COSMIC STATIC

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ABSTRACT

Cosmic static is a disturbance in nature which manifests itself as electromagnetic energy in the radio spectrum arriving from the sky. The results of a survey at a frequency of 160 megacycles per second show the center of this disturbance to be in the constellation of Sagittarius. Minor maxima appear in Cygnus, Cassiopeiae, Canis Major, and Puppis. The lowest minimum is in Perseus. Radiation of measurable intensity is found coming from the sun.

Experiments on the measurement of electromagnetic energy at radio wave lengths arriving from the sky have been conducted at Wheaton, Illinois, for a number of years. Preliminary results have already been published.[1] During the year 1943 new and improved apparatus was put into operation and considerably better data were obtained.

The electromagnetic energy is captured by the mirror shown in Figure 1 and is directed to the mouth of the drum at the focal point of the mirror. Within the drum are a pair of cone antennae. These convert the electromagnetic energy into alternating current. This current is fed from the tips of the cones up a parallel-wire transmission line to the receiver-mounting on the end of the drum. On this mounting is attached a five-stage amplifier of about 90-decibels gain over the frequency range 156–164 megacycles per second.[2] It uses type 954 acorn tubes and a circuit arrangement involving transmission-line elements. The output of the amplifier is rectified by a type 9006 diode, and the resulting direct-current voltage is fed down a concentric cable into the house, where the associated power supply and recorder equipment shown in Figure 2 are located.

It is well known that considerable amounts of random-charge voltage are generated in the grid and plate circuits of the first tube of a multistage amplifier. This background random-charge voltage will be rectified by the diode and appears as a constant direct-current voltage, V_{on}, at the end of the concentric cable. Its magnitude has been the point of much investigation and serves as a reference level for the calibration of the intensity of cosmic static phenomena. The value of V_{on} is noted on a meter before and after a set of data is taken. During the actual taking of data, V_{on} is canceled out by a small battery so that the cosmic static may be more easily perceived.

The mirror of Figure 1 is mounted on an east-west axis so that it may be pointed to any angle of declination between the limits of $-32\overset{\circ}{.}5$ and $+90^\circ$ along the north-south meridian. One of the circular tracks is calibrated in degrees. The mirror is set to point at the desired declination; and then, as the earth rotates, the mirror sweeps out a band in the sky along this particular declination. Whenever the mirror passes over a cosmic static disturbance, energy is collected, and the voltage at the end of the concentric cable increases by an amount ΔV_{on} The recorder of Figure 2 is set to a chart speed of 6 inches per hour. If no cosmic static is intercepted, the recorder will draw a straight line on the chart. If cosmic static is encountered, the pen will move up by an amount ΔV_{on}. Figure 3 shows sample charts taken at various declinations.

If no cosmic static had been intercepted, the recorder would have drawn a line of some constant slope. The magnitude of this slope is unimportant, provided the line remains

[1] G. Reber, *Proc. I.R.E.*, **28**, 68, 1940; *Ap. J.*, **91**, 621, 1940; *Proc. I.R.E.*, **30**, 367, 1942.

[2] G. Reber, *Electronic Industries*, **3**, 89–92, 1944.

