# SHORT PERTURBATIONS OF COSMIC RAY INTENSITY AND ELECTRIC FIELD IN ATMOSPHERE

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Starting from 1975 an experiment was carried out using Baksan E.A.S. array ($S = 200\ m^2$ of scintillators, $h = 1700$ m, $R = 6{,}5$ GV) /1/ to look at short perturbations in cosmic ray intensity. More than 140 events were recorded up to now, nearly 100 % of them can not be explained by pressure or temperature variations (at the level of observation). The characteristic amplitude of the recorded intensity variations is about 1%, the specific time scale 10 ÷ 20 min and duration up to 5 h. The mentioned "time scale" can be affected by the 4 min read out period in this experiment.

The meteorological nature of observed intensity perturbations was found as most probable from strong association of the phenomenon with precipitations out of cumulonimbus clouds also out of nimbo-stratus clouds. Similar effects were observed by Attolini et all /2/, authors suggested temperature variations as most probable to explain the phenomenon.

In our experiment we installed an electric field meter (from 1982) and included in the read out system (1984) the counting rate of the 6 outside detectors. The latter have $6 \times 9\ m^2$ total area, counting rate $4 \cdot 10^6$ counts/4 min. Though this is only 1/3 of the counting rate of the central part it is useful for speculation concerning energy spectrum of variations because of the difference in the thickness of the roofs, the muon energy threshold or central part being 90 MeV and outside detectors only 20 MeV. 43 events with complete information have been recorded in 1984. In all intensity perturbation cases, if electric field meter was in operation ( 80 total), a strong electric field $\sim 20$ kv/m was recorded. The fig.3 shows the correlation of durations of electric field ($t_E$ ) and intensity ($t_I$) disturbances. The typical examples of records (corrected for pressure) is shown on fig.1 and fig.2. There is no visible correlation between intensity perturbation and pressure or temperature. To explain fig.2 by temperature effect the increase of all the atmospheric temperature should exceed 15°C, which seems most unlikely. The difference of $I_{20}$ and $I_{90}$ responses (fig.1) is quite contrary to the temperature effect hypothesis (soft component contributes 40% to $I_{20}$ and only 7% to $I_{90}$ and temperature coefficient for soft component is smaller than for hard component /3/).

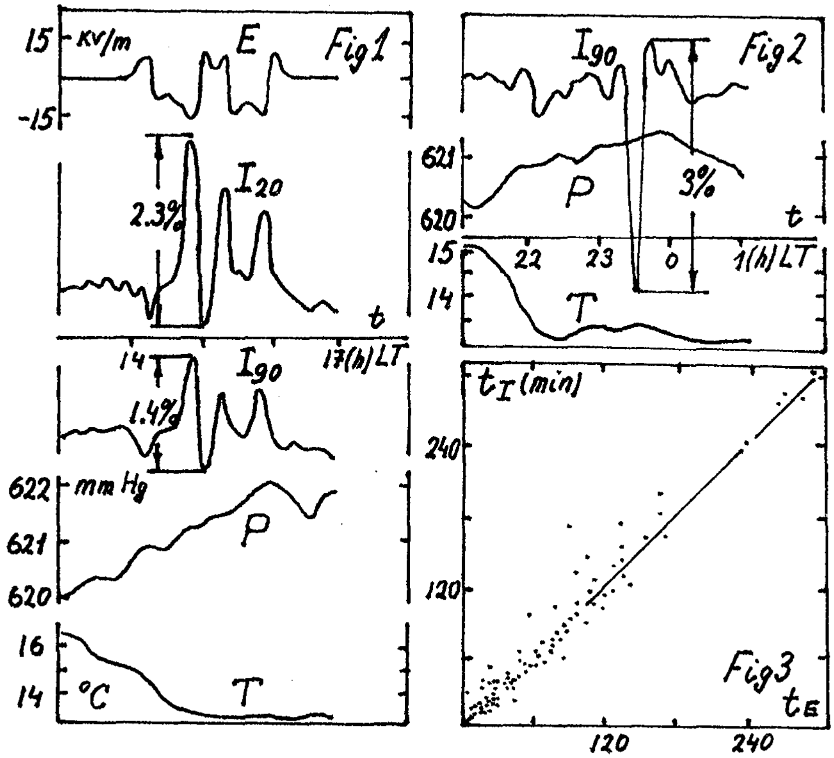


Fig.1. A typical event correlated with rain (13 July 1984) E - electric field. P - atmospheric pressure. T - temperature.

