Studies on Extensive Air Showers.

PART I. — Sea Level Observations on the Variation with Shower Size of the Total Number of Nuclear-Interacting Particles in Showers of \((10^4 \div 2.5 \cdot 10^6)\) Particles.

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Summary. — An experiment carried out at sea level on the lateral distribution of nuclear-interacting particles in air showers and the variation of their number with the size of the showers, is described; the showers recorded ranged in size from \(10^4\) to \(2.5 \cdot 10^6\) particles. The results indicate that the number of nuclear-interacting particles is proportional to \(N_e^{4.1 \pm 0.05}\) for showers of size \(N_e\) less than about \(6 \cdot 10^5\) particles, and the number is proportional to \(\sim N_e^{1.3}\) for larger sizes. What has been obtained in this experiment and in similar experiments conducted by other groups (Nicol'sky et al. and Lehane et al.), is the average number of nuclear-interacting particles in a large number of showers of a given size. The possibility that such an average may not be meaningful if large intrinsic fluctuations (other than normal statistical variations) exist, is pointed out.

1. — Introduction.

Nicol'sky et al. (1) have, in an experiment carried out at a mountain altitude of 650 g cm\(^{-2}\), determined the variation with shower size of the total number of nuclear-interacting particles, (N-particles), in extensive air showers which ranged in size from \(4 \cdot 10^3\) to \(10^6\) particles. A similar study has been carried out by Lehane et al. (2), at sea level, for showers whose sizes ranged from \(5 \cdot 10^4\) and \(2 \cdot 10^6\) particles. The experiment of Nicol'sky et al. showed

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that the number of N-particles varied with shower size, \( N_o \), as \( N_o^{a2} \) for showers of size less than \( 4 \times 10^5 \) particles, while the variation was given by \( N_o^{1.0} \) for larger shower sizes; the change of the exponent was sudden and occurred at a shower size of \( \sim 4 \times 10^5 \) particles (at an altitude of 650 g cm\(^{-2}\)). This sudden change of slope, in the curve representing the variation of the total number of N-particles with shower size, has been interpreted by Nicol'sky \textit{et al.} as indicating that nuclear collisions of particles of energy greater than \( 6 \times 10^{14} \) eV are radically different in their characteristics from those due to particles of lower energy.

In this paper we report an experiment carried out at sea level at Bombay, on the variation of the number of N-particles with shower size. The shower size recorded ranged from \( 10^4 \) to \( 2.5 \times 10^6 \) particles. The results indicate that the number of N-particles is proportional to \( N_o^{0.45 \pm 0.05} \) for showers of size less than about \( 6 \times 10^5 \) particles, and the exponent becomes \( \sim 1.2 \) for larger sizes.

2. – Experimental arrangement.

The extensive air shower array was set up on the terrace of the building of the Tata Institute of Fundamental Research, in Colaba, Bombay. The lay-out of the detectors (Fig. 1), was therefore determined to some extent by the dimensions of the terrace. \( S_1, S_2, S_3, S_4, S_5 \) are five liquid scintillation counters each of area 1 m\(^2\); \( N_1, N_2, N_3, N_4, N_5 \) are N-detectors, each of area 0.4 m\(^2\); \( G_1, G_2, G_3 \) are Geiger counter trays, each of area 500 cm\(^2\).

Fig. 1. – Extensive air shower array. \( S_1, S_2 \) are liquid scintillators, each of area 1 m\(^2\); \( N_1, N_2, N_3, N_4, N_5 \) are N-detectors, each of area 0.4 m\(^2\); \( G_1, G_2, G_3 \) are Geiger counter trays, each of area 500 cm\(^2\).

by the dimensions of the terrace. \( S_1, S_2, S_3, S_4, S_5 \) are five liquid scintillation counters each of area 1 m\(^2\); they were spread over an area of 30 m × 6 m. \( N_1, N_2, N_3, N_4, N_5 \) are five N-detectors placed close to each other at the centre of the array of scintillation counters. Each N-detector had an effective area of 0.4 m\(^2\) and consisted of enriched BF\(_3\) neutron counters embedded in paraffin and lead (Fig. 2); the BF\(_3\) counters were 75 cm long, 2.5 cm in dia-