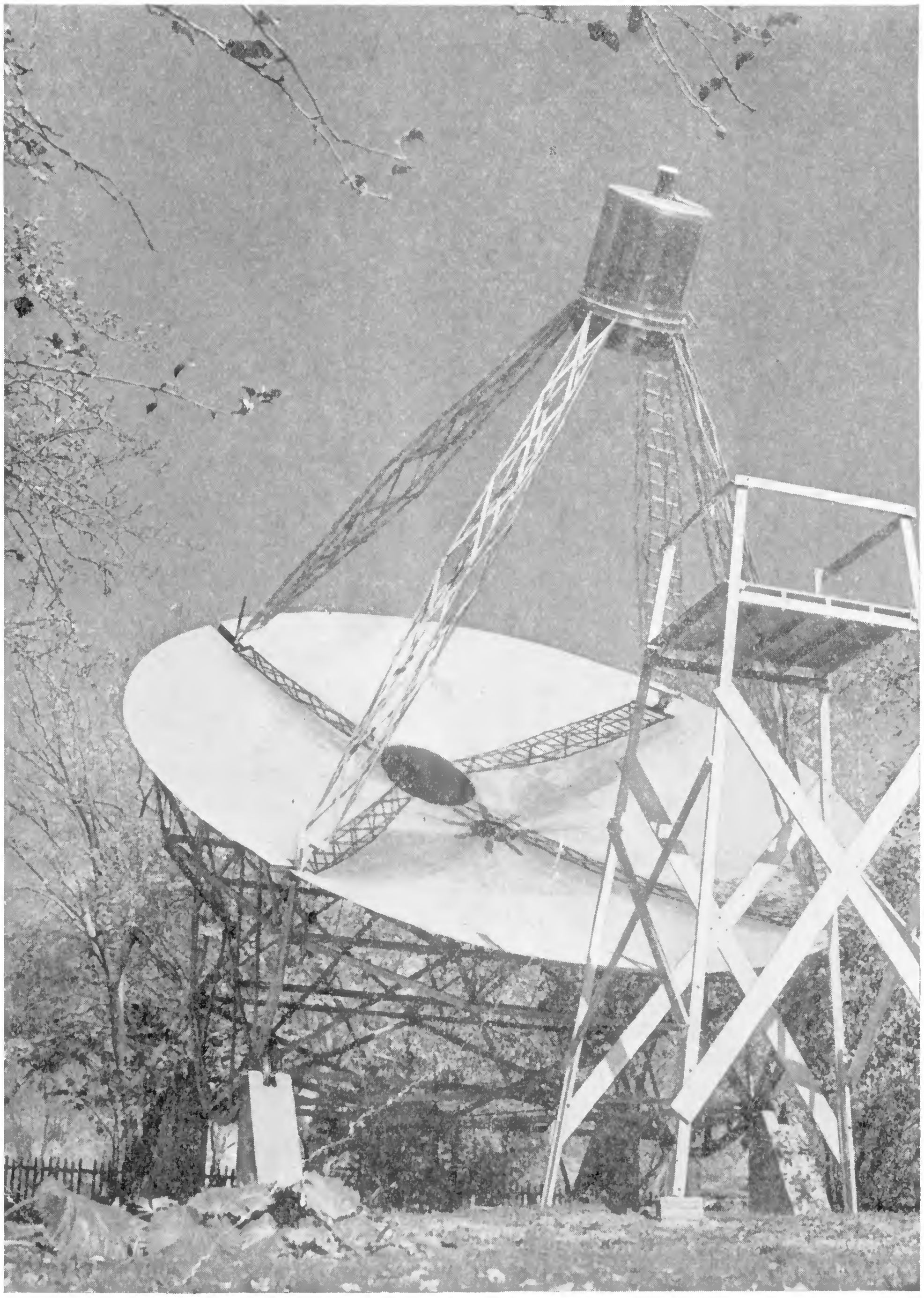


FIG. 1.—Sheet-metal mirror, 31.4 feet in diameter, 20 feet in focal length, used for collecting cosmic static

