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Some results of solar radio emission observations at the Siberian Solar Radio Telescope

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This paper gives the main characteristics of the Siberian Solar Radio Telescope as well as some results derived by investigating the *S*-component sources and radio bursts on the Sun using the SSRT.

Es werden die Hauptcharakteristika des Sibirischen Solaren Radioteleskops sowie eine Reihe der durch eine Untersuchung der *S*-Komponentenquellen und Radiobursts auf der Sonne mit seiner Hilfe gewonnenen Ergebnisse präsentiert.

Key words: Sun — solar radio telescope — bursts — observations

AAA subject classification: 072; 077

1. The SSRT: main characteristics

The Siberian Solar Radio Telescope (SSRT) operating in the routine observation mode is a powerful tool for studying active processes throughout the solar disk during several hours daily with a time resolution of about 2.5 minutes and a spatial resolution of up to 17″. The observing interval is from 23 to 11 UT and from 02 to 08 UT during the summer and winter months, respectively. The flux sensitivity is sufficient to measure radio flux variations of the *S*-component sources of order 0.1 SFU. Special purpose observing modes make it possible to carry out observations with a significant higher time resolution of up to tens of milliseconds.

Owing to such parameters, the SSRT has filled up the gaps in the study of *S*-component sources as well as of radio bursts, and provided further insights into the development of active processes on the Sun.

In this report we will present some results obtained with the aid of the SSRT.

2. Evolutionary features of *S*-component sources during an early evolutionary stage of active regions

An example illustrating this typical feature is given in Fig. 1, showing a curve which represents the variation in the radio flux as well as an evolving sunspot group (AR 4520, 22 June, 1984). It is evident when the following sunspot is evolving (from 05:41 to 09:24 UT it increased in its area more than three times, from 30 to $100 \cdot 10^{-6}$ Hemi), the radio flux increases not monotonically. Rather rapid increases in the flux alternate with relatively longer time intervals when the radio flux remains unchanged. Thus, the increase in the radio flux has a character of "steps". The "steps" are 10—30 minutes in duration and their amplitude is 0.5 SFU.

The above example is characteristic for the evolution of many active regions (AR). This permits us to argue that coronal heating — as the AR (its magnetic field) is evolving — has a "step-like" character.

3. On some properties of development of the spatial structure of radio bursts

Based on observational data of many years we have identified some interesting features in the development of radio bursts. Here, for illustrative purposes, we shall present observational data of one of the bursts. The burst was associated with a chromospheric flare of importance 2F observed on 23 August, 1988.

Fig. 2 b gives one-dimensional scans of radio brightness distribution for several moments of time. The first scan (08:18 UT) shows the radio brightness distribution before the flare. Source (A) is identified with a sunspot, and source (B) is associated with a plage. The subsequent scans give an idea of the spatial development of the burst generation region.

A most interesting feature in the development of this burst is the behaviour of the sunspot source ("A" in Fig. 3). As the burst is evolving, there is a decrease in size of the sunspot source until it disappears completely (see scan 08:37 UT), to recur again afterwards. The flux variation of this source is shown in Fig. 3 (see curve A). Interestingly, this source rather rapidly reaches a maximum and, subsequently, its flux remains almost unchanged, although the flux of flare sources continues to increase (see curves 1, 2, and 3 in Fig. 3).

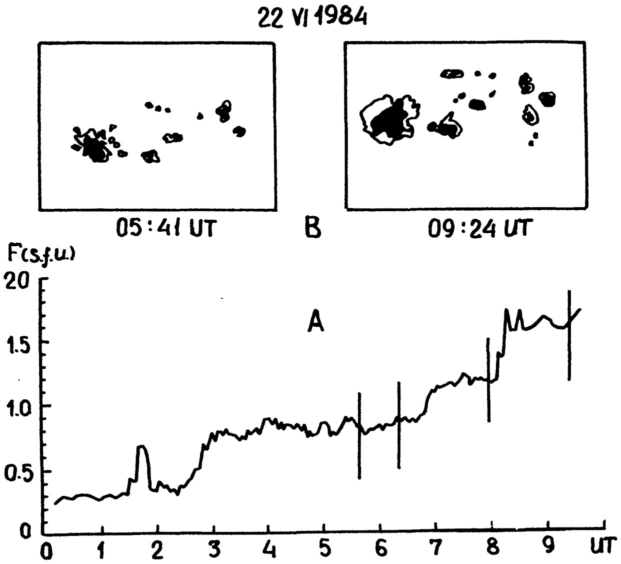

Fig. 1. The increase in radio flux of the *S*-component source (A) with increasing sunspot area (B) of AR 4520.

