EPSC Abstracts
Vol. 8, EPSC2013-31, 2013
European Planetary Science Congress 2013

Similar features that appear both on the dynamic spectra of the Sun and Jupiter

G. Litvinenko (1), A. Konovalenko (1), V. Zakharenko (1), V. Vinogradov (1), V. Dorovsky (1), V. Melnik (1), V. Shaposhnikov (2), H.O. Rucker (3), Ph. Zarka (4)
(1) Institute of Radio Astronomy, Kharkov, Ukraine, (2) Institute of Applied Physics, Nizhny Novgorod, Russia, (3) Space Research Institute, Graz, Austria, (4) LESIA, Observatoire de Paris, UMR CNRS (gallitv@rian.kharkov.ua / Fax: +38-057-7061415)

Abstract

At present, the physical nature of the basic components of the solar sporadic radiation has been well studied and reliably identified non-equilibrium particle emission mechanisms responsible for their origin [1, 2, and references therein]. Jupiter decameter emission (DAM) represents an extraordinary astrophysical phenomenon which is characterized by an unusual complexity of the frequency-temporal structure of its dynamic spectra. It should be noted that since of its discovering many problems in the theory of the Jovian decameter emission have been successfully investigated and solved [3, and references therein]. Nevertheless, a great number of physical features of this phenomenon still remain unclear. It should be noted that the quasi-similar in shape features appear in the dynamic spectra both in the Sun and the Jovian radio emission. We hope that future research of the similar properties in the emission spectra of Jupiter and the Sun and analogy between the plasma processes in the solar corona and magnetosphere of Jupiter can allow also define the similar features in the radiation mechanisms of these cosmic objects. One of the promising approaches to investigating features of the Jovian DAM emission and the decameter solar radiation is application of novel experimental techniques with a further detailed analysis of the obtained data.

1. Introduction

Observation of the fine structure in the spectrum of the radio emission of Jupiter and the Sun with a high frequency and time resolution, a detailed study of the features of non-equilibrium particle parameters that ensure the emergence of the fine structure and diagnostics of plasma parameters at the source of this radiation allow trying to find a certain analogy between the magnetic tube Jupiter's satellite Io and coronal magnetic loops on the Sun. In the case of Jupiter the acceleration of electrons in the tube occurs as a result of induced currents and electric field at Io motion of a conducting ionosphere through the magnetic field of Jupiter. In the case of Sun the currents and electric fields arise from the interaction of plasma photosphere convective currents with the magnetic field in the base coronal magnetic loop. The present paper is devoted to an illustration of the similar specific properties in the Jupiter DAM emission and in the Sun radiation which appear in dynamic spectra.
An amount of wide-band data of the Jovian and Sun radiation in the decametre range from has been obtained using a high frequency and temporal resolution digital receiver (DSP) installed into the world's largest decameter band radio telescope UTR-2, Kharkov, Ukraine (the antenna effective area is about 10^5 m^2, the frequency resolution is 4 kHz, the temporal resolution is 60 μs, and the dynamic range is 90 dB) [4]. The DSP is a fully digital baseband device which satisfies all modern requirements for investigation of the decameter emission and provides the ultimate spectral analysis capability by allowing digital signal processing in real time. An original software package consisting of two parts was developed to control the digital receiver and for off-line data analysis at the post-processing stage.

As it is known, solar radio emission, especially at low radio frequencies is complex with continual quasi-permanent components of the coronal radio emission as well as the burst sporadic component. For the primary purpose of our work a more interesting is observation of the known solar flares such as "drifting pairs", S - bursts and absorption bursts. At this time similar to solar types of bursts

were detected by us in the sporadic emission of Jupiter. This suggests similarities in the mechanism of electron acceleration in the system Jupiter - Io and coronal magnetic loops in the solar radio emission.

2. Some observational results and discussion

Below, few examples of the dynamic spectra of Jupiter and the Sun, containing the similar specific structures, are shown.

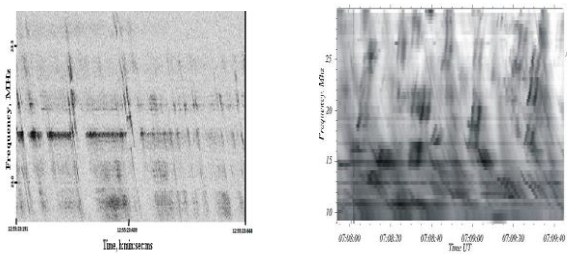

Figure 1: The left side of the Figure presents the "drifting pairs" in the Jovian decameter emission; the right panel shows the "drifting pairs" in the solar radiation.

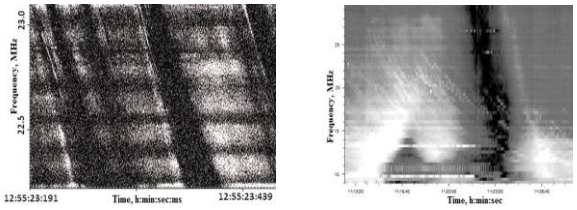

Figure 2: The left side of the Figure presents the absorption bursts in the Jovian decameter emission; the right panel shows the absorption burst in the solar radiation.

"Drifting pairs" are extremely complicated features of sporadic solar radio emission. These structures have stable parameters for independent events (emission range is 0.5 MHz, burst width is 0.5 sec, the distance between the pairs is 2 sec). The frequency drift can be negative or positive. In DAM emission of Jupiter the similar events have only negative frequency drift. It should be specially emphasized that these features do not yet have a physically reasonable explanation.

The absorption spectra are very rare in the solar radiation. High sensitivity, dynamic range of radio telescope UTR-2 and high-resolution time-frequency receiving equipment allowed reliably identify a number of absorption bursts against the background radiation. At that were reliably separated levels of intrinsic noise of telescope, galactic background, radiation from the quiet Sun and the levels of emission and absorption bursts. It was found that the radiation level at the minimum is much less than the emission of the quiet Sun. This may be due to abnormal conditions in the plasma of the solar corona at large spatial scales

3. Summary and Conclusions

The presence of a number of general properties of the radio emission of the Sun and Jupiter give the possibility to look for similar arrangements in the theory of the generation and propagation of electromagnetic radiation in the magnetosphere and ionosphere of the planet and the solar atmosphere. By analogy with the above absorption bursts observed in the background of the Jovian decameter S-emission can be also connected with some plasma effects in the magnetosphere of Jupiter.

Acknowledgements

This work is supported by the National Academy of Sciences of Ukraine and the Russian Foundation for Basic Research (Ukrainian-Russian Project 2012).

References

[1] Konovalenko, A., A. Stanislavsky, E. Abranin, et al.,: Absorption in burst emission, Solar Physics, v.245, 345-354, 2007.

[2] Melnik, V., A. Konovalenko, H.O. Rucker, et al.,: Decameter Type III- like Bursts, Solar Physics, v.250, 133-145, 2008.

[3] Litvinenko, G. V., A. Lecacheux, H. O. Rucker, et al.,: Modulation structures in the dynamic spectra of Jovian radio emission obtained with high time frequency resolution, *Astron. Astrophys.*, 493, 651–660, 2009.

[4] Konovalenko, A.A., Lecacheux, A., Rosolen, C. and Rucker H.O.: New instrumentation and methods for the low frequency planetary radio astronomy, in: Planetary Radio Emissions V, eds. H. O. Rucker, M. L. Kaiser, Y. Leblanc, Austrian Academy of Sciences Press, Vienna, pp.63-67, 2006.