V. V. VITKEVICH, A. D. KUZMIN, A. E. SALOMONOVICH, and V. A. UDALTSOV

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Abstract

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V. V. VITKEVICH, A. D. KUZMIN, A. E. SALOMONOVICH, and V. A. UDALTSOV

RADIO IMAGE OF THE SUN AT A WAVE-LENGTH OF 3.2 cm

(Presented by Academician D. V. Skobeltsyn on 25 IX 1957)

In July 1957, at the Crimean station of the P. N. Lebedev Physical Institute of the Academy of Sciences of the USSR, a new large radio telescope was put into operation ([1]), consisting of a fixed parabolic reflector 31 m in diameter. In constructing the radio telescope, according to the idea of V. V. Vitkevich, provision was made for its possible use in obtaining a radio image of the Sun. For this purpose the reflector was made with a high degree of precision in the form of a bowl excavated in the ground and then concreted and metallized. The geometrical axis of the paraboloid is oriented in the meridian plane at a declination of $+22^{\circ}$, which makes it possible each year in June–July to observe the radio emission of the Sun. The feed systems and receiving heads of the radio telescope are mounted on a special carriage located near the focus of the reflector. The direction of the electrical axis of the radio telescope can be changed within certain limits both in declination and in hour angle by changing the position of the carriage. For scanning the radio-reception pattern in declination during observations of a transit source, provision is made for automatic reciprocating motion of the carriage in a plane perpendicular to the axis of the reflector in the north–south direction.

In July 1957, work was undertaken with the aim of studying the two-dimensional distribution of the intensity of radio emission over the disk of the Sun at wavelengths of 3.2 and 10 cm. The work used modulation radiometers developed by A. E. Salomonovich and A. D. Kuzmin*. The modulation of the input signal, entering the radiometers through horn feeds arranged near the focal plane, was carried out with the aid of ferrites in circular waveguides. The radiometers were calibrated by the radiation of a black body (at the wavelength 3.2 cm) and by a gas-discharge noise generator (at the wavelength 10 cm). Recording was carried out on EPP-09 self-recording instruments and on a loop oscillograph with a time constant of about 0.2 sec.

The observations were carried out as follows. During the culmination of the Sun, the pattern of the radio telescope was scanned in declination within the limits of $\pm 32'$ by means of automatic reciprocating motion of the carriage with the feeds in the north–south direction. The mean position about which the scanning

Fig. 1. Radio isophotes of the Sun at wavelengths of 3.2 and 10 cm. Temperatures are indicated in 10^3 K. The visible disk of the Sun is shown by a dashed line, groups of optical spots by hatching. In the lower part of the figure, the radio isophotes at the wavelength of 3.2 cm corresponding to regions of enhanced radio brightness are shown by a thin dashed line.

Figure 1: Fig. 1. Radio isophotes of the Sun at wavelengths of 3.2 and 10 cm. Temperatures are indicated in 10^3 K. The visible disk of the Sun is shown by a dashed line, groups of optical spots by hatching. In the lower part of the figure, the radio isophotes at the wavelength of 3.2 cm corresponding to regions of enhanced radio brightness are shown by a thin dashed line.

was performed was set so that the mean declination of the axis of the pattern coincided with the declination of the Sun at the moment of its culmination. During the time required for the carriage to move from one extreme position to the other (7.5 sec), the Sun, owing to its diurnal motion, was displaced in hour angle by a certain angle (equal to $1'.7$). This ensured the recording of curves of the distribution of radio-emission intensity over the disk of the Sun along a series of successive strips in directions close to the north–south direction. These curves represent successive sections of the surface of the two-dimensional distri-

* N. A. Amenitskii, M. T. Levchenko, and L. I. Matveenko took part in preparing the apparatus for the observations.

cross-sections of radio brightness over the disk of the Sun, made along a zigzag line whose midpoints are separated from one another by angular distances equal to $1'.7$. The set of these curves, recorded during the entire time of the Sun’ s passage through culmination, makes it possible to construct a two-dimensional picture of the radio-brightness distribution. The small beam width at the wavelength of 3.2 cm ($6'$ at the 0.5 level) makes it possible to obtain a very detailed picture of the distribution—the radio image of the Sun. At the wavelength of 10 cm, because of the greater beam width ($15'$ at the 0.5 level), a rather crude picture of the distribution is obtained.

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When recording the radio emission of the Sun at wavelengths of 3.2 and 10 cm, the Sun gradually enters the receiving antenna pattern in such a way that the axis of the scanning pattern first touches and then crosses the solar disk along chords close to the edge of the disk. Then regions close to the center of the disk enter the pattern; gradually the Sun leaves the pattern.

In the course of the Sun’ s passage, the diagram crosses individual regions of enhanced radio brightness, which appears in the recording as sharp bursts. In all, 13 records were obtained at the wavelength of 3.2 cm (from 13 to 25 VII) and 9 at the wavelength of 10 cm (from 17 to 25 VII). On the basis of these records, maps of the two-dimensional distribution of radio brightness over the solar disk can be constructed.

Figure 1 shows radio isophotes for 3.2 and 10 cm, obtained from the records of 18 and 20 VII and not corrected for the smearing effect caused by the finite width of the radio receiver beam. The same figure also shows the contours of the visible disk of the Sun and the groups of spots according to data from the Mountain Astronomical Station of the GAO.

As can be seen from the figure, at the wavelength of 3.2 cm there are regions of enhanced radio brightness that are very nonuniformly distributed over the disk. The positions of these regions closely coincide with the positions of the groups of optical spots observed on these days. The radio isophotes at the wavelength of 10 cm indicate the presence of active regions whose positions, apparently, are close to the positions of the groups of optical spots and of the regions of enhanced radio brightness at the wavelength of 3.2 cm. A similar picture is observed on other days as well. A comparison of the radio isophotes obtained on 18 and 20 VII reveals a displacement of the group of spots of enhanced radio brightness corresponding to the rotation of the Sun about its axis.

At present, the processing of the material obtained and its comparison with optical data are under way.

Physical Institute named after P. N. Lebedev
Academy of Sciences of the USSR

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Note: Figure translations are in progress. See original paper for figures.