The Spatial Information of Microwave Spike Emission in a Microwave Burst Observed Coincidently by BAO and NRH

Qijun Fu[1] Guangli Huang[2] K. Shibasaki[3] H. Nakajima[3] and Yuying Liu[1]

[1] Beijing Astronomical Observatory, Chinese Academy of Sciences, Beijing 100012, P.R. China

[2] Purple Mountain Observatory, Chinese Academy of Sciences, Nanjing 210008, P.R. China

[3] Nobeyama Radio Observatory, Japan

The solar radio spikes at microwave bands may provide an important signature for understanding the energy release and the particle acceleration in solar flares. The features of the extremely short time scale and narrow bandwidth imply the spatial dimension of the sources may be as small as several tens to hundreds kilometers. In fact, it is quite difficult to observe the radio spikes simultaneously with high temporal and spatial resolution. There were very limited reports, such as Krucker et al. (1995) with the VLA and PHOENIX Spectrometer, Correia et al. (1995) with ITAPETINGA 13.7m radio telescope and Nancay Radioheliograph. In these examples, the arcsecond scales of the spike sources were proven, but the temporal and the spatial evolution of the radio spikes are still unknown, moreover, there is no any new idea or evidence for the mechanism of radio spikes from these observations.

One special event on May 14, 1993 was selected by Fu (1997) from the coincident observations by Beijing radio spectrometer and Nobeyama Radio Heliograph. The spikes were detected at 2545-2840 MHz (Beijing) and 2000 MHz (Nobeyama) and superposed on a LDE, which was associated with a M4.4/2N flare in the active region N20W48. Meanwhile, the time profiles of several sources were analyzed from the data of Nobeyama Heliograph, it was interesting that the spikes only corresponded to a source with smaller size, lower brightness temperature and much higher polarization degree than that of the main source, and the distance between the spike source and the main source is about 17 arcseconds or 20 thousands kilometers. In comparison with the magnetograph by the Beijing Huirou Solar Magnetic Field Telescope, the spike source was just located in the north pole of a magnetic loop, where the magnetic field strength (1600 Gauss) was much higher than that in main source ($>$ 100 Gauss). Moreover, there were some radio brightness spots (arcseconds) appeared around the north pole in the same time order as the series of spikes observed by the Beijing radio spectrometer with high time resolution (10ms).

The most favorable mechanism for radio spikes is the electron cyclotron maser instability, which may amplify the electromagnetic waves in a very short time scale with a very narrow bandwidth due to a resonant wave-particle interaction in the velocity space. There are three necessary conditions for this mechanism, which are strongly supported by this event. The first one is the energetic electrons, the velocity of the electron beams is estimated as 0.3c by the frequency drift (30 GHz/sec) and the height of the sources. The second point is the strongly magnetized plasma, the ratio between the electron plasma and cyclotron frequencies in the spike source is 0.32, which is ten times smaller than the value in the main source. The third condition is the small spatial dimension of the sources (in respect to the micro magnetic tube), which is directly proven by the scale of the radio spots. The remained question is whether the evolution of the spike sources (spots) are due to a quasi-periodically penetrating of the electron beams from an acceleration region or a fast avalance process of the instability as suggested by Lu et al. (1991), which will be studied further by the authors.

References

Correia E., Costa J.E.R., Kaufmann P. et al.: 1995, Solar Phys., 159, 143.
Fu, Q.J.: 1997, a report at Nobeyama Radio Observatory.
Krucker S., Aschwanden M.J., Bastian T.S. et al.: 1995, Astron. Astrophys., 302, 551.
Lu E.T., Hamilton R.J.: 1991, ApJ, 380, L89.