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A NEW STUDY ON THE EMISSION OF EM WAVES FROM LARGE EAS

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1. Introduction. Studies on Cosmic Ray Showers of energy $E_p \gg 10^{16}$ eV have been continuously pursued since 1970 in Gauhati University, Assam (1). With an GM counters array. EM waves-both at optical Čerenkov and at Radio frequencies (from 2 to 220 MHz) - associated with the showers have been studied in this laboratory. Experimental results obtained reveal the following features:

(i) Frequency spectrum of Radio as well as Cerenkov pulses decreases with increasing pulse heights.

(ii) Field-strength of radio pulses decreases with increase in frequency.

(iii) Radio pulses are polarised in E-W direction. The high value of polarization ratio at 9 MHz appears to confirm the predominance of geomagnetic effect on emission mechanism.

(iv) Studies on the correlation coefficients of emission between radio pulses of different frequency pairs from the same shower indicate:

(a) There is no correlation between low ($\ll$80 MHz) and high ($\gg$80 MHz) radio frequencies.

(b) The positive correlation coefficient between the frequency pairs below 80 MHz (eg. 9-60 MHz) and negative correlation coefficient between any frequency pair below and above 80 MHz (eg. 9-220, 60-80, 60-110 MHz) confirm that the production mechanism of radio pulses below and above the cut off frequency ($\sim$80 MHz) may perhaps be different.

(c) There is no correlation between the emission of optical Čerenkov radiation and radio pulses at different frequencies.

The above observations have tempted us to repeat the whole experiment with a sophisticated particle detector array with facilities for corelocation and energy determination of individual showers. In this paper the new array and the core detection technique along with a few of the sampled parameters, obtained so far, are reported.

2. Methods. (a) The array. The present array consists of seven plastic scintillators (50cm x 50cm x 5cm each) the outermost is located at 100 m from the array centre. Fig 1 gives the schematic diagram of the array used along with

the positions of the antennas and Čerenkov detector.