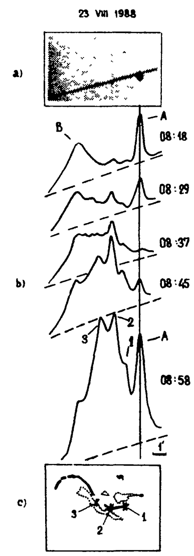

Fig. 2. a) the area of the AR photosphere where the flare of importance 3F occurred
b) radio brightness distribution scans at 5.2 cm wavelength with an angular resolution of 35″ as obtained during the development of the flare
c) the position of the burst brightness centers 1, 2, 3 (see skew crosses), determined using the SSRT, with respect to the chromospheric flare ribbons (see regions marked by a dashed line). The filament is shown by dark (solid) filling.

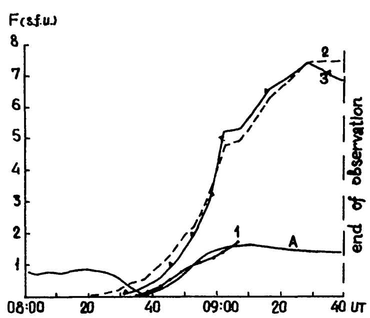

Fig. 3. The time variation of the radio flux of the *S*-component source (A) and of the burst radio brightness centers (1, 2, 3).

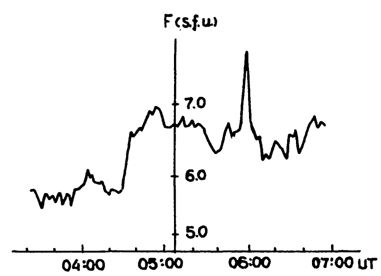

Fig. 4. The variation of the radio flux during the appearance of the leading sunspot of the sunspot group from behind the limb.

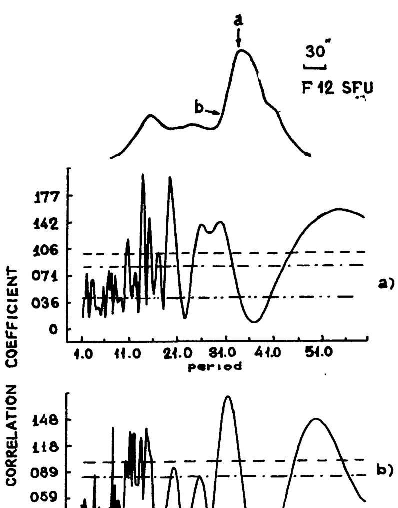

Fig. 5. The radio brightness distribution of the *S*-component source (see upper part of the figure) and spectra of second pulsations for its central (a) and peripheral (b) parts.

The spatial structure, which is characteristic for a maximum stage of development when the burst consists of three brightness centers, it changed substantially with the time (see scans for moments 08-29 and 08-37 UT).

4. The radio brightness distribution in the AR Corona with height

Fig. 4 gives a plot, showing the flux variations of the radio emission at the time of the appearance of the leading sunspot of the sunspot group. The sunspot moved across the limb at 04:30 UT, and this was coincident with an abrupt increase in the radio flux, lasting for about 30 minutes. Abrupt changes (of opposite sign, however) are also observed at the time of disappearance of large sunspots behind the limb.

It is most likely that such radio flux variations of *S*-component sources are caused by emergence (or submergence) of the transition region between the chromosphere and the corona, where the temperature varies from 10^4 to 10^6 K. The duration of this process (~ 30 min) indicates that the thickness of the transition region over the sunspot is ~ 1000 km.

5. The investigation of sources of second oscillations of the radio emission flux on the Sun

At present it is generally known that active regions provide sources of radio flux pulsations. The high resolving power of the SSRT has made it possible to investigate the character of radio flux pulsations of different parts of *S*-component sources.

Fig. 5 gives an example of second-pulsation spectra for the central (a) and peripheral (b) parts of the *S*-component source. It is evident that the spectra differ markedly.

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