URSI GASS 2023, Sapporo, Japan, 19 – 26 August 2023

Measurement of radio wave scintillation through radio telescopes

B. Forte* (1), R. Fallows(2), M. M. Bisi(2), P. Flisek(3), K. Kotulak(3)
(1) Department of Electronic and Electrical Engineering, University of Bath, United Kingdom, email: b.forte@bath.ac.uk
(2) RAL Space, United Kingdom Research and Innovation (UKRI) – Science & Technology Facilities Council (STFC) – Rutherford Appleton Laboratory (RAL), Harwell Campus, UK, e-mail: mario.bisi@stfc.ac.uk
(3) Space Radio-Diagnostics Research Centre, University of Warmia and Mazury in Olsztyn, Poland, e-mails: pawel.flisek@uwm.edu.pl, kacper.kotulak@uwm.edu.pl

When traversing plasma density irregularities the wavefront of radio waves is subject to perturbations introduced by phase changes. These phase changes are associated with changes in the plasma density along the wavefront and, thus, to changes in the refractive index. These perturbations distributed along the wavefront progressively interfere along the propagation distance producing an interference (or diffraction) pattern on the plane where the radio receiver is located. If there is a relative motion between the ray path, the irregularities, and/or the receiver, then the signal intensity and phase of the received radio waves appear to be fluctuating in time. This phenomenon is known as radio wave scintillation.

In the case of radio wave frequencies between VHF and C band transmitted from artificial satellites, scintillation originates from the propagation through plasma density irregularities forming in the Earth's ionosphere.

Radio signals emitted from distant radio objects traverse plasma density irregularities and can also manifest radio wave scintillation as received from radio telescopes. The Low Frequency Array (LOFAR) radio telescope is capable of receiving a wide interval of radio wave frequencies, ranging across the VHF interval, and of measuring intensity scintillation on the received radio signals.

This contribution focuses on the interpretation of radio wave scintillation as measured through radio telescopes such as LOFAR. LOFAR allows to detect scintillation originating, for example, in the inner heliosphere as well as in the ionosphere. As such, it allows to reveal the presence of plasma density irregularities through the detection of radio wave scintillation, thus providing insights on physical processes that take place along the ray path as well as on the mechanisms responsible for scintillation.