



Monthly Newsletter of International URSI Commission J – Radio Astronomy

July 2018

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News Items

Greetings Commission J Members!

Planning is underway for the Pacific Radio Science Conference (AP-RASC). The latest list of Commission J sessions is provided below. I'll pass along additional information as it becomes available.

I'm soliciting for workshop and session ideas for the 2020 URSI General Assembly and Scientific Symposium in Rome. We want to be sure to cover the latest trending research topics in radio astronomy. A list of the sessions held at the 2017 GASS is provided below for reference. Beginning next month, I will fold your ideas into a working draft of the 2020 GASS Commission J program which we can continue to modify over the coming months.

“Beauty is in the eye of the beholder.” The English form of this idiom was first used by the Irish writer Margaret Wolfe Hungerford in her novel “Molly Bawn” (1878). One could argue that it also applies to research: “Beautiful data are in the eye of the investigator” This month's Activities Spotlight is focused on research by Maaijke Mevius and Richard Fallows who used LOFAR to probe the structure of the ionosphere. Their article nicely summarizes their recent work and includes several references for those inclined to probe further.

On a related topic, there are discussions underway about organizing a inter-commission Workshop on Space Weather to be held in conjunction with either the AP-RASC or the 2020 GASS. Details are forthcoming.

I kindly request your ideas, articles, news, photos, etc. for upcoming editions of Newsletter. Let's keep it interesting and informative! I thank all of you who have already contributed.

Submitted by R. Bradley

2019 URSI Pacific Radio Science Conference (2019 AP-RASC)

9 -15 March 2019, New Delhi, India

Plans are underway for the 2019 AP-RASC in New Delhi, India.

Please see <http://aprasc2019.com/> for details. Here are few highlights:



Conference Venue - India Habitat Centre, New Delhi

- Located at the Central part of New Delhi right next to the historic Lodhi gardens.
- Several star rated hotels within a few km radius.
- 2,500 sq.m of fully air-conditioned indoor convention space.
- Capable of hosting 20 sessions simultaneously.
- Auditorium with simultaneous interpretation and 35mm projection facility
- State of the art Audio-Visual facility
- Several outdoor venues for holding a variety of functions
- Underground parking for 1000 cars
- Excellent Food by In-House Chefs of fine dining Restaurants

Commission J sessions being discussed include:

J 1. One 2 hour session on uGMRT with a historical Introduction by Govind Swarup

*** session celebrating Govind's 90th year ***

J2. Updates from existing Radio Astronomy facilities - I

J3. Updates from existing Radio Astronomy facilities - II

J4. VLBI : current status and future prospects

J5. Radio Astronomy instrumentation & techniques - I

Receiver systems (analog, digital, optical fibre etc)

J6. Radio Astronomy instrumentation and techniques -- II

Data processing (imaging, big data handling etc).

J7-GH Recent Science Results - solar and solar wind and space weather observations

J8 Recent Science Results - galactic, extra-galactic, star formation, transients etc

J9. The Early Universe (EoR expts and related)

J10. Future radio astronomy facilities (including SKA)

Joint Sessions with Comm. D : THz Devices and Circuits, Photonics

Joint Sessions with Comm. E : RFI propagation & Mitigation, Spectrum allocation

There is some discussion of a Space Weather Workshop at the AP-RASC but this has not been finalized.

2020 URSI General Assembly and Scientific Symposium (2020 URSI GASS)

Rome, Italy

We are now in the early stages of planning for the next URSI General Assembly and Scientific Symposium. Volunteer to convene a session or organize a one-day topical workshop around an important area of research. Let's work together to maintain the long tradition of excellence that the GASS provides to the radio science community.

