



Report from event supported by RadioNet

TITLE LOFAR Science 2019

DATE: 19/06/2019

LOCATION: Leiden, the Netherlands

MEETING WEBPAGE: <https://www.astron.nl/lofarscience2019/>

HOST INSTITUTE: ASTRON

**RADIONET
BENEFICIARY / NO:**

*OK accepted
24.6.2019
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Report:

1 SCIENTIFIC SUMMARY

The LOFAR Science 2019 Meeting consisted of three events: the LOFAR Users Meeting (20 May 2019), the LOFAR Community Science Workshop (21-22 May 2019) and the LOFAR 2.0 Discussion (23 May 2019).

At the **LOFAR Users Meeting**, staff from the ASTRON Radio Observatory (RO) gave an overview of the current status of the LOFAR telescope and outlined plans for future technical and software developments. Feedback from the community of LOFAR users collected by the LOFAR Users Committee was addressed by the RO. Most of the issues raised concerned data quality control, software development and how to open LOFAR to the wider astronomical community. The RO was given valuable advice on how to improve the user experience, make LOFAR more efficient and increase scientific output.

A welcoming reception in the evening provided a great opportunity to network and make new contacts ahead of the LOFAR Community Science Workshop.

The **LOFAR Community Science Workshop** brought together all active LOFAR users, including members of the Key Science Projects, as well as researchers from the European and global community involved with, or interested in, LOFAR science. The programme covered the gamut of the LOFAR science case from cosmology and extragalactic research to galactic, planetary, and solar system topics. A few highlights of the workshop are listed below:

- A presentation of the products from the LOFAR Two-Metre Sky Survey Data Release 1 (LoTSS-DR1), covering 400 deg² and containing 325,000 radio sources. Advanced techniques were used to identify the radio source host galaxies and the value-added catalogue is enabling a vast range of science. Improvements to the calibration and imaging for the upcoming LoTSS-DR2 were outlined, resulting in the deepest images ever made at low radio frequencies.
- A report about the detection of several exciting transient candidates in the Amsterdam-ASTRON Radio Transients Facility And Analysis Center (AARTFAAC), which is studying variability in the entire northern sky on second timescales.
- An update of on-going activities with the New Extension in Nançay Upgrading loFAR (NenuFAR in Nançay, France) operating at 10-85 MHz, including first results from the pulsar instrumentation of NenuFAR. Still under construction, this new radio telescope consists of over 1000 antennas and is already competitive with LOFAR.
- Ground-breaking results from a recent Nature paper on lightning observations with LOFAR were presented. LOFAR allows for metre-scale precision which is needed to probe the physics behind lightning propagation.
- There were a number of talks on the detection of stellar systems with LOFAR, important for studying stellar coronae, planetary magnetospheres and star-planet interactions. We heard about the first low-frequency detection of a quiescent star, where the emission was most likely induced by an exoplanet.
- Low-frequency observations of the redshifted 21-cm line are opening a new window on the first billion years of the Universe, allowing us to directly study the astrophysical processes occurring during the Epoch of Reionization (EoR) and the Cosmic Dawn. We were given a review of the latest developments of the LOFAR-EoR project. The talk explained the calibration and foregrounds mitigation challenges, and discussed preliminary LOFAR upper limits on the EoR as well as future perspectives.
- There was a discussion of LOFAR's new imaging capabilities allowing for studies of eruptions and transients in the solar corona in unprecedented detail. Recent examples of Type II, III and IV radio bursts were shown at a spatial resolution of 15 arcsec.

During the **LOFAR 2.0 discussion**, plans for the LOFAR upgrade, which will keep LOFAR at the cutting edge well into the 2020s, were discussed in detail with the user community. The topics covered included:

- The commissioning of COBALT2.0, LOFAR’s new correlator which will vastly increase the online computing and enable massively parallel observing modes.
- The status of the DUPLLO upgrade, which will provide an order-of-magnitude increase in sensitivity at 10-90 MHz by maximising the use of existing infrastructure.
- Plans to create a new leading-edge European research facility for space weather science, of which an important application would be forecasting the severity of geomagnetic storms.

New ambitious science projects stretching LOFAR’s current capabilities were also discussed, including a survey of the entire northern sky at sub-arcsec resolution and an all-sky monitor at 1-second cadence utilising the full LOFAR core.

