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Microwave study of coronal active regions from the CORONAS-F list of solar flares observed in Gamma- and X- rays

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Abstract. We analyze some of the tens of active regions (AR) each supposed to produce at least one solar flare detected in Gamma- and hard X–rays by the SONG–M spectrometer on board the CORONAS–F satellite. Of special interest is the AR NOAA 9601, which gave rise to the solar flare at 14:30 UT on September 5, 2001 with up to 4 MeV intensity in Gamma and of M6.0 class only in soft X–rays. We examine 1D radio scans of NOAA 9601, taken with the RATAN–600 in Stokes I and V at a set of wavelengths from 1.92 to 10 cm and radio maps taken with the Solar Siberian Radio Telescope (SSRT) at 5.2 cm. The type of this microwave source is classified among the other sources. The some prediction evidences of such type sources are listed.

1. Observation results

The RATAN–observations are made in ~ 4.5 of hours before the flare. They are consistent well with the SSRT–maps (see figure 1). Comparing the pre–flare and post–flare observations, we find no detectable changes of the local microwave source in NOAA 9601 after the proton flare. Estimated post–flare heating of the solar corona of 20% is without the accuracy of our microwave measurements.

2. Discussion

The analysis of the observation results is shown that NOAA 9601 is a well–known type of proton flare producing active region, namely a combination of an old active region and a new bipolar magnetic flux intruding into the remnant [Kuznetsov et al. (2003)]. The structural features of this type microwave source are as follows [Peterova & Korzhavin (1998)]: (a) peculiar detail, where the inversion of the sense of circular polarization through the microwave range is due to the inversed gradient of temperature in the microwave source, not to the quasi–transverse propagation of microwaves well above the source; (b) detail appeared at the site of a solar flare some days before its onset. As for NOAA 9601, the detail "a" is observed above a sunspot turned into two sunspots (detail A12). The detail "b" is the microwave brightening associated with the

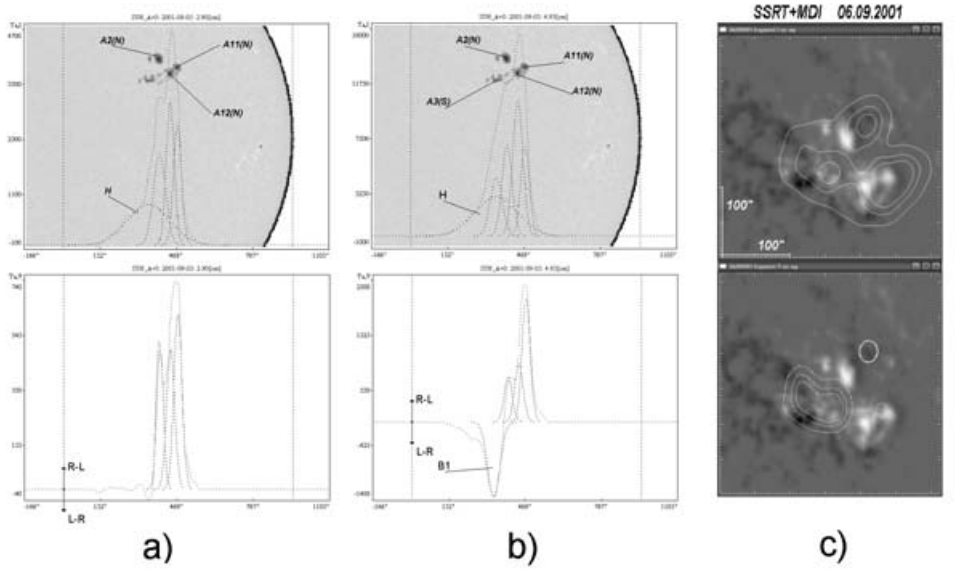

Figure 1. The one dimension (E–W) distribution of the radio emission brightness along the source situated above the active region NOAA 9601 as observed with the radiotelescope RATAN–600 at the wavelengths 2.90 cm (a) and 4.93 (b) . The source image is superimposed on the photoheliogramma, and a division of the total source structure on the separate details is shown (using the gauss–analysis method). The detail H is a source of halo type genetically connected with plasma confined in the active region magnetosphere top. The details A11, A12 and A2 are associated with cyclotron sources. The detail A3 is the site of the flare observed 05.09.2001 in 14.5 UT. (c)–The SSRT–maps of the radio emission source situated above the active region NOAA 9601 superimposed on the MDI–gramma (I–top, V–bottom). The sign and the maximum magnetic field at the photosphere level as well as the brightness temperature at the wavelength 5.2 cm are given.

follower part of the AR (detail A3), where both non–thermal spectrum and as high circular polarization as in the case of a sunspot-associated source are derived at the long wavelengths. It is worth to note that the proton flare occurs in the region of the relatively week magnetic field. May be that is why the power of the proton event associated with NOAA 9601 was less than in case of NOAA 9591, the flare in which took place in the region of the sunspot.

References

Kuznetsov, S.N., Kudela, K., Myagkova, I.N. & Yushkov, B.Yu. 2003 *Proc. 28th International Cosmic Ray Conference*, 3183–3168.

Peterova, N. G., & Korzhavin, A. N. 1998 *Bull. Spec. Astrophys. Obs.* **44**, 71–100.

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