URSI GASS 2021, Rome, Italy, 28 August - 4 September 2021

Recent Observations of the Sun with LOFAR, results from the Key Science Project Group

Pietro Zucca [(1)] and the LOFAR Solar and Space Weather KSP
(1) ASTRON, The Netherlands Institute for Radio Astronomy, Oude Hoogeveensedijk 4, 7991 PD Dwingeloo, The Netherlands; e-mail: zucca@astron.nl

During solar flares and CMEs, the corona is heated, plasma motion, waves and shocks are ignited, and particles are accelerated. The accelerated particles propagate through the solar corona causing a variety of plasma instabilities that lead to enhanced non-thermal radio emission, known as “radio bursts”. By studying radiobursts’ characteristics we can gain insight into the properties of energetic particles and the ambient coronal plasma, and the properties of particle acceleration mechanisms, such as magnetic reconnection and/or shocks in the solar atmosphere. The Low Frequency aRray (LOFAR) can be used to study the fundamental plasma physics of solar radio bursts with unprecedented time resolution in dynamic spectra, as well as with both interferometric imaging and tied array imaging.
However, to better understand and predict how the Sun, its atmosphere, and more in general the Heliosphere works and impacts Earth, the combination of in-situ spacecraft measurements and ground-based remote-sensing observations of coronal and heliospheric plasma parameters is extremely useful.
LOFAR imaging capabilities allow for the detailed study of eruptions and transients in the solar corona. A series of recent examples will be shown including Type III, II and IV radio bursts. Using core and remote stations a spatial resolution of 15 arcseconds may be achieved. The detailed propagation of the radio bursts and the study of the related fine structures will be presented. The presentation includes a discussion of the new observing modes and capabilities of LOFAR for solar observations and a detailed comparison of LOFAR imaging with previous facilities such as the Nançay Radio heliograph. Finally, several results of the joint LOFAR and Parker Solar Probe (PSP) campaign will be presented, including the localization and kinematics of propagating radio sources in the heliosphere, and the challenges and plans for future observing campaigns including PSP and Solar Orbiter.

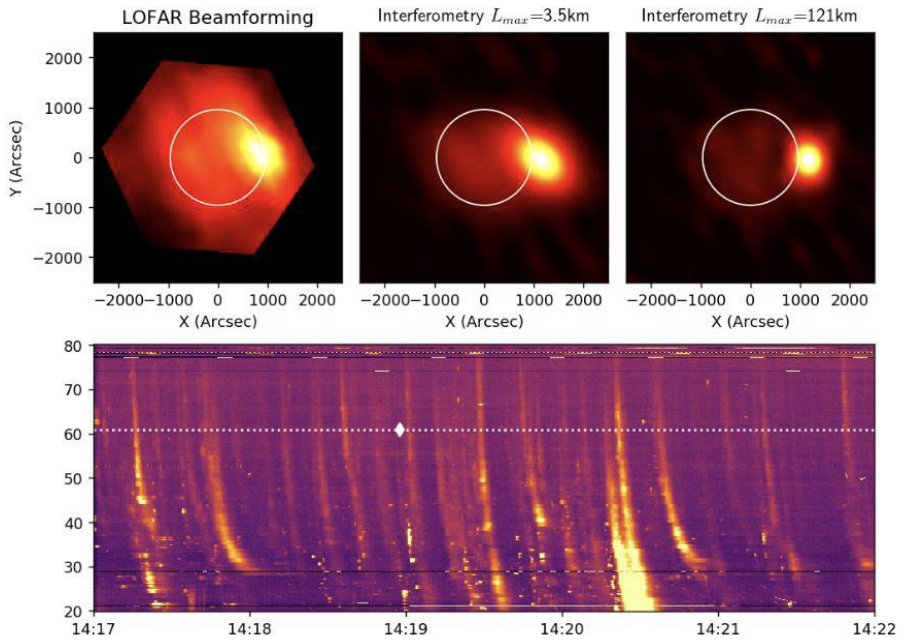

Figure 1. Example of LOFAR imaging capabilities. Tied array beam, interferometric mode, and dynamic spectrum of the recent type III storm recorded on the 21st of March 2019 during the Parker solar Probe co-observing campaign.