LOW FREQUENCY RADIO EMISSIONS

From

COSMIC RAY AIR SHOWERS

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by

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...these matters I have very diligently analysed and pondered for a long time, and now having summarised them in a little book, I am sending them to Your Magnificence.

Niccolo Machiavelli
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SUMMARY

Between 1965 and 1975, there was considerable interest in radio pulses produced by extensive air showers. The main interest was centred on the expectation that studies of these pulses might reveal the nature of the high energy primary cosmic rays. A theory, based on the deflection of shower particles by the earth's magnetic field was developed, and proved successful in explaining features of the radiation at frequencies above 20 MHz. However, below this frequency there was gross disagreement between the theoretical prediction that the pulse amplitude would fall to zero at low frequencies, and a number of experimental measurements of very high pulse amplitudes. This project was conceived with the aim of determining the origin of these pulses.

A series of experiments was performed at a frequency of 2 MHz, but neither these experiments, nor the analysis of a previously unpublished 3.6 MHz experiment showed the presence of any signal. Upper limits, of the order of one-tenth of the previously reported field strengths were established.

However, experiments performed at 100 KHz confirmed the presence of variable, and on occasion very large, signals. Although the observing period was severely limited by these variations, the relationships of pulse amplitude to shower size and core distance were established. No indication of the nature of the production mechanism was found. However, it is suggested that the variations observed at 100 KHz extend to higher frequencies and are thus responsible for the confused situation at frequencies near 2 MHz, and also some apparently anomalous results at higher frequencies.
This thesis also includes a description of work carried out in connection with the air shower detector used in the above experiments. A system was designed and built to record data from this array on magnetic tape, and this was subsequently improved and extended to cater for more detectors. Some calculations were made to explore the capabilities of the array, how these capabilities can best be used, and the optimum siting of additional detectors.