EPSC Abstracts
Vol. 5, EPSC2010-31, 2010
European Planetary Science Congress 2010

Different types of temporal variations in the decameter emission of Jupiter

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Abstract

In 2009 year with the UTR-2 radio telescope (Kharkov, Ukraine) several observational campaigns have been performed with the aim to investigate the fine temporal structures in the Jovian decameter radio emission (DAM). As recording equipment the broad band digital receiver with 8192 frequency channels (33 MHz frequency band in common) and 0.25 ms time resolution was put into operation. Experiments have been arranged in accordance to the known diagram occurrence of Io-dependent sources. Periods of the different sources have been chosen, which enable to obtain possible new results for the sporadic S-emission of Io-A, Io-B, Io-C and Io-D sources and their combinations. Continuous measurements for Io-B source lasted approximately 3.5 hours. Long duration of observations provided the possibility to watch the continuous time evolution of the Jovian radiation with complete coverage of the planet's culmination and consideration of the different stages of radiation variation in detail.

1. Introduction

The Jovian S-burst emission appears during the decameter radio storms, several-hour long events, which are predictable on the basis of the analysis of the geometric configuration between the Earth, Jupiter, and Io [2]. Monitoring of the Io-dependent DAM emission revealed the characteristic Jupiter emission zones known as Io-A, Io-B, Io-C, and Io-D [1]. In spite of the more than 50 years of extensive exploration of the Jovian DAM radiation the physical nature of this phenomenon is still unclear. One of the perspective approaches of finding the possible realistic solution of this problem is the experimental investigations on the more high quality and quantity level. With this aim several observational campaigns have been performed in 2009 with the UTR-2 radio telescope (Kharkov, Ukraine) and the effective registration systems with high frequency and temporal resolutions (antenna effective area is close to 100 000 m^2, a frequency resolution is 12 kHz, a time resolution is 0.25 ms, a dynamic range is 70 dB).

1.1. Equipments

The huge amount of wide-band data of the different Io-dependent sources radiation taken for the present analysis have been obtained with the high frequency and time resolution DSP [3] installed into the Ukrainian world's largest decameter band radio telescope UTR-2 [4]. It is a fully digital baseband device which is satisfied to the modern requirements for the Jovian decameter emission investigations. Depending on the sampling clock frequency, it can perform a Fourier analysis in a continuous frequency band of up to 70 MHz in two independent data streams (two input channels, ON/OFF regime). The DSP provides the ultimate spectral analysis capability performing real time digital signal processing. The device is also capable of recording the signal waveforms, i.e., catching the output of the ADC (analog-to-digital converter).

1.2. Data processing algorithm

For controlling the receiver parameters, the data acquisition process, and the real-time display, original software (AESA, Astronomical Enhanced Spectral Analyzer) was developed. The software operates under the Windows NT/2000/XP/Vista operating system. The main goal of this program is the construction and optimal visualization display of the Jovian radiation dynamic spectra (Fourier or waveform). The main goal of this program is the construction and optimal visualization of the Jovian radiation dynamic spectra (Fourier or waveform).

Analysis of high spectra quality enabled to detect the new interesting properties and proved the reliable of obtained earlier results without any additional correction procedures.

2. Some observational results

Experiments have been arranged in accordance to the known diagram occurrence of Io-dependent sources (see Table 1). A special period of time of appearance of the weak Io-D source was more precisely defined during the observations. This result was feasible due to the high sensitivity of the used receiving equipment.

As it was mentioned above that the continuous measurements for Io-B source lasted approximately 3.5 hours. Long duration of observations provided the possibility to watch the continuous time evolution of the Jovian radiation with complete coverage of the planet's culmination and consideration of the different stages of radiation variation in detail.

Table1: Observational periods for the different Io-dependent sources

Source	T_{start}, UT	T_{fin}, UT
	h:m:s	h:m:s
Jupiter, Io-A 3.11.2009	15:15:00	16:00:00
Jupiter, Io-D 4.11.2009	16:00:00	17:30:00
Jupiter, Io-A, Io-C 26.11.2009	10:10:00 12:00:00	12:00:00 14:00:00
Jupiter, Io-B 27.11.2009	12:00:00	15:30

In the Figure 1 one example of dynamic spectrum with structure of the Jovian emission with the positive frequency drift and quasi-periodic temporal variations over the frequency for Io-B source is presented. In the Figure 2 the structures of the vertical bursts demonstrating a negative frequency drift is shown.

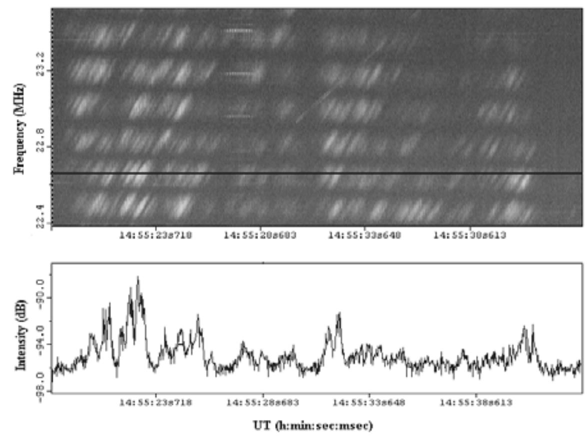

Figure 1: Dynamic spectrum of Io-B emission demonstating the positive frequency drift and quasi-periodic temporal variations over the frequency.

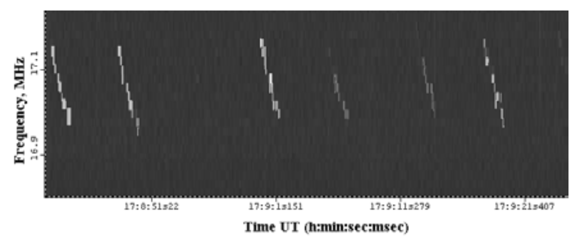

Figure 2: Jovian decameter emission structures where each of them is composed from vertical bursts

3. Conclusion

In the present work the wide-band dynamic spectra of the Jovian decameter emission which have been obtained during last years with the high-frequency and high-time-resolution equipment on the UTR-2 radio telescope have been demonstrated. Several new intriguing kinds of the temporal spectrum modulation have been found. Without any doubt the theoretical and experimental investigations of these phenomena are necessary to be continued.

Acknowledgements

This work is partly supported by the Ukrainian-Russian Project **Ф28.2/005** and the Russian Foundation for Basic Research (**09-02-90406-Ukr-f-a**).

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