The conference website is available at <https://www.astron.nl/lofarscience2019/>.

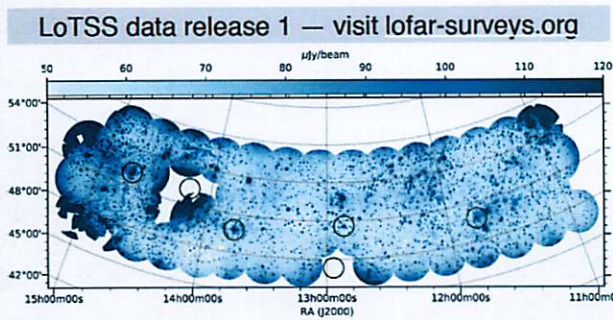


Figure 1: Presentation of the products from the LoTSS DR1 which was published in Feb. 2019 together with ~25 science papers from the Survey Key Science Projects. The catalogues, images and all data processing software and pipelines are fully public (T. Shimwell).

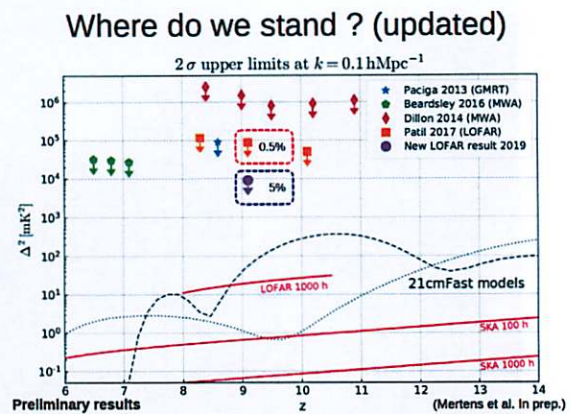


Figure 2: Preliminary LOFAR upper limits on the EoR compared with other experiments (F. Mertens).

1.1 RADIONET RELEVANCE

The conference focused both on the scientific results achieved using the RadioNet facility LOFAR, as well as planned LOFAR technical development which will enable exciting new science opportunities. The event triggered cross-disciplinary discussions as it brought together astronomers from all LOFAR Key Science Projects (Cosmic Magnetism of the Nearby Universe, Ultra-high-energy Cosmic Rays, EoR, Solar Physics and Space Weather, Deep Extragalactic Surveys, Transients and Pulsars). It also explored links to complementary radio facilities as well as to major observatories at other wavebands, thereby broadening the scientific horizon of the participants.

1.2 IMPACT

The meeting provided an important forum for users to give feedback on LOFAR operations and highlight potential improvements. It brought international LOFAR users up to speed with the latest LOFAR science results and promoted the exchange of ideas and new collaborations. The RO is striving to grow the community of LOFAR users by making more science-ready data available and organising events such as this meeting. Special emphasis was given to providing younger members the chance to develop their career by show-casing their results.

Discussions on major technical developments, in particular on more sophisticated calibration techniques and enhancement of the LOFAR station electronics, will ensure that the telescope remains unique and scientifically impactful in the SKA-era.

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2 AGENDA OF THE EVENT

The agenda of each of the three events is attached.

3 PARTICIPANTS

There were 130 participants from 12 EU countries and Australia. 58 (45%) of the participants were PhD students or postdocs and 37 (28%) of the participants were female. There were 12 invited speakers. The attendance list, including name, affiliation and country, and signed by the participants, is attached.



Figure 1: Conference group photo



4 RADIONET FINANCIAL CONTRIBUTION

As communicated to RadioNet management on 17 April 2019, the financial contribution from RadioNet will be used to cover part of the coffee breaks and lunches for the full list of attendees. The relevant receipts are attached.

5 PUBLICATIONS

No publications related to the conference are planned.

6 CONFIRMATION

We confirm that RadioNet is allowed to publish this report, including the list of participants, statistical details, pictures, etc..

