obvious importance because there must be a monotonic relation between increasing size of showers and increasing energy of the primary cosmic radiation.

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Investigations of extensive air showers have been largely characterized by widespread arrays of Geiger-Müller tubes in trays or of scintillators. In addition to the obvious necessity of such dispersal if any knowledge of the lateral structure of the showers about their cores is to be obtained, there is the practical consideration of obtaining reasonably high counting rates. Because of the rapid decrease in particle density as one leaves the shower core and because of the fairly rapid decrease in the rates of the showers with increasing size, appreciable counting rates could be obtained with detectors of practicable size only by employing many such detectors and by distributing them over a very large area. Now, however, good experimental evidence of the lateral structure has become available together with theory that closely approximates the observed distribution; also, improved techniques in the manufacture of photomultiplier tubes has made it possible to construct scintillators of very large acceptance area. These circumstances made it appear desirable to investigate the behavior of extensive air showers using but a single large scintillator in place of many smaller ones. This paper is concerned with developing the expected response of such a scintillator to the extensive air showers. The following paper presents the results of the experiment as they apply to the size-spectrum of the showers.

2. - Properties of extensive air showers.

In order to calculate the response of a single scintillator to the extensive air showers, it is necessary to know something of the structure of the air showers. The particular properties that are most pertinent are the lateral structure, the form of the number-spectrum, and the angular distribution of the shower axes.

It has generally been observed that the lateral distribution of the electronic particles comprising an extensive air shower has the same form regardless of size (i.e., total number of particles) of the shower and regardless also of the height of the point of observation in the lower atmosphere (1-4). The distributions will therefore be treated in the form

\[ F_1(x) = Nf_1(x), \]

(1)


