PAPER 50

ON THE POLARIZATION OF SOLAR RADIO EMISSION AT 1.5-M WAVELENGTH

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1. Solar radio emission is usually characterized only by the intensity, i.e. by a single value at a given frequency.

In polarization measurements the radio emission is characterized by four values (for example, by the unpolarized-component intensity and three components of the polarization ellipse).

Here we see that observations of solar radio emission with a polarimeter give us considerably more extensive information than the usual observations give. It is a very important fact that the polarization of the radio emission is determined by the strength and direction of the magnetic field of emitting regions. Thus, we connect the polarized radio emission with a magnetic field that is noticeably higher than the field in the region which we can study by optical methods.

It should also be noticed that one of the most interesting unsolved problems is establishing the nature of the disturbed solar radio emission. It is clear that new information on the polarization of radio emission will contribute to the solution of this problem; but in spite of its importance and urgency, investigations to solve it are being carried on only in a small number of observatories. The observations in Australia and the work in Japan may be mentioned.

2. With the aim of continuing this work at the Crimean scientific station of the Physical Institute of the Academy of Sciences of the U.S.S.R. suitable apparatus was developed (Fig. 1).

Two antennas mounted on one rotating device receive the signal. The first antenna consists of 96 half-wave horizontal dipoles with a reflector. The second one, receiving the vertical component, consists of 20 antennas of Uda-Yagi type and the same reflector. The receiver is a compensation type without modulation.

Five different records are made simultaneously: the vertical component of the signal, the horizontal component, and three signals obtained as a result of composition with different phase displacements: left polarization ($\varphi = 90°$), linear component inclined at 45° to the horizontal component ($\varphi = 0$), right polarization ($\varphi = -90°$). The sensitivity of the receiver is 15°K, the bandwidth is 150 kc/s, the time constant is usually 0.5 seconds. The band of the system is determined by the output of the intermediate-frequency device. The total band of all the previous cascades is about 2 Mc/s.

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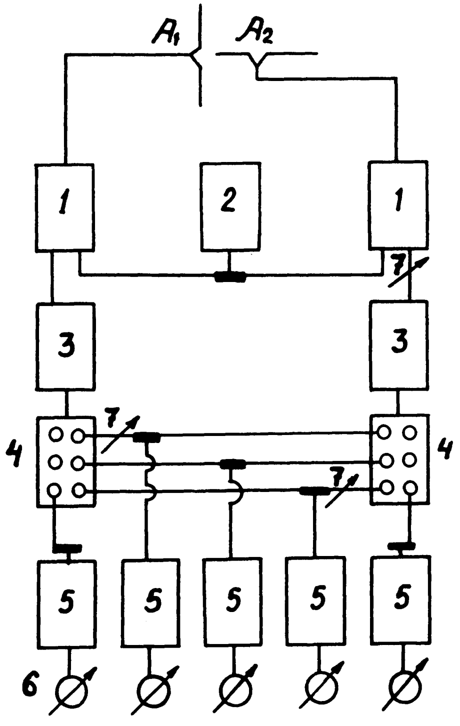

FIG. 1. A_1, A_2—antennas: (1) high frequency amplifiers; (2) heterodyne; (3) intermediate-frequency amplifiers; (4) decoupling cascades; (5) output of the intermediate-frequency amplifiers, detectors, compensators; (6) registering equipment; (7) phasing elements.

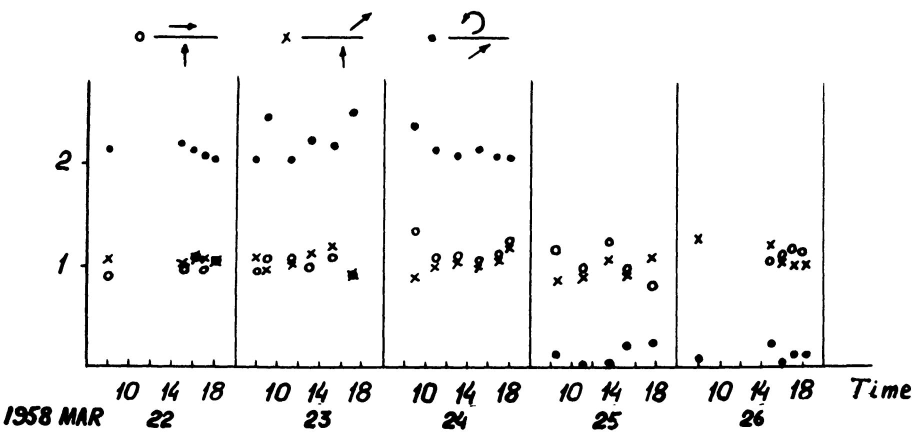

FIG. 2. The change of signal ratio of various channels (the change of the degree of polarization) with time. O = horizontal/vertical, × = linear at 45°/vertical, • = left circular/linear at 45°.