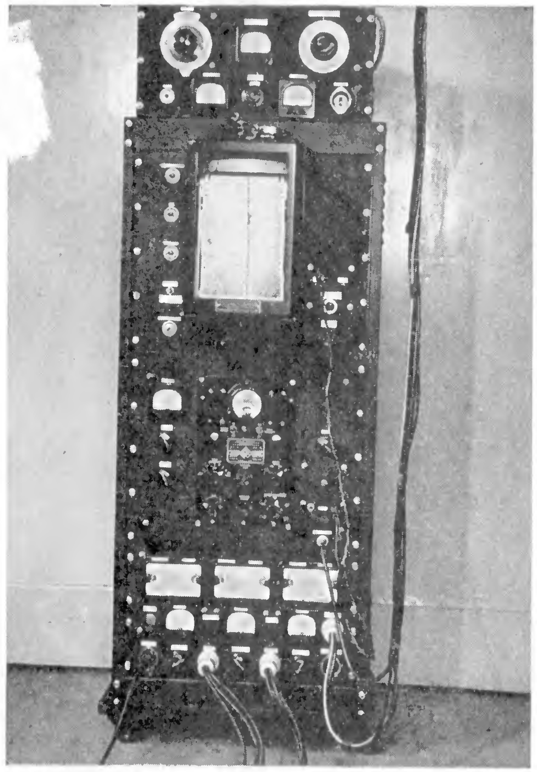


FIG. 2.—Power supply and automatic recorder for cosmic-static investigation

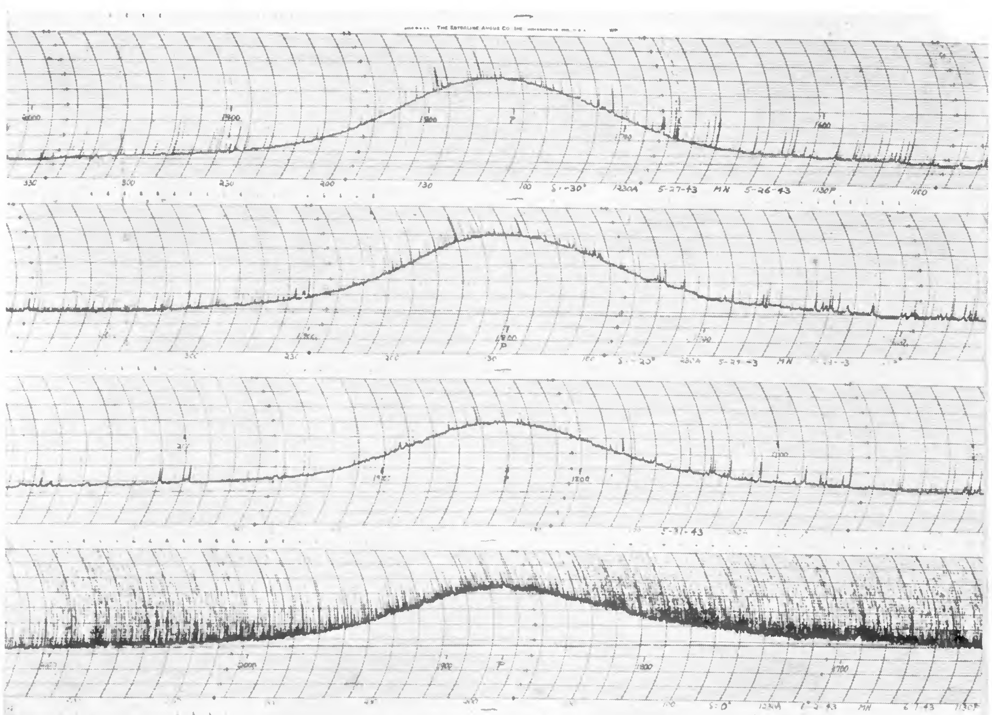


FIG. 3*a*

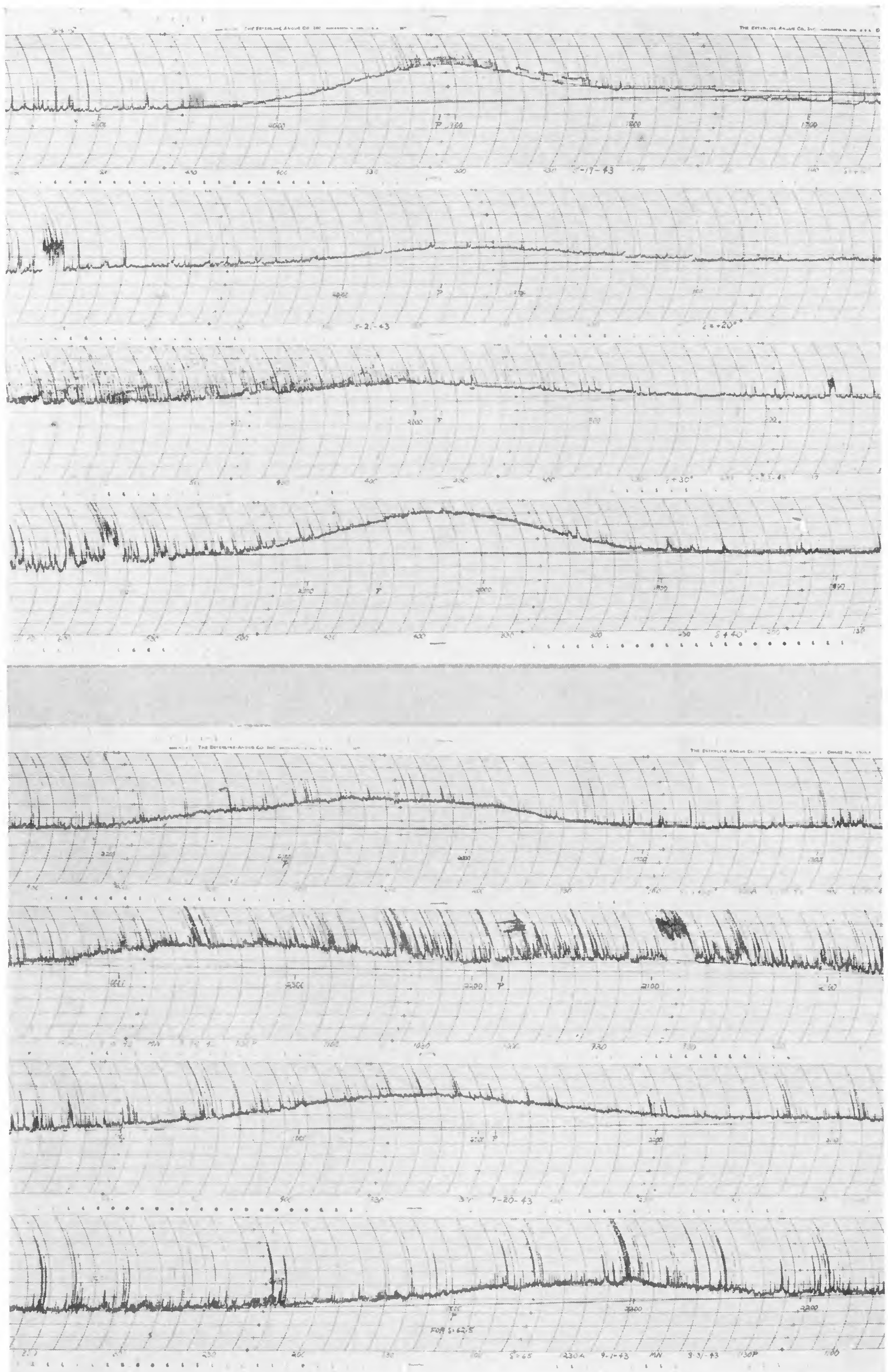


FIG. 3*b*

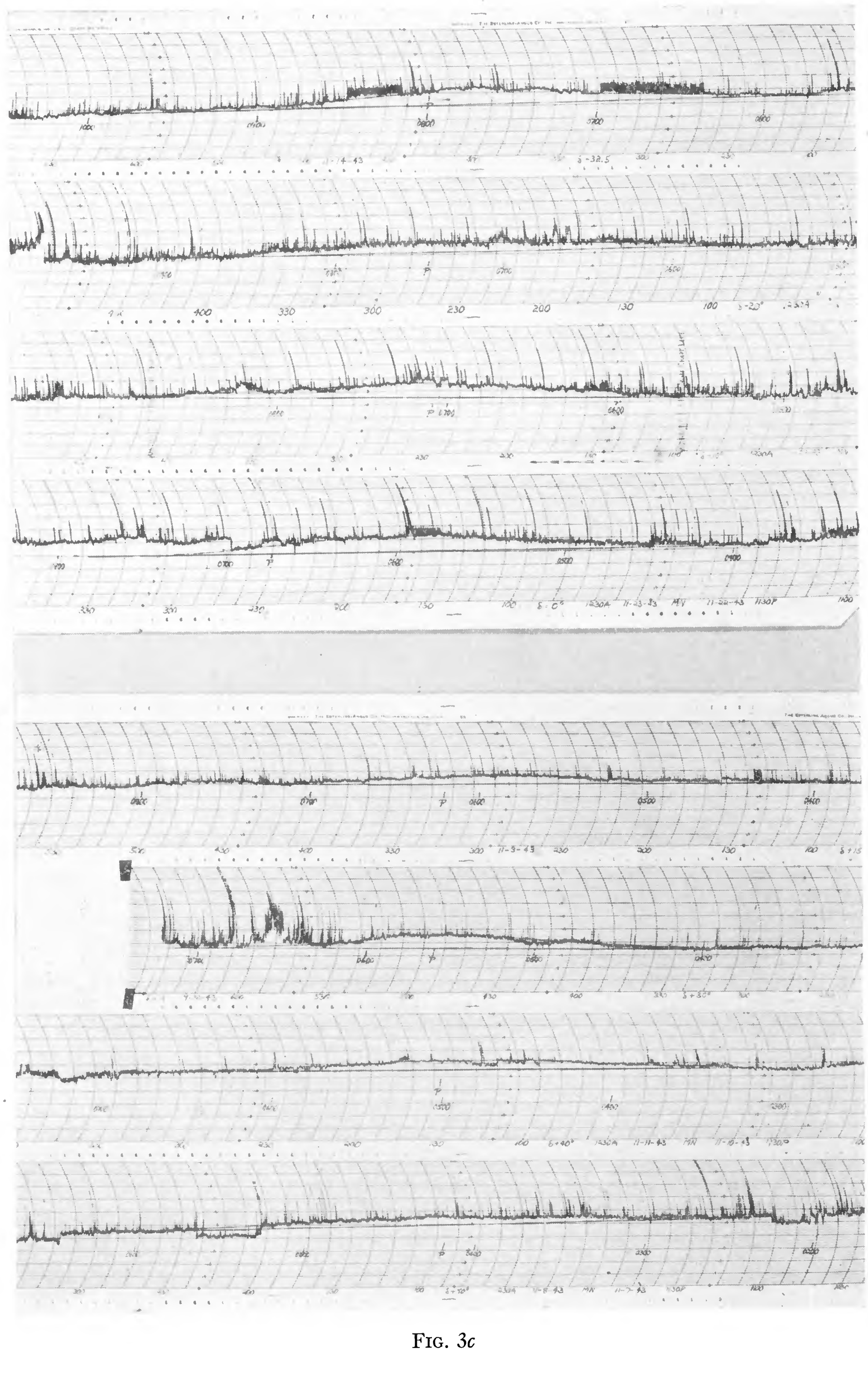


FIG. 3*c*

on scale for the required length of time. On the charts of Figure 3 this slope has been drawn in. The rise of the curved line above the straight one indicates cosmic static, and its magnitude is ΔV_{on}. The small peaked rises are due to the ignition noise from passing automobiles. The sharp spikes are caused by opening and closing of switches. Central Standard time is noted in the margin. Right ascension in hours is marked by short lines on the chart. The plane of the galaxy is indicated by the mark at P.