Tuesday 21 May

- 8:55 - 9:00 Welcome by René Vermeulen
SURVEYS AND METHODS (chair: Stijn Buitink)
- 9:00 - 9:30 **Shimwell, Tim** ASTRON
The LOFAR Two-metre Sky Survey
- 9:30 - 10:00 **Williams, Wendy** Leiden University
The LoTSS optical/IR identifications
- 10:00 - 10:15 Tasse, Cyril Observatoire de Paris
Improvements of LoTSS calibration and imaging for DR2 and application to LoTSS-deep fields
- 10:15 - 10:30 de Gasperin, Francesco Hamburg University
The LOFAR LBA Sky Survey: first thermal noise limited images
- COFFEE
- SURVEYS AND METHODS cont'd** (chair: Antonia Rowlinson)
- 11:00 - 11:30 **Kuiack, Mark** University of Amsterdam
The seconds timescale radio sky with AARTFAAC
- 11:30 - 12:00 **O'Sullivan, Shane** Hamburg University
A LOFAR Faraday Rotation Measure Grid for studying Cosmic Magnetic Fields
- 12:00 - 12:15 **Mooney, Sean** University College Dublin
Blazars in the LOFAR Surveys Data
- 12:15 - 12:30 **Creaner, Oisín** Dublin Inst. for Advanced Studies
BeamModelTester: a calibration testing tool for LOFAR
- LUNCH
- PULSARS AND ISM** (chair: Cathy Horellou)
- 13:30 - 14:00 **Bondonneau, Louis** LPC2E Orleans
Low frequency pulsar observations with NenuFAR
- 14:00 - 14:15 **Bak Nielsen, Ann-Sofie** MPIfR/Bielefeld University
ISM studies with low-frequency pulsar observations
- 14:15 - 14:30 **Rozko, Karolina** Univ of Zielona Gora
The importance of low frequency observations for the understanding of the GPS pulsars spectra
- 14:30 - 14:45 **Sobey, Charlotte** CSIRO
Faraday rotation measures towards pulsars using LOFAR: probing the 3-D Galactic halo magnetic field
- 14:45 - 15:00 **Arias, Maria** University of Amsterdam
Supernova Remnants with LOFAR
- 15:00 - 15:15 **Jelic, Vibor** Ruder Boskovic Institute
Magnetically aligned straight depolarisation canals
- COFFEE
- EARTH** (chair: Emanuela Orrú)
- 15:45 - 16:15 **Hare, Brian** University of Groningen
Lightning Leaders Imaged with Meter-Scale resolution
- PLANETS AND STARS**
- 16:15 - 16:45 **Vedantham, Harish** ASTRON
Low frequency radio emission from stars and planets
- 16:45 - 17:00 **Callingham, Joseph** ASTRON
Stellar systems at low frequencies: Radio stars and exoplanets
- 17:00 - 17:15 **Feeney-Johansson, Anton** Dublin Inst. for Advanced Studies
A new method to measure magnetic fields in jets from young stars using LOFAR
- 17:15 - 17:30 **Griessmeier, Jean-Mathias** LPC2E Orleans
The search for exoplanetary radio emission: Jupiter as an exoplanet
- 19:00 - 22:00 Conference dinner at Grand Café de Burcht

Wednesday 22 May

- THE EXTRAGALACTIC UNIVERSE** (chair: Marijke Haverkorn)
- 9:00 - 9:30 **Mertens, Florent** University of Groningen
Observing the Epoch of Reionization with LOFAR
- 9:30 - 9:45 **Schwarz, Dominik** Bielefeld University

9:45 - 10:00 *The angular two-point correlation of LoTSS radio sources*
Best, Philip University of Edinburgh

The LOFAR Deep Survey Fields
10:00 - 10:30 **Marcus Brüggen** (for Annalisa Bonafede) Hamburg University
Galaxy clusters at low frequencies

COFFEE

THE EXTRAGALACTIC UNIVERSE cont'd (chair: Diana Morosan)
11:00 - 11:15 Cuciti, Virginia Hamburg University
Ultra-low frequency follow-up of the galaxy cluster Zwcl0634.1+4750

11:15 - 11:30 Di Gennaro, Gabriella Leiden University
Exploring particle (re-)acceleration in merging galaxy clusters

11:30 - 11:45 Gourdji, Kelly University of Amsterdam
LOFAR observations of gravitational wave merger events and GRBs

11:45 - 12:00 Stacey, Hannah University of Groningen
Gravitationally-lensed star formation and AGN activity at low radio frequencies

12:00 - 12:15 Chyzy, Krzysztof Jagiellonian University
Magnetisation of the Universe - the case of the irregular galaxy NGC4449