Fig.2. The biggest decrease during a thunderstorm (19--20 June 1983)

Fig.3. The correlation between $t_I$ and $t_E$

The difficulties in explanation by temperature effect and the obvious connection of short intensity perturbations with electric phenomena (see fig.1,2,3,4,5) make us to examine hypothesis of the influence of electric field on intensity of cosmic rays. The question is not quite new. Many years ago C.T.R.Wilson /8/ suggested the acceleration of electrons by electric field in thunderstorm clouds. The atmospheric electricity effects have been investigated experimentally very long ago /4/, /5/ also /6/ but so far the evidence has been scarce and contradictory.

The main feature of electric field-intensity correlation consists in unambiguous strong connection between both phenomena and, on the other hand, in absence of a strong correlation between E(t) and I(t). More than that, fig.4 and fig.5 show, that there happened to exist events with correlation coefficients R of different sign. There is thought an obvious excess of events with negative R. As a positive direction of electric field was chosen down, so negative R corresponds to the negative charge excess of accelerated (decelarated) particles. Fig.6 shows the

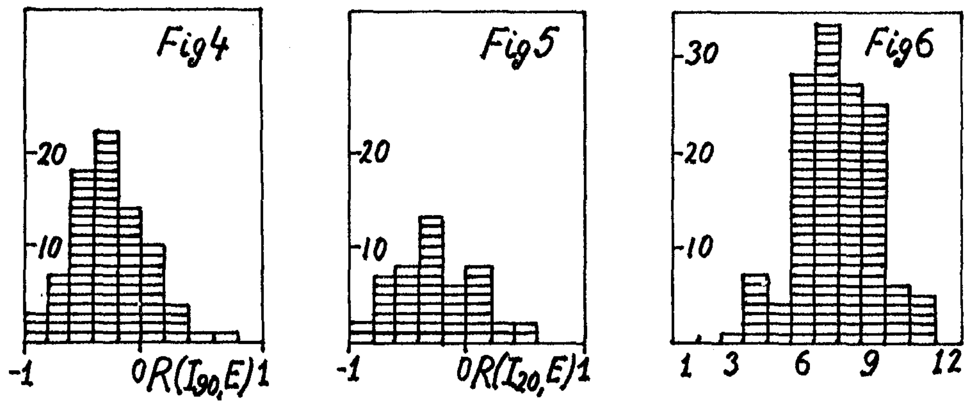


Fig.4. The distribution of correlation coefficients $R(I_{90},E)$

Fig.5. The distribution of correlation coefficients $R(I_{20},E)$

Fig.6. The seasonal distribution of short perturbations of cosmic ray intensity.

absence of events in winter, which is not controversal with the electric field hypothesis.

In principle the electric fields in atmosphere can affect all 3 important c.r.components: electrons, muons and primary protons.

1) e-mechanism due to the excess of negative electrons is presumably a local one because of the short range of electrons, therefore a strong E ↔ I correlation is expected, especially for $I_{20}$. But experimentally this is not the case - see fig.5 also fig.4. One can think of only small contribution of this mechanism to $I_{20}$ and negligible to $I_{90}$.

2) $\mu$ - mechanism due to the positive excess of muons in the middle atmosphere. Because there is no ± excess for low energy muons at the level of observation /7/ this mechanism is not local, so the electric field of all atmospheric does affect the $I_{20}$ and $I_{90}$. This can explain the small and of different signs correlation coefficients R.

3) p-mechanism is located especially high in the atmosphere where the interactions of primary protons with air nuclei give a contribution to the observed muon flux. The change of electric potential at these levels relative to the earth or ionosphere (we believe them to be zero) will change energy of interactions and accordingly the intensity of muon flux. To explain 1% variation in muon intensity the potential at 7 ÷ 15 km should reach 1 GeV or more.

<u>Conclusions.</u> Short perturbations of c.r. intensity were found to be quite common phenomenon. Its meteorological origin and correlation with electric field is established without doubt. The phenomenon probably can be explai-

ned by the electric field if the strength of this field at high altitudes is much bigger than the measured one at surface.

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