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SPATIO-TEMPORAL FEATURES OF THE DEVELOPMENT OF MICROWAVE EMISSION OF ACTIVE REGIONS AND FLARES

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At SibIZMIR, a stepwise commissioning of the Siberian Solar Radio Telescope is being under way (Smolkov, 1982a; Smolkov et al., 1983a). This special-purpose instrument is designed to: 1) survey and monitor during daylight hours the state of solar activity (SA) with high two-dimensional resolution on a real time basis in a wave band permitting maximum possible detectability of active regions (AR's) and flares (F's); 2) study structures and development of AR's by day and the time of their observation on the solar disk; 3) study F's; 4) study the three-dimensional pattern of development of AR's and F's jointly with the Sayan Mountain and Baikal Astrophysical Observatories of SibIZMIR (Smolkov, 1982b), and 5) to make a synoptic study of SA during one or several solar rotations in the interests of solving challenging problems of Solar Physics and STP.

The SSRT operational wavelength is about 5.2 cm. The spatial resolving power has been chosen based on typical sizes of inhomogeneities of local sources (LS) of radio emission of AR's, as determined from eclipse observations (Gel'freikh, 1969; Smolkov et al., 1982), and to permit monitoring the state of SA, with simultaneous discrimination of salient features of AR's and F's. It is chosen to be 20"x20" at zenith during summer solstice.

The SSRT antenna system is a 256-element cross interferometer, consisting of two 128-element linear equidistant arrays pointing to the four cardinal points. Each array is of $1.2\ 10^4\lambda$ length. The mirrors are of 2.5 m diameter, spaced 94λ apart, as determined by the solar radio diameter. All the mirrors are in synchronism to track the Sun from sunrise to sunset, thus enabling the use of interference maxima of the multilobed beam of the cross, oriented within direction diagram (DD) of a single element.

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Parallel synthesis of solar radio images is accomplished by using a 180-channel receiving system via a parallel-series composition of signals from the antennas, providing an equality of electrical lengths of waveguide lines and making it possible to use a frequency band, appropriate for solar coverage with a fun of lobes (vertical scanning), and owing to corotation of the DD with the Earth. During the daytime it is possible to record hundreds of distributions of circular polarization and intensity in AR's and hence to carefully investigate their development. It is also possible to study the development of flares, whose lifetimes exceed the time required for the Sun to transit the DD interference maxima. The dynamic range is 10^4 and the time constants are 1.4, 0.6 and 0.2 s.

Even one-dimensional radio brightness distributions obtained during phase adjustment of the operating model, an 8-element interferometer, and a stepwise commissioning of the W-beam (the resolution thus increasing from 4'.5 to 34") enabled us to refine some of our earlier understanding and to gain new insights into spatio-temporal features of development of microwave emission from AR's and F's (Smolkov et al., 1983b,c). Thus, the LS intensity may temporarily and substantially either decrease (burst in "absorption") or increase without or with reverting without any notable polarization changes, seemingly reflecting changes in physical conditions higher in AR's. Once a sunspot group is born in an AR and starts to develop, a polarized emission comes from it within half an hour, which corresponds to a thickness of the transition zone of 1000 km, with a constant rise velocity of the magnetic field with height. The LS polarization is reversed due to a change in conditions of either propagation or generation of the emission. In the former case the inversion proceeds stepwise in course of several hours with nearly the same LS intensity (even if there are gross changes in sunspot area) against fluctuations of the degree of polarization. The latter type of inversion applies to significant, simultaneous changes in LS intensity and area of related spots for the same time.

Spatial development of F's in AR's becomes traceable once LS features get separated above leading and following parts of a sunspot group. Flares, evolving above the interspot zone (at the tops of a loop-like configuration of the magnetic field), are manifest in the microwave emission either only above one of the parts or sequentially above different parts or, finally, above the entire spot group. The LS emission intensity first decreases above the part of a spot group, producing a flare thereafter. The degree of polarization temporarily intensifies, with a possible reversal of polarization.