To help with the planning, a listing of the Commission J sessions included in the 2017 URSI GASS (Montreal) program is given below. Descriptions of these sessions and workshops may be found at http://www.ursi2017.org/side_program/scientific_program/commission_j_e.shtml

Very Long Baseline Interferometry

Conveners: Huib-Jan van Langevelde, Hideyuki Kobayashi

The Square Kilometre Array

Conveners: Robert Braun, Justin Jonas, Douglas Bock

Millimeter/Submillimeter Arrays

Conveners: Jongsoo Kim, Lars-Ake Nyman

Single Dish Instruments

Conveners: Karen O'Neil, Ettore Carretti, Zhiqiang Shen

Historical Radio Astronomy

Conveners: Richard Wielebinski, Ken Kellermann, Richard Schilizzi

Receivers and Radiometers: Design and Calibration

Conveners: S. Srikanth, Miroslav Pantaleev, Arnold van Ardenne, Roberto Neri

Digital Signal Processing Hardware

Conveners: Albert-Jan Boonstra, Dan Werthimer

Detection of Short-Duration Transients and Pulsars

Conveners: Ben Stappers, Vicky Kaspi, Joeri van Leeuwen

Recent and Future Space Missions

Conveners: Fabrice Herpin, Martin Giard

Latest News and Observatory Reports

Conveners: Richard Bradley, Willem Baan

AstroPhotonics (Commissions JD)

Conveners: Martin Roth, Peter Maat, Stefan Minardi

Characterization and Mitigation of Radio Frequency Interference (Commissions JEF GH)

Conveners: Frank Gronwald, V. Deniau, Richard Bradley, Terry Bullet, Hanna Rothkaehl, David LeVine, Amit Kumar Mishra, M. Haredim, J. Gavan

Ionospheric Models and their Validation (Commissions JG)

Conveners: Stefan Wijnholds, Sean Elvidge

Spectrum Management (Commissions ECJ)

Conveners: J. Pedro, A. Tipaldy, A. Shukla, H. Liszt

Solar, Planetary, and Heliospheric Radio Emissions (Commissions HJ)

Conveners: P. Galopeau, G. Mann, H. O. Rucker, Y. Yan, S. White, T. Bastian

Workshop on RFI Mitigation and Characterization (Commissions EFGHJ)

Conveners: F. Gronwald, R. Bradley, T. Bullet, H. Rothkaehl, D. Le Vine, A. Maitra, M. Haredim, J. Gavan, V. Deniau, P. de Matthaëis

Workshop on Extreme Space Weather Environments (Commissions GHJ)

Workshop Chair: Mike Hapgood,

Workshop Co-Chair: Terry Onsager,

Conveners: Tony Mannucci, Viviane Pierrard, Mauro Messerotti, Ludwig Klein

Activities Spotlight - Ionospheric Measurements Using LOFAR

Although the ionosphere mainly proves a nuisance for radio astronomy at low frequencies, radio interferometric instruments can also be used to probe the structure of the ionosphere. It is well known that the amount of disturbance of an electromagnetic signal due to the ionospheric plasma scales with the wavelength of the signal. With LOFAR's low frequencies we are able to detect effects that are not seen by instruments operating at higher frequencies, such as GNSS.

LOFAR is a large low frequency telescope, with a dense core of 24 stations distributed within a 3 km diameter circle in the East of the Netherlands. Another 14 Dutch stations have baselines up to 100 km, whereas 13 international stations are distributed over many countries in Europe. Each station consists of many antennas of two different types, the low band antennas (LBA) with a frequency range between 30 and 80 MHz and the high band (HBA) with the possibility to measure between 110 and 240MHz. The data of a single station are added with appropriate delays to form a station beam in a particular direction. These data can be used to produce dynamic spectra with high time (sub second) and frequency (0.2 MHz) resolution. In interferometric mode, the data of all stations are correlated to create visibilities with highest resolution of 1s, 3kHz. Typically, after flagging for RFI, these data are processed at lower resolution.

With the LOFAR telescope we gain insight on the ionosphere in various ways. Since ionospheric diffractive delays are a main source of calibration errors, calibration parameters give a direct measure of the differential integrated electron content over the array. Amplitude scintillation can be measured with single station data and moving scintillation patterns are observed if the data of more stations is combined. Also, dual polarization elements allow the measurement of rotation of the polarization angle of a linear polarized signal due to the interaction with the ionospheric plasma and the Earth magnetic field, known as Faraday rotation. Interestingly, even an unpolarized signal can become artificially polarized if the Faraday rotation effect above the two arms of an interferometric differ.

