

Soviet-era science, translated into English

**N. L. KAIDANOVSKY,
D. V. KOROLKOV, N. S.
SOBOLEVA, and S. E.
KHAIKIN**

1957

SovietRxiv

View the original and related papers at <https://sovietrxiv.org/items/ru-195701.30283>

Source: Math-Net.Ru and CyberLeninka. Machine translation. Verify with the original.

Fig. 1. Diagram of the high-frequency path of the radiometer: 1 – counter-reflector, 2 – grid symmetrizing the pattern in the E- and H-planes, 3 – open end of a circular waveguide, 4 – reflector, 5 – variable sections (empty, with an absorbing plate, and with a $\lambda/4$ plate), 6 – motor-modulator with a $\lambda/2$ plate, 7 – ferrite isolator, 8 – transition to a rectangular waveguide, 9 – mixer and heterodyne, 10 – microwave amplifier, detector, low-frequency amplifier, and synchronous detector, 11 – recording instrument

Figure 1: Fig. 1. Diagram of the high-frequency path of the radiometer: 1 – counter-reflector, 2 – grid symmetrizing the pattern in the E- and H-planes, 3 – open end of a circular waveguide, 4 – reflector, 5 – variable sections (empty, with an absorbing plate, and with a $\lambda/4$ plate), 6 – motor-modulator with a $\lambda/2$ plate, 7 – ferrite isolator, 8 – transition to a rectangular waveguide, 9 – mixer and heterodyne, 10 – microwave amplifier, detector, low-frequency amplifier, and synchronous detector, 11 – recording instrument

Abstract

Full Text

ASTRONOMY

N. L. KAIDANOVSKY, D. V. KOROLKOV, N. S. SOBOLEVA, and S. E. KHAIKIN

OBSERVATIONS OF THE POLARIZATION OF RADIO EMISSION FROM SUNSPOTS AT A WAVELENGTH OF 3.2 cm

(Presented by Academician M. A. Leontovich, 13 IX 1956)

The study of the polarization of radio emission from sunspots in the centimeter range is of considerable interest, since it makes it possible substantially to broaden our knowledge of the magnetic fields of spots, and also to clarify the mechanism of their emission. All published works on the polarization of solar radio emission relate to the meter and decimeter ranges, with the exception of Covington' s work at a wavelength of 10.7 cm ($\{1,2\}$). However, the result of Covington' s work ($\{1\}$), in which polarization of the radio emission of a spot was observed, is unreliable owing to the low sensitivity of the method: the apparatus used made it possible to detect polarization amounting to not less than 2% of the total radiation intensity.

Fig. 1. Diagram of the high-frequency path of the radiometer: **1** – counter-reflector, **2** – grid symmetrizing the pattern in the (E)- and (H)-planes, **3** – open end of a circular waveguide, **4** – reflector, **5** – interchangeable sections (empty, with an absorbing plate, and with a ($\lambda/4$) plate), **6** – motor-modulator

with a $(\lambda/2)$ plate, **7** –ferrite isolator, **8** –transition to a rectangular waveguide, **9** –mixer and heterodyne, **10** –microwave amplifier, detector, low-frequency amplifier, and synchronous detector, **11** –recording instrument.

The results of observations given below were obtained in the period from 17 VII to 4 IX 1956 at the Main Astronomical Observatory with the aid of a polarization radiometer developed at the Physical Institute of the Academy of Sciences of the USSR ($(\hat{\sim}\{3\})$), the block diagram of which is illustrated in Fig. 1.

Thanks to a certain modernization of the polarization radiometer (the use of a symmetrical feed with an adjustable pattern and a ferrite isolator), the reliably measurable value of polarization was brought to 0.1% of the total radiation intensity. The principal data of the radiometer are as follows: 1) maximum sensitivity in antenna temperature ($T_a = 3^{\wedge}\{ \}$) K at a time constant ($= 2$) sec.; 2) noise factor 12; 3) bandwidth of the microwave amplifier 16 MHz; 4) half-power beamwidth of the antenna pattern $35'$; 5) wavelength 3.2 cm; 6) diameter of the radio-telescope mirror 4 m. Fig. 2 shows the course of the observed circular polarization and the synoptic map of the Sun, making it possible to compare the observed polarization with sunspots.

On 17 and 18 VII no polarization was observed; from the map it is evident that there were only several very small groups of spots on the Sun. The observations were then interrupted and resumed on 28 VII, when a large group of spots, marked on the map with index 1, was located on the Sun close to the central meridian. On that and the following days circular polarization (left-handed, relative to the direction of propagation) was recorded, gradually–

gradually decreasing as the group moved away from the central meridian. When the group had moved to a distance of $(45)–(50^{\wedge}\{ \})$ from the meridian, the intensity of the polarized emission fell to zero.