Referring to a previous paper,[3] the intensity of cosmic static is

$$I = \frac{2U}{E_d E_m A \phi_e \phi_m}, \tag{1}$$

where

$$U = 15.1 \times 10^{-14} \Delta \text{ watts/M.C. band},$$

$$E_d = 1.00 = \text{Drum efficiency},$$

$$E_m = 0.85 = \text{Mirror efficiency},$$

$$A = 7 \times 10^5 \text{ sq. cm.} = \text{Mirror area},$$

$$\phi_e = 8^\circ = \text{Resolving-power in plane of electric vector},$$

$$\phi_m = 6^\circ = \text{Resolving-power in plane of magnetic vector},$$

and

$$\Delta = \frac{\Delta V_{on}}{V_{on}}.$$

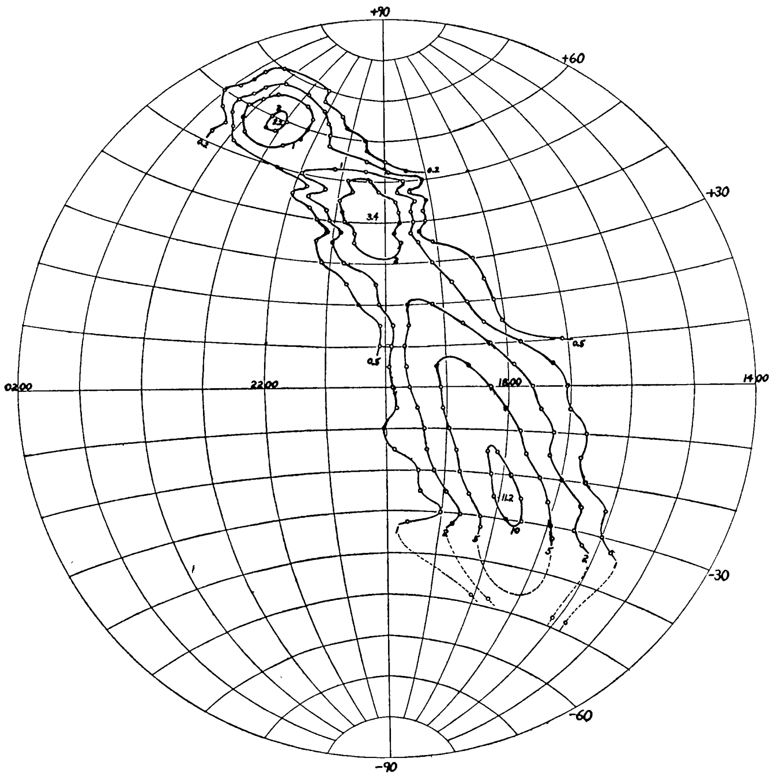
Assembling these values gives

$$I = 10.6 \times 10^{-21} \Delta \text{ watts/sq. cm., cir. deg., M.C. band}. \tag{2}$$