We have used the station beam data to find ionospheric scintillation patterns of a bright astronomical source, such as Cas A. Comparing the scintillation amplitudes of several stations, one gets a direct view of the patterns in the ionosphere at the station positions projected along the line of sight. Imaging these patterns in time this gives a movie of the ultra fine structures in the ionosphere, moving around above the LOFAR core. Although at midlatitude, at these frequencies amplitude scintillation is observed almost continuously, contrary to what has been observed with GNSS measurements at higher frequencies (*R. A. Fallows et al, 2016 ApJL 828 L7*).

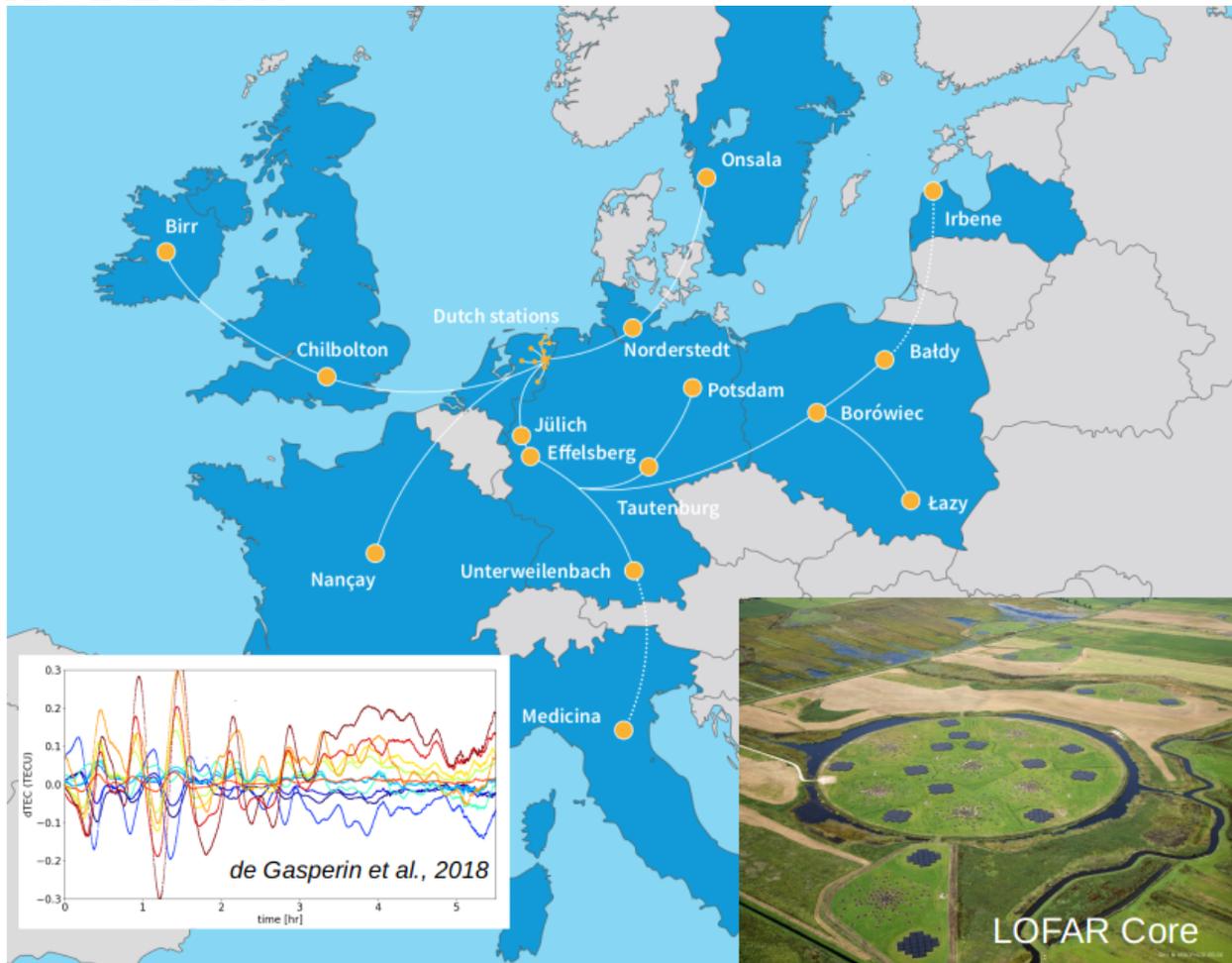
In interferometric mode, the data of all stations are correlated and averaged to typical 1 second time resolution. Since, in this mode the system is only sensitive to the phase difference of a signal arriving at two stations, the measured ionospheric effects are also mainly differential. A linear gradient in ionospheric Total Electron Content (TEC) over the array will cause a (frequency dependent) shift of the measured position of a source. Higher order terms will cause the source to be deformed in the image plane. Typically, the ionospheric variation in a single direction can be described by a linear gradient for the LOFAR core, where higher order terms show up at longer baselines. When imaging the position shifts of a large number of sources inside the LOFAR beam as a vector field, larger scale disturbances, like Traveling Ionospheric Disturbances (TID)s or duct like structures (*e.g. Loi, S. T., et al. (2016), J. Geophys. Res. Space Physics, 121, 1569–1586*), become visible over an area corresponding to the LOFAR beam. Although a single pointing of the LOFAR HBA beam only corresponds to about 10 degrees, and therefore to about 50 square km at an altitude of 300 km, it is possible to use LOFAR in simultaneous multi-beaming mode, sacrificing bandwidth for more pointings. In order to have enough S/N to measure the positions of hundreds of sources with high enough accuracy, the time cadence of movies made in this mode is typically 1 minute.

