Recent advances in the search for radio emissions from exoplanets

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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 >10
0 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.

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.

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


References