Fig. 2. Graph of the variation in circular polarization of the solar radio emission and synoptic chart of the Sun according to data from the Kislovodsk mountain astronomical station for the period from VII 17 to IX 1, 1956. The circles indicate large sunspot groups, numbered according to the daily bulletins. The numbers of groups according to the Kislovodsk data are: 1–246, 2–261, 3–271, 4–280, 5–275. Continuous curves: the measured polarization at the center of the solar disk; in percent of the total intensity of the solar emission. Dotted curves: the maximum observed left- and right-polarization in the case of two or more emitting objects on the solar disk.

Beginning on August 1 there began an increase and then a decline of the right-polarized component; at the same time a group of spots with index 2 was passing across the solar disk. After this group had likewise moved $(45)–(50^{\wedge}\{ \})$ away from the meridian, over the course of several

days before 15 VIII the polarization was not observed or amounted to a very small value.

Fig. 3

Figure 2: Fig. 3

The rapid increase in polarization between 14 and 15 VIII coincided with the transformation of group 3 into a bipolar group from a multicentered one and with the “rise” of group 4. It is not yet possible to say definitely which of them was responsible for the jump, but from subsequent observations it became clear that group 4 emits the right-polarized component.

Fig. 3. Curves of horizontal and vertical transits of the Sun through the antenna pattern. Along the abscissa is plotted the distance of the axis of the pattern from the center of the Sun in minutes of arc; along the ordinate, the antenna temperature in degrees. The spots on the disk are plotted as they were visible in the optical guide of the radio telescope.

It was interesting to observe the reappearance of group 1, the only one of those observed that emitted a left-polarized component. Its appearance begins to be noticeable on 18 VIII from the curves of the Sun’s transit through the antenna pattern. During this period, measurement of the magnitude of the polarized component at the center of the solar disk proved insufficient, since the left and right polarizations of spots 1, 3, and 4 partly, and on some days completely, compensated one another.

Figures 3 and 4 present several characteristic transit curves, from which the appearance of spot 1 can be traced. From these curves (especially from Fig. 4) it is seen that, although the width of the antenna pattern is comparable with the angular dimensions of the Sun, the transit curves make it possible to localize the source of radiation with an accuracy of up to several minutes.

From the data presented, the following conclusions may be drawn:

- 1) radio emission at a wavelength of 3.2 cm, originating from the regions of certain groups of spots, is to a large extent circularly polarized;
- 2) the maximum observed intensity of the circularly polarized component reached 2.5% of the total radiation intensity, or 300 °K in antenna temperature;
- 3) the upper limit of the effective temperature in the region of emission amounts to about 500,000 °K, if the angular size of the emitting region is conventionally taken to be of the order of 1 square minute;
- 4) groups 2 and 4 of the northern hemisphere emitted a right-hand polarized component, and group 1 of the southern hemisphere a left-hand polarized component*. Groups 1 and 2 were observed repeatedly. Whether groups 3 and 5 emitted remained unclear;

Fig. 4

Figure 3: Fig. 4

- 5) the width of the directional pattern of the radiation from the spots is about $\pm 30^\circ$ at half power and approximately $\pm 50^\circ$ at zero.

Simultaneously with circular polarization, linear polarization was observed, but its magnitude did not exceed 0.5% of the total radiation, and it was not possible to relate it to the results of the observations of circular polarization and to visible changes on the Sun.

The data presented undoubtedly indicate the presence of circular polarization in the radio emission at a wavelength of 3 cm originating from regions of sunspots.

For a detailed study of the detected effect, further accumulation of material and an increase in the resolving power of the instrument are required; therefore work has now begun on setting up polarization observations with an instrument having a resolving power of 1-2'.

Fig. 4. Recording of the circularly polarized signal as the Sun passed through the antenna pattern on 1 IX. Along the abscissa is plotted the distance of the axis of the pattern from the center of the Sun in minutes of arc; along the ordinate—the antenna temperature in degrees. The center of emission, determined from the curves of passage, is marked on the disk with a cross. The spots on the disk are plotted as they were seen in the optical guide of the radio telescope; *a*—horizontal passage at 11 30 ; *b*—vertical passage at 11 30 ; *v*—vertical passage at 17 30 ; *g*—horizontal passage at 17 30 .

The authors express their gratitude to Yu. N. Pariiskii, A. B. Berlin, and V. N. Ikhsanova for assistance in the work.

Main Astronomical Observatory
of the Academy of Sciences of the USSR
Pulkovo

Received
13 IX 1956

CITED LITERATURE

1. A. E. Covington, Proc. Inst. Rad. Eng., **36**, 454 (1948).
2. A. E. Covington, J. Canad. Roy. Astron. Soc., **45**, 157 (1941).
3. Transactions of the 5th Conference on Problems of Cosmogony, Publishing House of the Academy of Sciences of the USSR, 1956.

* On 6-9 IX, one more group was observed in the southern hemisphere, emitting

a left-hand polarized component of very high intensity (about 700 °K in antenna temperature).

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

Source: Math-Net.Ru and CyberLeninka. Machine translation. Verify with the original.