During calibration, station based phase errors are estimated by comparing a model of the sources in the sky (usually a calibrator, a bright source in the center of the beam) to the actual data. The ionospheric effects are separated from other (instrumental) phase effects by making use of the wide bandwidth and the typical frequency behavior of ionospheric delay. To first order the ionospheric phase errors go with freq^{-1} , although at the lowest LOFAR frequencies (<40 MHz) third order frequency effects (freq^{-3}) become visible. Since phase errors can be measured with very high accuracy, LOFAR is able to measure differential integrated TEC with an accuracy smaller than 1 milliTECU ($10^{13} \text{ e}^-/\text{m}^2$), using a typical HBA calibrator observation with 10s integration. Using the phase solutions in the direction of a single calibrator, we measure the differential TEC on an area in the ionosphere equal to the footprint of LOFAR. (*Mevius et al, 2016, Radio Sci. 51, 927–941*)

The second order phase delay effect, Faraday rotation, scaling with (freq^{-2}) , causes a phase delay of circular polarized signals like GNSS. At LOFAR it becomes visible as a rotation of the linear polarization angle. Given an Earth magnetic field model, the measured time varying rotation angle of a polarized source can give a direct measure of the absolute TEC (*Sotomayor-eltran C. et al 2013 A&A 552 A58*). But even for an unpolarized source the effect is visible if the ionospheric Faraday rotation angle above the stations of a baseline differ, either because of differential TEC, or a slightly different parallel magnetic field vector. In a recent paper we show all three orders of ionospheric phase effects in LBA calibrator data (*de Gasperin et al, 2018, A&A, <https://doi.org/10.1051/0004-6361/201833012>*).

Submitted by M. Mevius and R. Fallows

Photo from the Field



Plot of total electron content variation along the observation path (in TECU). Values are differential between Core Station 001 (assumed constant at 0) and Remote Stations. The backdrop is a map showing the locations of the LOFAR stations. An aerial photograph of the LOFAR Core is included.

Photo courtesy of R. Fallows

If you have an interesting photograph that you wouldn't mind sharing with others in the public domain I encourage you to please send a copy to me along with a brief caption and the person's name or organization to whom I should credit.