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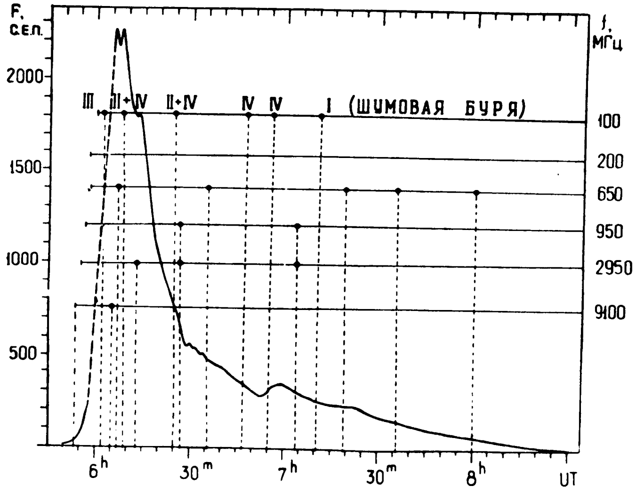

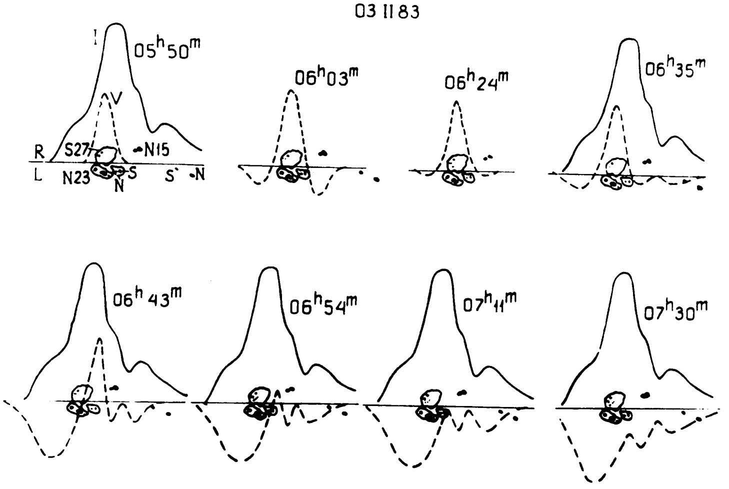

Fig. 1. Development of the burst on 3.02.83.

a) Development of the burst of an integrated solar flux at 5.2 cm wavelength and a schematic for its recordings at other wavelengths: the onset and maxima are labeled by vertical marks and full circles respectively and the bursts in metric wave band are denoted by their indices.

b) The variation of structure and sign of the LS circular polarization (34" resolution). A solid line shows the initial intensity distribution.

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Prior to a flare, above a composite complex of activity at solar disk center, on 3.02.83, for example, a polarized emission from an LS was recorded above the greatest spots (Figure 1). Before the burst maximum, together with a slight increase of polarized flux of this spot component of the LS, oppositely-polarized features appeared on both sides of it. The west source is associated with individual spots of N-polarity but there is no photospheric cause of the east one. After some decrease from 06.35 the polarization was increasing intensively in these new features of the LS. The parent right hand polarized source is "devored" and the size as well as the degree of polarization of the east feature of the LS increase. The change of the structure and polarization sign of the LS is completed at 07.11. From that time onward there occurred three LS features, with a polarization sense opposite the original one. They corresponded to three anticipated loop-like configurations of the magnetic field of the activity complex. Restructuring and reversal of the polarization of the LS were provoked by the flare. A change of sign of the LS polarization due to central heliographic meridian passage by the spot group was observed from 4 to 5.02.83.

The burst activity correlation between the mutually separated LS's is most pronounced in a polarized flux. Both prior to and following the explosive phase of F's the intensity and degree of polarization of the bursts undergo simultaneous fluctuations with an increasing period.

References

Gel'freikh, G.B.: 1969, Vestnik AN SSSR, 4, p.46.

Smolkov, G.Ya.: 1982a, In: "Radio astronomical equipment, antennas and methods", Yerevan, p.230.

Smolkov, G.Ya.: 1982b, In: "Sun and Planetary Systems", W. Fricke and G.Teleki (eds.), D.Reidel Publ. Co., Dordrecht, p.123.

Smolkov, G.Ya., Dutov, A.S., Zandanov, V.G., et al.: 1977, In: "Issled. po geomagn. aeron. i fiz. Solntsa", Moscow, Nauka, 42, p.76; 1982, 62, p.181.

Smolkov, G.Ya., Treskov, T.A., Krissinel, G.B., and Potapov, N.N.: 1983a, In"Issled. po geomgn. aeron. i fiz. Solntsa" Moscow, Nauka, 64, p.130.

Smolkov, G.Ya., Treskov, T.A., and Nefedyev, V.P.: 1983b, In: Problems of solar activity, Alma-Ata, p.70.

Smolkov, G.Ya., Treskov, T.A., and Potapov, N.N.: 1983c, In: "Issled. po geomagn. aeron. i fiz. Solntsa, Moscow, Nauka, 65, p.204.

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