EPSC Abstracts
Vol. 6, EPSC-DPS2011-1068, 2011
EPSC-DPS Joint Meeting 2011

Recent advances in the search for radio emissions from exoplanets

P. Zarka
Observatoire de Paris - CNRS, LESIA, Meudon, France (Philippe.Zarka@obspm.fr, +33 (0)1 45 07 28 06)

Abstract

I will focus on the large program carried on at the UTR2 array in Kharkov (Ukraine), as well as the plans for observations with the new LOFAR telescope. The methodology, method of analysis, and results obtained until now will be described.

1. Introduction

Theoretical extrapolations of our present knowledge on Solar system planetary (magnetospheric) radio emissions suggest that exoplanets, especially hot jupiters, might emit polarized radio waves with a flux near the detection limits of available (UTR2) or soon available (LOFAR) radiotelescope arrays (see Fig. 1, ref. [1] and references therein). Observations have thus been performed since a few years at the largest ground-based radiotelescopes, such as the VLA, GMRT, or UTR2.

2. The UTR2 exoplanet program

The largest program is carried on at UTR2 (Kharkov, Ukraine), where >100 nights have been devoted to radio-exoplanet search, on a few tens of targets, in the spectral range 10-32 MHz. In this range, sky brightness, Radio Frequency Interference (RFI), and ionospheric scintillations are major limitations to the effective sensitivity of the observations. We use high (time,frequency) resolutions digital receivers specifically developed for this program [2]. Observations are performed in dual-beam mode (simultaneous On & Off). Each beam being 30' wide thanks to correlation between the two UTR2 branches (EW & NS), limiting thus confusion effects. Than an dedicated automated RFI mitigation software is applied to the data, followed by calibration by and subtraction of the sky background, parametric dedispersion, and time-frequency integration over unpolluted pixels (fulfilling conditions on the variance of the integrated signal [3]). Finally time variations are searched in the reduced data at the orbital period of the corresponding exoplanet observed.

Figure 1: Top: UTR-2 antennas in Kharkov. Bottom: the LOFAR station in Nançay and below it a zoom on its HF and LF antennas (photos I. Thomas & I. Cognard).

3. Tests of the methodology

Weak pulsars and Saturn's lightning were observed as test sources. Figure 2 shows examples of lightning and weak pulsar detection. The former illustrates the usefulness of dual beam observations, and the latter that of RFI mitigation. Both detections translate into a sensitivity of ~1 Jy at 1 sec×1 MHz integration.

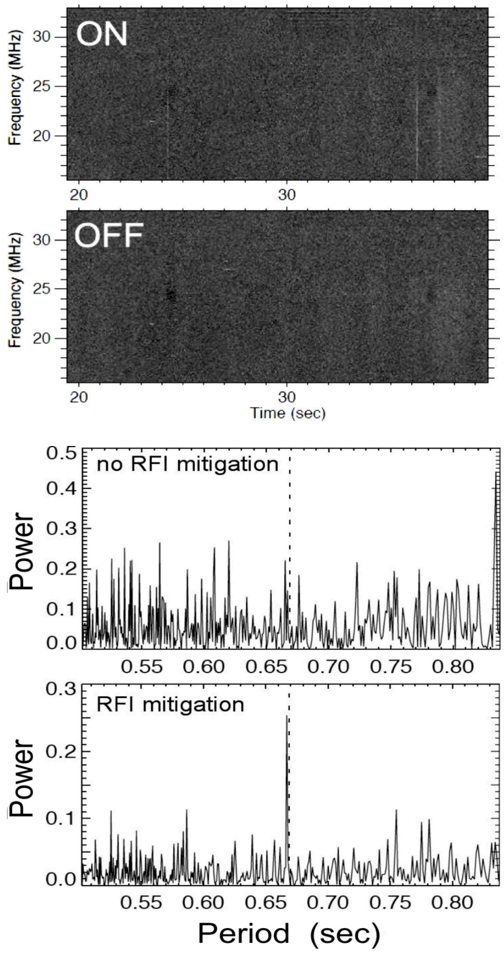

Figure 2: Top: Detection of broadband radio lightning (near second 24, 36 & 37) with UTR-2, in "On" dynamic spectrum only, at resolution of 20 msec × 4 kHz. Their typical flux density is ~100 Jy. Bottom: Synchronous detection of the weak pulsar PSR 1322+83 (flux =36 mJy at 100 MHz, DM=13.27 pc.cm^{-3}, P=0.67 sec, pulse width ~ 0.03×P), after RFI mitigation only, in 500 sec (15 sec effective) × 20 MHz integration.

4. Motivations

The difficult step is to detect a signal. Establishing its planetary origin should be relatively easy, based on emission polarization (highly circular/elliptical for all solar system planetary radio emissions only) and periodicity (orbital, especially). Comparison to models should bring new information on the observed systems, such as the type of star-planet plasma interaction, planetary field magnitude, tilt and offset, planetary rotation period and even orbital inclination [4], broadening the field of comparative magnetospheric physics to star-planet plasma interactions at large. Strong expectations for the radio detection and study of exoplanets are carried by the new giant european low-frequency array LOFAR (*www.lofar.org*).

Acknowledgements

The author thanks B. Cecconi, A. Coffre, L. Denis, P. Dierich, C. Fabrice, A. Gerbault, J. Girard, J.-M. Griessmeier, S. Hess, A. Konovalenko, R. Kozhin, J. Queinnec, P. Ravier, C. Rosolen, H.O. Rucker, B.P. Ryabov, V.B. Ryabov, V.A. Shevcenko, M. Sidorchuk, D. Vavriv, V. Vinogradov, R. Weber. G. Woan, S. Zakharenko, et al., and acknowledge the support of the ANR program NT05-1 42530 "Radio-Exopla" (2006-2010).

References

[1] Zarka, P.: The search for exoplanetary radio emissions, in "*Planetary Radio Emissions VII*", H. O. Rucker et al. eds., Austrian Acad. Sci. Press, Vienna, in press, 2011.

[2] Ryabov, V. B., et al.: A low-noise, high dynamic range digital receiver for radio astronomy applications: an efficient solution for observing radio-bursts from Jupiter, the Sun, pulsars and other astrophysical plasmas below 30 MHz, Astron. Astrophys., 510, A16, 2010.

[3] Zarka, P., et al.: Ground-Based High Sensitivity Radio Astronomy at Decameter Wavelengths, in "*Planetary Radio Emissions IV*", H. O. Rucker, S. J. Bauer, and A. Lecacheux eds., Austrian Acad. Sci. Press, Vienna, p. 101-127, 1997.

[4] Hess, S. L. G., and Zarka, P.: Modeling the radio signature of the orbital parameters, rotation, and magnetic field of exoplanets, Astron. Astrophys., in press, 2011.