The Cosmic Ray Increase on February 23, 1956

Dear Sir,

The increase in cosmic radiation on February 23rd, 1956 was registered in Stockholm, geomagn. lat. 58° N, geograph. long. 18.0° E, as well as in Kiruna, geomagn. lat. 65° N, geograph. long. 20.4° E. In Stockholm a set of 4-channel directional counter telescopes mounted for the zenith, north, and south directions (30° zenith angle) at an elevation of 46 m delivered three records (*Z*, *N*, and *S* in the left part of the figure). In the meridian the telescopes have an opening of roughly 25° for the *Z* and 23° for the *N* and *S* directions. Perpendicular to the meridian plane their openings are 90°. The mass of the roof above these telescopes is less than 10 g per cm^2.

By chance a cubical counter telescope of international standard type was operated in a locality where the mass of the roof is 80 to 100 g per cm^2. Owing to the program of test runs the record starts at 1500 G.M.T. on February 22nd. The mechanical counter failed between 0600 and 0700 G.M.T. and was probably restarted too late for a full count during the following hour.

In addition to the four curves from the counter telescopes a record of the soft component was delivered by a small neutron monitor (ECKHARTT).

The counter telescopes in Kiruna are of the same geometry as those in Stockholm. The elevation is 400 m. For reasons of economy the impulses from the four channels in each direction are not counted separately. The dangers involved were demonstrated on the day in question, when one of the *S* channels was out of order and spoiled the whole record of this direction. The *Z* and *N* records from Kiruna are found to the right in the figure.

In all the instances the impulses have been counted during one hour intervals. As a result the increase between 0300 and 0400 G.M.T (0400 and 0500 CET) has been distributed over the whole hour. From quarter hour and continuous registrations elsewhere (SITTKUS, ELLIOT) we know that the time of maximum was at approximately 0345 G.M.T. and that the increase did not start before 0340. A recalculation of the one hour values from Stockholm and Kiruna so as to give the number of impulses during the period 0340—0400 G.M.T shows that the counting-rate in the *Z* direction was at least 2.5 times the normal in Stockholm and 2.8 times the normal in Kiruna. The corresponding values for the *N* directions are 2.1 and 2.2. In the *S* direction in Stockholm the intensity appears to have risen at least to 1.8 times the normal. The cubical telescope in Stockholm, shielded by a mass equalling 7—9 cm of lead, indicates an increase of at least twice the normal.

The *Z* values from Stockholm display a periodic variation preceding the sudden increase. This variation is well outside the staistical fluctuations. The same variation is also present in the *N* and *S* records, but in these two cases it is so small as to fall inside the statistical fluctuations. The minimum before the flare effect is present in the record from the cubical telescope but the preceding maximum, if it exists, appears to have taken place before that shown by the small-angle telescopes. Turning to the Kiruna records we find that the *Z* direction reveals traces of the periodic variation agreeing tolerably well with that from the small-angle telescopes in Stockholm.

As regards the return to normal conditions that indicated by the *S* direction in Stockholm

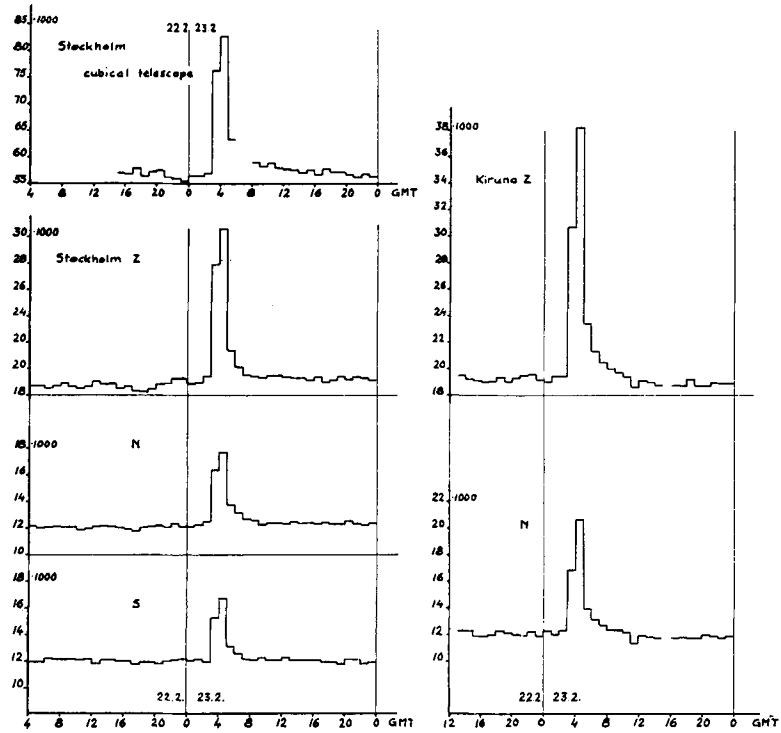

Fig. 1. The sudden increase in cosmic radiation on February 23, 1956.

was the most rapid. Then came the *Z* direction, while the *N* direction indicated a slightly later return. The cubical telescope reveals a still less rapid return to normal. There is no obvious difference between the two records from Kiruna but in both cases the measurable increase in C R intensity appears to have been of a slightly longer duration there than in Stockholm.

