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Comparative analysis of the quasi-similar structures on the dynamic spectra of the Sun and Jupiter

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Abstract

In many literary sources planet Jupiter called the Sun, which is not fully developed. It should be partially confirmed by the experimental fact that the quasi-similar in shape features appear in the dynamic spectra both in the Sun and the Jovian radio emission. The comparative analysis 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

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 [3, and references therein].
In the present work an amount of wide-band data of the Jovian and Sun radiation in the decametric range has been analyzed. The investigated data 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].
Investigation and the comparative analysis of the fine structures in the Jovian and the Sun radio emission which obtained with a high frequency and time resolution of the fine structure and diagnostics of plasma parameters at the source as well as a detailed study of the features of non-equilibrium particle parameters allow trying to find a certain analogy between the processes in the Jupiter's satellite Io magnetic tube 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 work mostly devoted to the comparison specific properties of the quasi-similar structures in the Jupiter DAM emission and in the Sun radiation which appear in the both dynamic spectra.
The primary purpose of our work is investigation and comparative analysis between the solar flares such as «drifting pairs», S – bursts, absorption bursts and zebra patterns with the similar types of bursts which were detected 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. The plasma emission model which is based on non-uniform source with weakly anisotropic and Double Plasma Resonance at the electron cyclotron harmonics is suggested for the explanation both of the Jovian and solar decametric emission specific properties.

2. Comparative analysis of quasi-similar components properties of Jovian and solar emission

Bellow, the examples of the decametric spectra and comparative analysis of the specific parameters for quasi-similar structures appearing both on the dynamic spectra of Jupiter and the Sun are presented.

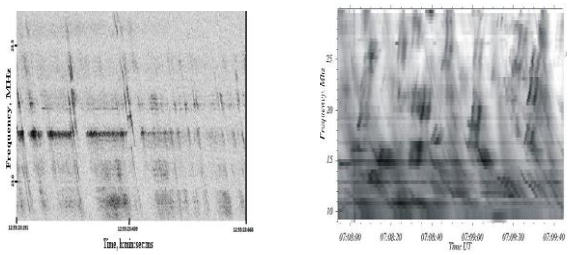

Figure 1: The left side of the Figure presents the «drifting pairs» in the Jovian decameter emission; the right panel shows the «drifting pairs» in the solar radiation.

In the case of in the Jovian radiation «drifting pairs» effects occur only with negative frequency drift - (5 ÷ 20 MHz/s), and «drifting pairs» in the solar emission can have both positive and negative frequency drift of the order of ± (0.5 ÷ 2 MHz/s) (see Fig.1).

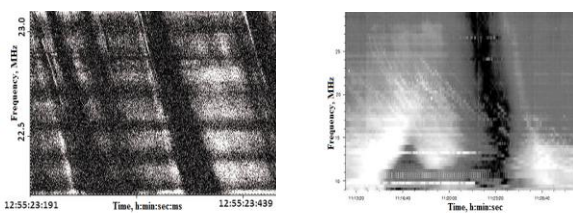

Figure 2: The left side of the Figure presents the absorption bursts in the Jovian decameter emission; the right panel shows the absorption burst in the solar radiation.

In the dynamic spectra of Jupiter DAM emission absorption bursts appear as periodic sequence (5 - 10 bursts) with the time scale units - tens of microseconds and the frequency band from 0.5 to 1 MHz. Bursts of absorption in the solar radiation usually appear as a single event with a time scale of the order of seconds, and frequency band from 10 to 15 MHz (see Fig.2).

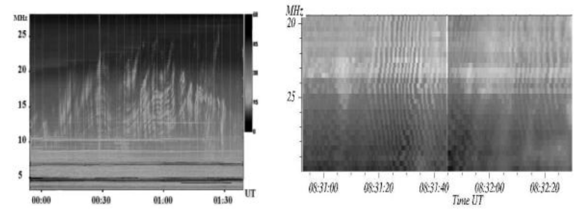

Figure 3: The left side of the Figure presents the «zebra»-structure in the Jovian decameter emission; the right panel shows the «zebra»-structure in the solar radiation.

In both case the observed zebra-structures are a number of quasi-equidistant stripes of enhanced brightness parallel drifting in time; the frequency spacing between the stripes is much less than the frequencies themselves; the frequency spacing slightly increases with the frequency (see Fig.3).

3. Summary and Conclusions

The similar characteristics appearing in the dynamic spectra of the Sun and Jupiter were detected and comparative analysis was carried out. This analysis is a pioneer, because till the present time such studies have not been presented. Such investigations begin possible through the use of the Ukrainian world's largest radio telescope UTR-2 (with high sensitivity and large dynamic range), Poltava telescope URAN-2 (polarization measurements) and novel receiving equipment with high time-and-frequency resolution.

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.