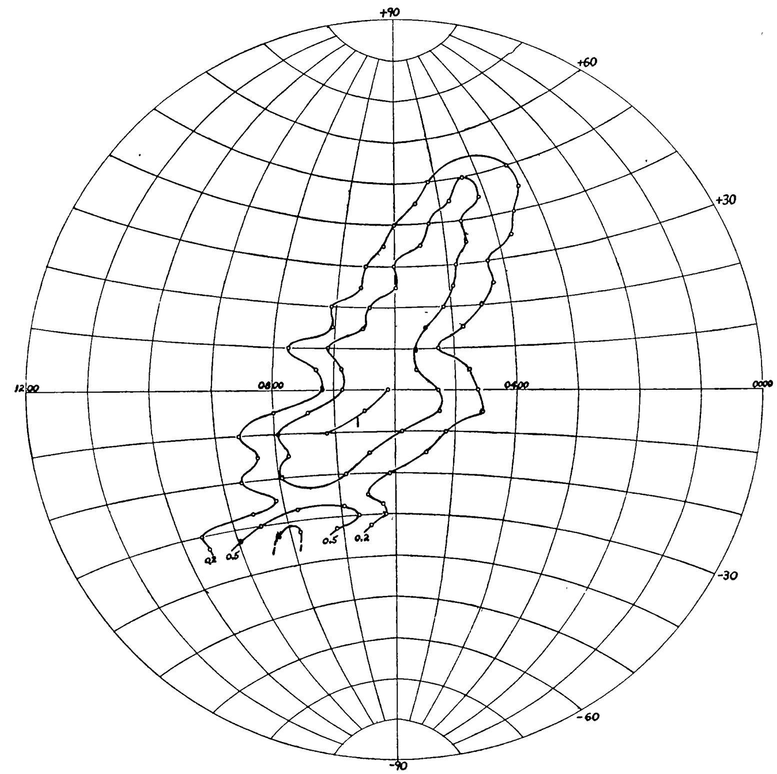
Several charts are taken at each declination under consideration. All charts of like declination are then worked up, the right ascension for a given intensity is determined, and the results are averaged to give mean right ascension for this intensity. About two hundred charts were obtained in 1943. The final results plotted on a flattened globe are shown in Figure 4, *a* and *b*, for the two hemispheres of the sky. The constant-intensity lines are in terms of 10^{-22} watts/sq. cm., cir. deg., M.C. band. The small numbers at the centers of major maxima are the top values in this direction. The points at declination -48° in Figure 4, *a* are beyond the normal range of the collector machine. They were obtained as the result of an accident when the machine was run off the end of the track in a heavy snowstorm. It lodged with the mirror nearly vertical and the drum somewhat out of focus and resting in the service tower. These points show the general trend of the phenomena but are not of a high order of accuracy and, consequently, are connected with dashed lines.

Too little is known about the cause of this phenomenon to read a great deal from Figure 4. However, it is suggested that this disturbance is in some way connected with the amount of material in space. Since the wave length is long (1.87 meters), the absorption caused by dust is small. Therefore, the intensity is roughly indicative of the amount of material between us and the edge of the Milky Way. On this basis the various maxima point to the directions of projections from the Milky Way. These projections may be similar to the arms often photographed in other spiral nebulae. In the case of the Milky Way this general picture would call for the center toward Sagittarius, and arms in the directions of Cygnus, Cassiopeiae, and Canis Major. A minimum occurs in Perseus, indicating that we are nearest the edge of the galaxy in that direction. The maximum in lower Puppis is possibly a general rise toward the center. This region from Puppis to

[3] *Proc. I.R.E.* **30**, 376, eq. (20), 1942.



a



b

FIG. 4.—Constant intensity lines in terms of 10^{-22} watt/sq. cm./cir. deg./M.C. band