Observations of solar emission have been carried on from 1957 August with an antenna following the sun, and with a sea interferometer. The antenna is situated on the shore of the Black Sea, at a height of 284 meters, which corresponds to a lobe width of 8′.8.

3. The first conclusion that can be drawn from the observations relates

to the change of the degree of polarization of separate bursts (pips) in time.

To determine the degree of pip polarization during a day and from day to day, the ratio of signals on different channels of the polarimeter was calculated and plotted (Fig. 2). The ratios on the curve are reduced so that the first one corresponds to the equality of the signal intensities affecting the channels. The degree of signal polarization does not depend on the total intensity of the signal, but is determined by the degree of polarization and the portion of the polarized part of the total signal intensity. Each point of the curve is obtained by averaging 8 to 10 pips during a period of approximately 10 minutes. Pips having only randomly polarized components (for

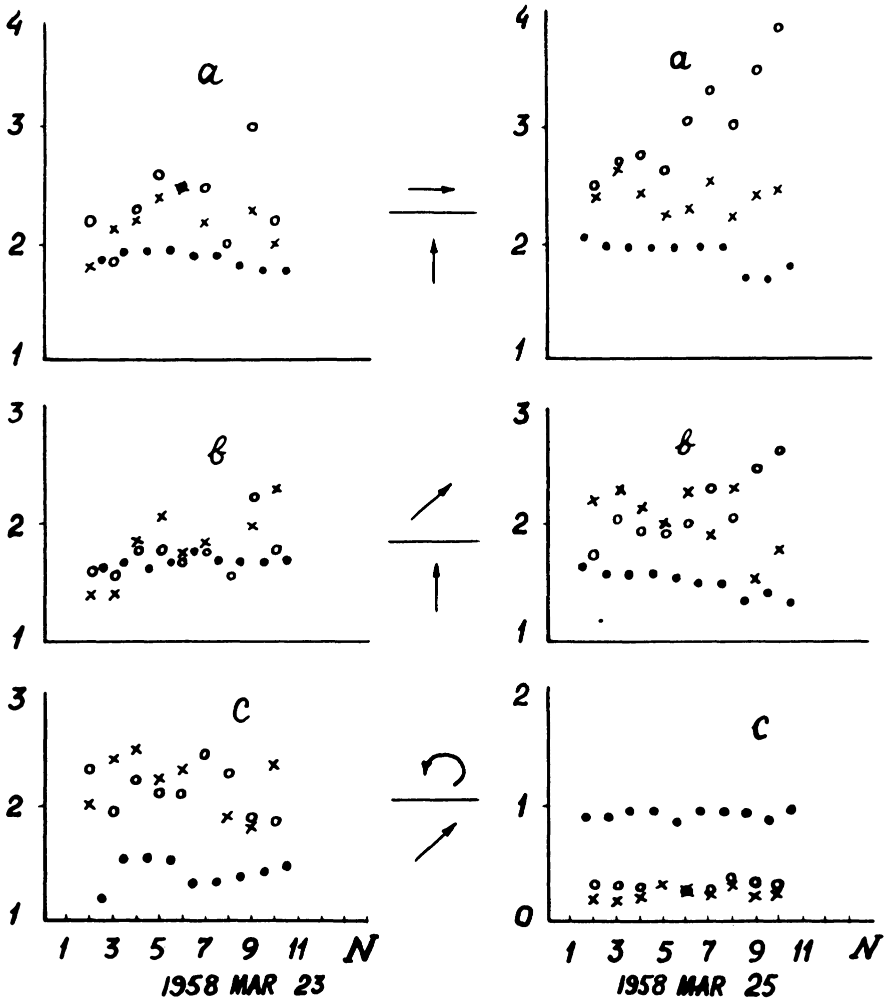

FIG. 3. The comparison of the polarization of bright regions and pips: (*a*) horizontal/vertical; (*b*) linear at 45°/vertical; (*c*) left circular/linear at 45°; ○ = bright regions, × = pips, ● = background, *N* = lobes of interference pattern in order.

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these pips all ratios are on the level of 1), which occur occasionally, were not averaged.

On the basis of the study the following conclusions can be drawn:

(*a*) The degree of polarization of pips usually does not change for a long period of time (for some days).

(*b*) The polarization of pips is nearly circular (or in some cases random).

(*c*) The degree of polarization of consecutive pips is not precisely the same but shows a dispersion exceeding the instrumental errors and the calculation errors.

(*d*) The sense of polarization usually changes rather quickly during less than 12 hours.

(*e*) Observations with the sea interferometer permitted measurement of polarization of the separate bright regions (excluding the background of the solar radio emission) and of the pips. Fig. 3 shows a comparison of polarization. It follows that the polarization of the bright regions is near the polarization of the pips. This gives ground for concluding that the levels (the height above the photosphere) of pips and bright regions are the same.