Non-astronomical use of LOFAR in single station mode

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1 Extended Abstract

LOFAR is an astronomical radio-interferometer working in the frequency range between 10 - 240 MHz. It allows the performance of radio-astronomical observation in the lowest frequencies available on Earth's surface. It consists of 52 separate stations. Each of them can operate as a separate radio telescope with limited parameters [1]. Due to the broad frequency range, as well as wide range of possible configurations and measurements, it is possible to use it for non-astronomical observation. In this work, we present the examples of LOFAR use for observation of anthropogenic and natural signals in the near-Earth environment. Figure 1 shows the amplitude recorded in direction of Cygnus A, as well as, human made signal below 20 MHz - in radio astronomy - interpreted as RFI (Radio Frequency Interference).

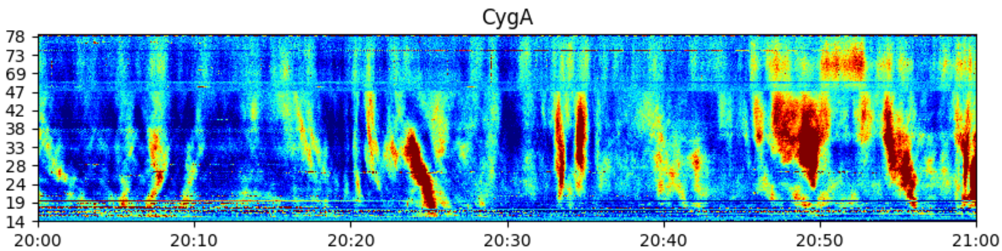

Figure 1. The observation carried out in direction of Cygnus A radio source on 2018-05-13 between 20:00-21:00 UTC. The modulation of amplitude caused by ionospheric irregularities, as well as human made signal below 20 MHz of broad cast HF stations origin, are clearly visible.

Ionospheric amplitude scintillation - High sensitivity and the frequency range between 10 - 90 MHz allow the measurements of signal scintillation originating from natural radio sources. Its analysis enables to characterize the scintillation in mid-latitude geomagnetic region.

Angle of incidence scintillation of signals reflected from the ionosphere - A single LOFAR station allows observation of the signals emitted by broadcast stations, along with the direction they come from. The signals manifest with long-term variability related to their global propagation, as well as short-term changes dependent on plasma parameters in the place of signal reflection from the ionosphere. We show both of described effects.

Scintillation of arrival angle of satellite VHF signals - With the use of Low Earth Orbit satellite sourced signal, the observation of the scintillation of the signal's arrival direction can be carried out. The scintillation is caused by small-scale structures of the ionosphere. The high velocity of pierce point motion, along with the range of its movements, allows a fast scan of the ionospheric parameters over a large area.

References

[1] M. Pożoga, H. Ciechowska, B. Matyjasiak, H. Rothkaehl, M. Grzesiak, R. Wronowski, Ł. Tomasik, K. Beser, "Ionospheric Scintillation Diagnostic on LOFAR ILT Network in Single Station Mode",2021 Signal Processing Symposium (SPSympo), 20-23 Sept. 2021 Łódz, DOI: 10.1109/SPSympo51155.2020.9593637