12:15 - 12:30 Seethapuram Sridhar, Sarrvesh ASTRON
Magnetizing the universe with dwarf galaxies: A new low-frequency radio continuum perspective

12:30 - 12:45 Heesen, Volker Hamburg University
The LOFAR radio continuum view on galactic winds

LUNCH

SUN (chair: Hanna Rothkaehl)
13:45 - 14:15 **Morosan, Diana** University of Helsinki
Imaging Radio Shock Signatures of Solar Coronal Mass Ejections with LOFAR

14:15 - 14:30 Tiburzi, Caterina ASTRON
Pulsars track the Solar wind

14:30 - 14:45 Maguire, Ciara Dublin Inst. for Advanced Studies
Insights into Coronal Mass Ejection: Shocks with the Irish Low Frequency Array (I-LOFAR)

14:45 - 15:00 Ryan, Aoife Maria Trinity College Dublin
Imaging the Solar Corona during the 2015 March 20 Eclipse using LOFAR

15:00 - 15:15 Zucca, Pietro ASTRON
Interferometric and beam-formed observations of the Sun with LOFAR: Present situation and future challenges

COFFEE

(SPACE) WEATHER (chair: Marcus Brüggen)
15:45 - 16:15 **Grzesiak, Marcin** Space Research Center
Spatio-temporal analysis of LOFAR scintillation measurements

16:15 - 16:30 Rothkaehl, Hanna CBK PAN
Monitoring of Space Weather conditions with LOFAR station in Borowiec

16:30 - 16:45 Mevius, Maaijke ASTRON
Overview of Space Weather activities with LOFAR

COSMIC RAYS
16:45 - 17:15 **Mulrey, Katie** University of Brussels
Detecting Cosmic Rays with LOFAR

17:15 - 17:30 Corstanje, Arthur Radboud University
Xmax reconstruction and mass composition of cosmic rays with LOFAR

5th LOFAR Users Meeting - Programme

Monday 20 May 2019

10:30 - 11:00	Registration & coffee	
11:00 - 11:05	WELCOME	
The LOFAR Radio Observatory: current status and future work (I)		
11:05 - 11:20	R. F. Pizzo	<i>LOFAR observatory overview and feedback from 4th LOFAR Users Meeting</i>
11:20 - 11:35	M. Drost	<i>LOFAR technical operations & maintenance</i>
11:35 - 11:50	M. Brentjens	<i>The LOFAR Technical Working Group</i>
11:50 - 12:05	J. Annyas	<i>LOFAR software development</i>
12:05 - 12:20	H. Jense	<i>The Radio Observatory Road Map</i>
12:20 - 13:50 Lunch		
The LOFAR Radio Observatory: current status and future work (II)		
13:50 - 14:05	V. Pandey & C. Bassa	<i>COBALT2: capabilities of the new LOFAR correlator</i>
14:05 - 14:20	R. Kaptijn	<i>The LOFAR Efficiency Improvement project</i>
14:20 - 14:35	T. Shimwell	<i>The Science Delivery Framework project: Production Pipeline Enhancement</i>
14:35 - 14:50	H. Holties	<i>Perspectives on processing on LTA infrastructures & ASTRON Data Portal</i>
Forum RO - Users Community		
14:50 - 15:10	J. M. Griessmeier	<i>The LOFAR Users Committee</i>
15:10 - 15:40	Coffee break	
15:40 - 17:45	<i>Discussion between Users and RO: Users experience (proposals, observations, data reduction, ...)</i>	
17:45 - 19:30	<i>Welcoming reception</i>	

The path to a LOFAR2.0 - Programme

Thursday 23 May 2019

9:00 - 9:15	C. Jackson	ASTRON's view of LOFAR futures
9:15 - 9:45	J. Hessels	Setting the stage: COBALT2.0, DUPLLO and LOFAR for Space Weather
9:45 - 10:15	W. van Cappellen	LOFAR2.0 Stage 1 development
10:15 - 10:30	C. Bassa	COBALT2.0 status and commissioning
10:30 - 11:00	Coffee	
11:00 - 11:30	F. de Gasperin	LOFAR LBA imaging
11:30 - 12:15	H. Röttgering	Pitch: Extending LOFAR's uv coverage on intermediate baselines
12:15 - 12:45	R. Wijers	Pitch: All-sky monitoring with AARDWOLF
12:45 - 13:45	Lunch (lunchbox)	