The *Z* and *N* records from the small angle telescopes in Stockholm display a very curious feature. These two records, corrected for the barometric effect, show a 3 per cent increase in the number of counts per hour after the event as compared to the day before. None of the other records show a corresponding increase. The arrangement of the 3 × 4 channels is such as to make it very improbable that an increased sensitivity of the counters would appear in two directions but not in the third. Nor does a study of the separate channels indicate any explanation.

The ionosphere observatory in Uppsala (70 km from the telescopes) reported extremely strong absorption in the D-layer between 0800 and 1600 G.M.T.

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Uppsala, March 22, 1956.

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Dear Sir,

Registrations of the soft component of cosmic radiation have been made using a small neutron monitor similar to SIMPSON's Standard Two-Counter Geometry (SIMPSON ET AL, 1953). The monitor is located in the same room as the directional counter telescopes of the C.R. station in Stockholm (SANDSTRÖM, 1956), magnetic latitude 58° N and geographic longitude 18° E, at an altitude of 48 m above sea level, and under a roof equal to 10 g per cm^2. Except for some periods of change and improvement in the electronic and recording equipment, continuous registrations of the soft component have been carried out since March last year. The number of pulses per hour has been corrected for air pressure to a standard value of 1,000 mb using SIMPSON's coefficient — 0.94 %/mm Hg (SIMPSON ET AL, 1953).

The hourly pressure-corrected pulse rates of this small monitor from the 22nd to the 25th of February are plotted in the diagram. On the 23rd between 3 h. and 4 h. G.M.T. the intensity rose to about 14 times its normal value. Taking into account that the sudden increase began in the last third of the one hour interval, as measured by several other stations (SITTKUS, ELLIOT), this ratio would be even greater, certainly exceeding 42 times. The next hour gave a value about 15 times higher than normal. Then the intensity slowly returned to its normal value, which it reached in the late evening hours. For correcting the pulse rates at the increased intensity we used the same pressure coefficient.

The monitor contains two counter tubes made of brass with sensitive length and diameter of 200 mm and 29 mm resp., filled with BF_3 gas enriched to 95 % B^{10} up to a pressure of 700 mm Hg. Each counter is surrounded by a rectangular paraffin block lying between the horizontal parts of an I-shaped bar of lead 5 cm thick. The lead bar itself is covered on all sides by a paraffin layer about 15 cm in thickness. The small pulses from the proportional counters run through pre-amplifier, main-amplifier, discriminator, and scaler to a mechanical printing recorder. Every full hour the mechanical recorder is triggered to print down the figures and to reset them to zero. Positive high voltage for the counter tubes and d.-c. voltage for the amplifiers are supplied by highly stabilized units. The room temperature is kept constant. The air pressure is recorded by an aneroid—barograph the precision of which is sufficient considering the relatively low counting rate of the monitor. By covering the counter tubes with a 0.5 mm thick cadmium shield we measured a background of 3.5 % of the normal counting rate.

As shown by SIMPSON and his collaborators (1953) nearly all the neutrons counted with such a monitor originate from nuclear disintegrations in the lead. These disintegrations are the end of a chain of nuclear processes developing through the atmosphere, and are initiated by primary protons of cosmic radiation having a mean rigidity of about 7 GeV/c assuming undisturbed primary spectrum.

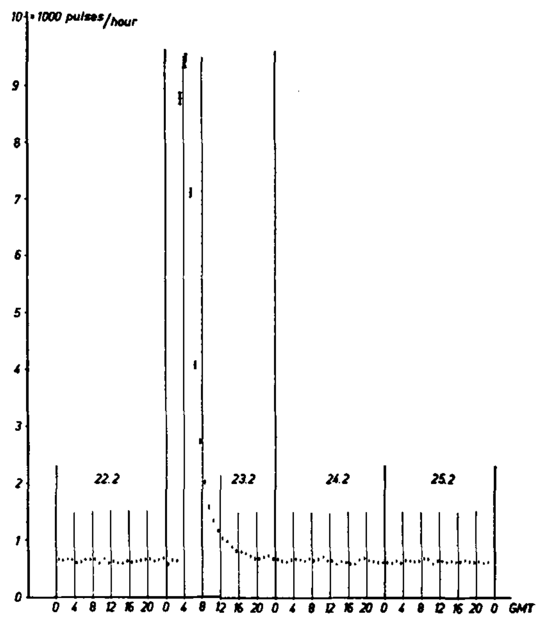

Fig. 2.

It may be noted that we were also able to measure the return of the neutron intensity to normal values during the daytime hours of the 23rd of February with a second monitor. As this instrument was just under construction only one third of the paraffin and lead parts with four counter tubes were ready for measurements. It was located under about 100 g per cm². The factors by which the pulse rates rose above the normal value differ slightly from those for the small monitor in the corresponding hours, being somewhat larger before 11 h. and somewhat smaller thereafter.

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Stockholm, March 22, 1956.

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REFERENCES

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SIMPSON, J. A., et al, 1953; Cosmic Radiation Intensity-Time Variations and Their Origin. I. Neutron Intensity Variation Method and Meteorological Factors, *Phys. Rev.* **90**, p. 934.
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