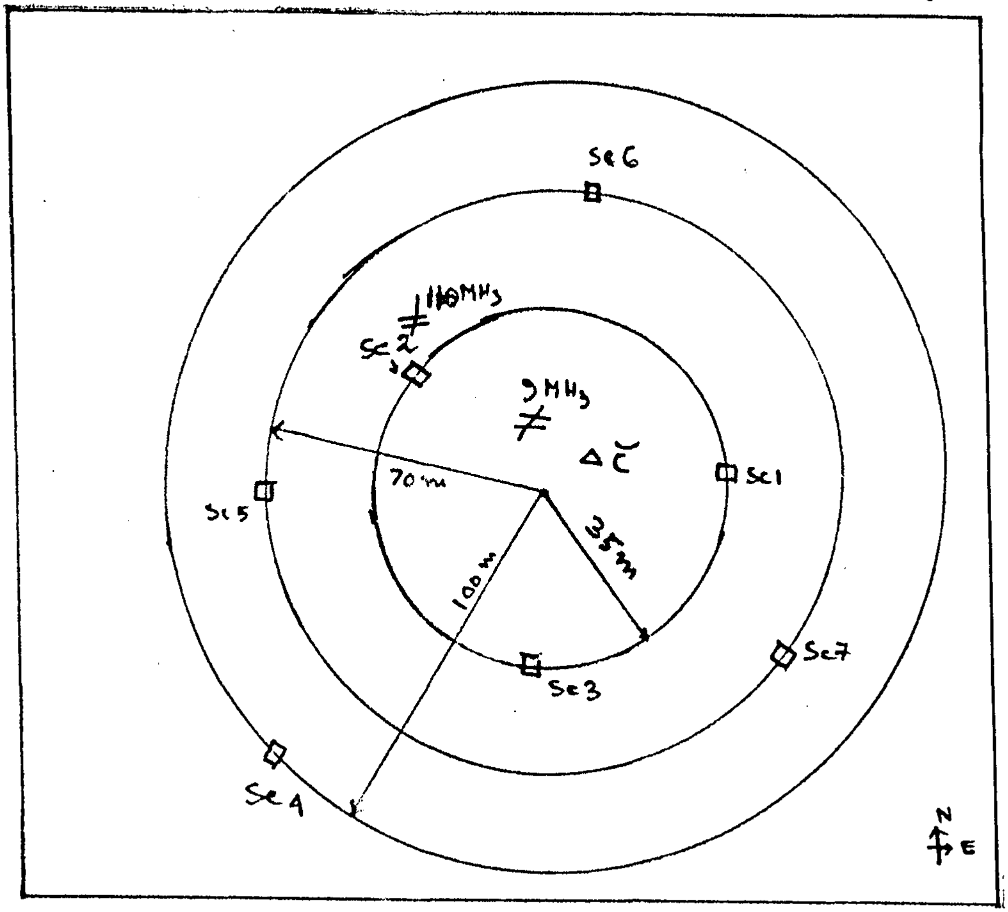

Fig 1. The array. Sc 1–Sc 7 – Positions of scintillators ≠ –positions of Antennas, Δ –position of Č detector.

2.(b) Core location. Each shower can be specified by four parameters viz size (N), co-ordinates of the core (x_0, y_0) and the age (s). Therefore, measurements of four particle densities are, in principle, enough to evaluate these parameters. We assumed NKG lateral distribution for particles given by $\Delta = Nf(r,s)/R_1^2$. It is evident from this that by taking the ratio of densities between any two detectors the parameter N can be eliminated. Numerical calculations using computer (Ellipse 316), give a set of curves i.e. locii of the shower axes producing different density ratios. With these sets of locii, assuming different 'S' values, one can locate the shower core within ±3.3 metres.

The above method has been applied in locating the core of each individual shower. Using a microprocessor-based detecting system (2), the density distribution and hence, energy of each detected shower has been estimated.

2.(c) Detection of Radio & Cerenkov pulses. Two antenna systems for detecting radio pulses at frequencies 9 MHz and 110 MHz have been set up. For detection of optical Cerenkov pulses associated with each shower, a parabolic reflector of 76 cm diameter, and 13 cm focal length viewed by a Dumont 6364 PMT has been used. The positions of the antennas and the Cerenkov detector in the array are shown in **Fig** 1.

For each shower, the detected outputs of the receivers (for radio pulses) and signals from the PMT (for Cerenkov pulses) are digitized using sample and hold (S/H) and A/D converter, triggered by the master coincidence pulse. The digitization and the storing of the informations are controlled by a 8085 A microprocessor (2).

3. Results. As the data can only be collected during clear moonless nights, the experiment is yet to be completed. However, a few of the sampled parameters, obtained sofar, are presented in Table 1.

TABLE - 1

Event No.	Distances of the cores from the scintillators in metre				$E_p \times 10^{16}$ in eV	Pulse heights (arb.unit) $\times 10^{-2}$		
	r_1	r_2	r_3	r_4		9MHz	110MHz	Optical
1	55	60	10	80	4.30	75	26	58
2	50	45	28	80	3.57	96	20	40
3	80	53	56	30	0.80	67	26	44
4	65	13	65	105	6.70	80	16	60
5	64	64	105	68	5.90	60	26	30
6	60	60	10	71	0.50	50	20	28
7	62	58	40	68	3.20	70	28	30
8	70	65	40	80	1.20	60	30	40
9	68	60	25	68	4.80	78	30	26
10	45	50	20	65	0.70	65	20	37

r_1, r_2, r_3, r_4 are the distances of the core from Sc 1, Sc 2, Sc 3 and Sc 4 respectively.

4. Conclusions. The work is in progress and we hope to get adequate data within a couple of months or so to test our earlier observations as mentioned in the introduction.

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