EPSC Abstracts
Vol. 11, EPSC2017-122, 2017
European Planetary Science Congress 2017

Synchronous observations of Jupiter decameter radio emission at radio telescopes UTR-2, URAN, GURT with the spacecraft Juno

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Abstract

The paper is devoted to the description of multi-antenna observations on radio telescopes UTR-2 URAN and GURT [1] within the framework of ground support for the Juno space mission. Parameters and some results of observations are given. Time and frequency binding allows to use all the data obtained in a joint processing with the data of the radio receiver of the spectrometer, which is installed on the spacecraft, and simultaneously with other ground-based low-frequency radio telescopes.

1. Introduction

Jupiter radio emission investigations [2] are carried out more than 60 years. But the beginning of the Juno mission launched the integration of all terrestrial telescopes that support space mission (radio, infrared, ultraviolet at the spacecraft, etc.) into a single network to study in the most detail the mechanisms giving rise the Jupiter emission and its satellites and other physical phenomena in the Jupiter ionosphere and magnetosphere. All aspects of spacecraft closest approach to Jupiter (perijove - PJ) and overflight above polar regions are used by ground-based radio and optical telescopes for simultaneous observations with a variety of scientific spacecraft instruments (optical and infrared cameras, low-frequency receivers, particle detectors, etc.). At low frequencies that are accessible for terrestrial observations (8-40 MHz), providing ground support by European radio telescopes NDA, NenuFAR (France), UTR-2, URAN, GURT (Ukraine), LWA1, OLWA (USA), Iitate and Zao instruments of Tohoku University (Japan), etc. which permit to continuous tracking of Jupiter, regardless of time of day. In addition, low-frequency observations at many spaced telescopes provide much better results with a view to overcome the negative effects of local interference and irregularities of the Earth's ionosphere.

2. Observations

Multi-antenna observations at radio telescopes UTR-2, URAN and GURT in the framework of ground support of the Juno mission are conducted under an extensive program, taking into account the presence of S-bursts of Io-controlled emission or L-radiation, effective area of radio telescopes and effective area of a specific radio telescope. Since the closest approach of the spacecraft with the planet is of the greatest interest, the observations are concentrated in the period of ~ 24 hours before and after PJ. However, to obtain a sufficiently uniform and extensive set of observations, some of them are conducted independently from the Juno position. The larger effective area of the radio telescope, the higher time resolution specified. For example, to record L-bursts at the UTR-2 radio telescope, a time resolution of 5 ms is used and Δt =15 ns is used for recording S-bursts. The recording parameters for all Ukrainian radio telescopes participating in the program are given in Table 1. The duration of a single observation session was 6-8 hours.

Table 1: This is the example of an included table

Telescope	Effective area, m^2	Range, MHz	Time res., ms low/high
UTR-2	140 000	8-32	5/0.00015
URAN-2	28 000	8-32	10/1
URAN-3	14 000	8-32	10
GURT	1 000	8-50*	10

* Full band of GURT is 8-80 MHz.

3. Results

In the framework of the ground support program of the Juno space mission, more than 10 observation sessions were conducted. Of greatest interest were observations of S-bursts that occurred at a time close to PJ. Such data allow us to hope for a detailed comparison of the observations of the spectrometer WAVES on board of the spacecraft and other ground-based radio telescopes. Figure 1 shows an example of a recorded storm using the URAN-2 radio polarimeter.

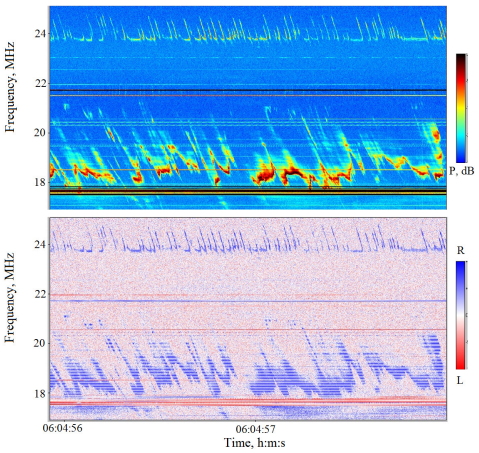

Figure 1: Observations of Io-controlled emission at URAN-2 Dec 12, 2016 (UTC) with a time resolution of 1 ms.

It is very important that the high spatial selectivity of large radio telescopes such as UTR-2 and URAN-2 allows one to obtain recordings with a minimal amount of RFI of artificial and natural origin coming at low angles to the horizon through the side lobes. Such example (a fragment of the recording of the radio emission from Jupiter on the radio telescope UTR-2) is shown in Figure 2. It is interesting that some bursts resemble S-bursts, although the probability of their occurrence was rather low. These and other types of radiation [3] require a detailed further study.

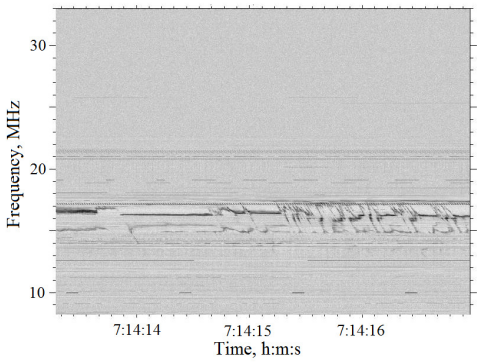

Figure 2: Observations at UTR-2 Oct 19, 2016 (UTC, Δt = 5 ms).

4. Summary and perspectives

The spacecraft Juno and regular synchronous observations within the framework of ground support of the mission with the help of terrestrial radio telescopes will provide new extremely valuable scientific results on the mechanisms of the formation of radio emission from Jupiter, as well as planets and exoplanets with a strong magnetic field.

References

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