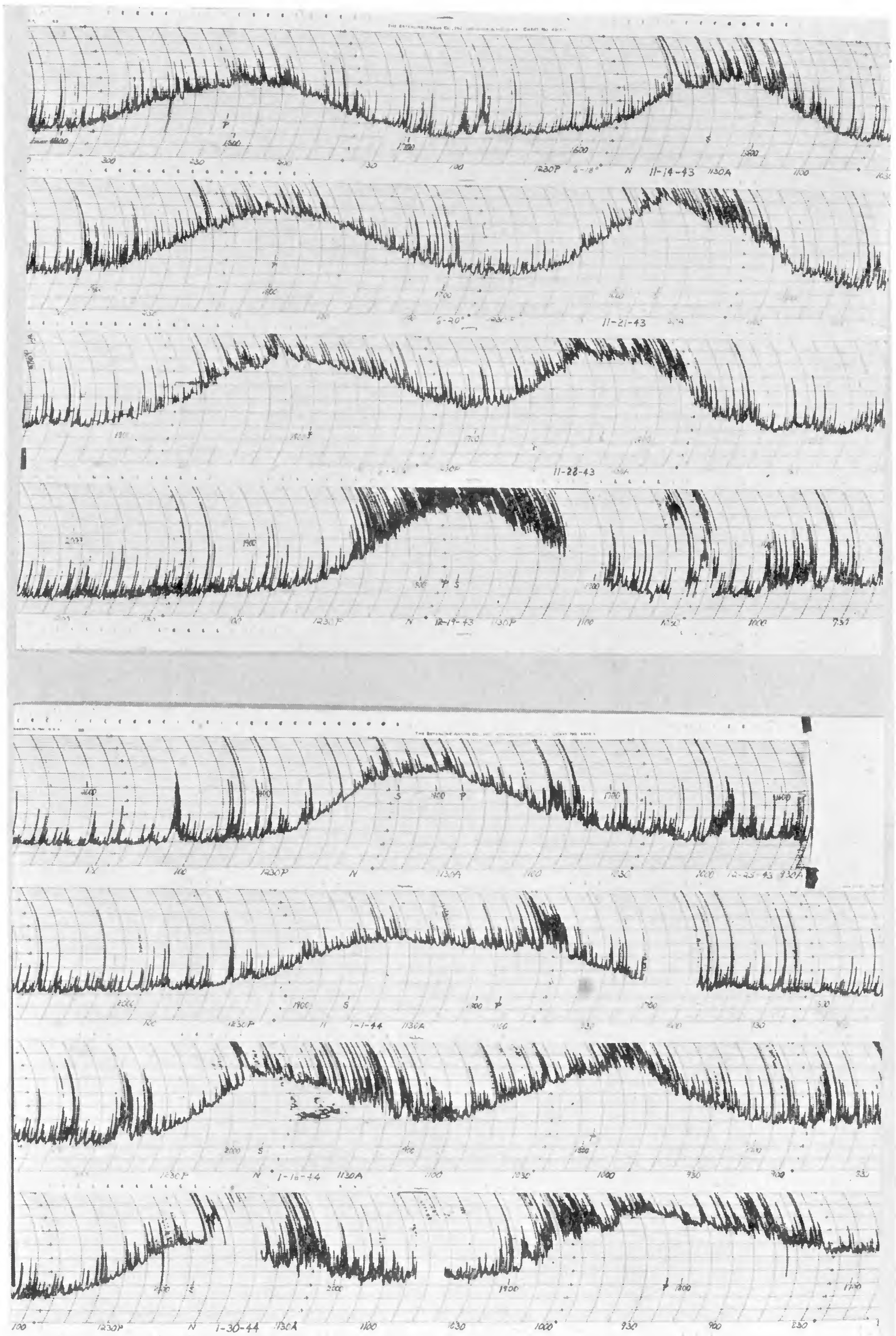


FIG. 5

Scorpius is out of reach at the latitude of Wheaton. However, it is deserving of study, as it may contain other minor maxima.

It has been suggested that this long-wave radiation could be set up in the corona of the sun. Until recently no positive evidence was available. However, the new apparatus was sufficiently stable to allow some data to be taken during the day in spite of severe automobile noise. Figure 5 shows a series of charts taken over several months as the sun passed through the center of the Milky Way. V_{on} is different on the various charts; hence they are not strictly comparable. In any case the sun had the rather surprising center intensity of 10×10^{-22} watts/sq. cm., cir. deg., M.C. band. In spite of the apparent great strength from the sun, this source must be greatly discounted when explaining the origin of cosmic static. If it were the source and the Milky Way were made of average stars like the sun, a very large area in Sagittarius would have a visible intensity equal to that of the sun. Since this is not the case, some other cause must be found to make up the difference of 20 or 30 mag.

A few other objects, such as the moon, the Pleiades, the Orion Nebula, and the spiral in Andromeda have been tested without conclusive results. The last object seems to be at the threshold of sensitivity of the present apparatus, namely, 0.2×10^{-22} watt/sq. cm., cir. deg., M.C. band. Further improved sensitivity will probably pick up a variety of other objects, and an increase in resolving-power will probably show more detail in the galactic structure.