Monthly Newsletter of International URSI Commission J – Radio Astronomy

January 2018

Prepared by R. Bradley, Chair, Commission J, rbradley@nrao.edu

Officers

Chair:	Richard Bradley	ECRs:	Stefan Wijnholds
Vice-Chair:	Douglas Bock		Jackie Gilmore

News Items

Greetings Commission J Members!

Reminder - the abstract deadline for the 2018 URSI Atlantic Radio Science Conference (2018 AT-RASC) is January 10, 2018! We encourage you to present your research findings or project updates at the AT-RASC in May. A limited amount of travel support is available for students and Young Scientists - please see the AT-RASC article and website for details. If you have questions or concerns regarding a particular session please feel free to contact the session convener.

The "Book Shelf" this month features a new release by Jaap Baars and Hans Kärcher. A brief synopsis of the book's content is included in the Newsletter.

This month, we highlight *Radio Science*, the journal that is co-sponsored by URSI. Its origin dates back to the *Journal of Research of the National Bureau of Standards* (now NIST) that has been published since 1904. Its Section D (Radio Propagation, 1959-1963, Radio Science, 1964-1965;) was continued as the journal *Radio Science* since 1966. Over the past several years, quite a few radio astronomy papers have appeared in *Radio Science* spanning a wide range of topics. Phil Wilkinson, Editor in Chief of *Radio Science*, gives us a overview of the journal and provides a listing of recently published papers that may be of interest to Commission J members. Please keep *Radio Science* in mind when considering where to publish your latest research findings!

All this and a photo, too! I hope you're finding the Newsletters both interesting and informative - your comments and suggestions are always welcome.

Submitted by R. Bradley

2018 URSI Atlantic Radio Science Conference (2018 AT-RASC)

28 May – 1 June 2018, ExpoMeloneras Convention Centre, Gran Canaria

Submission deadline: January 10, 2018

http://mailchi.mp/intec/submission-for-at-rasc-2018-is-now-open-pprh9v00w2?e=6dc54cab9b

J.1 *Software Enabled Radio Astronomy*

Richard Prestage, Cedric Viou, Alessandra Zanichelli

The worldwide astronomy community is pushing forward on an unprecedented scale to create large aperture and dense low frequency arrays. Single-dish telescopes are being equipped with phased array feeds, ultra-wideband receivers, real-time fast radio burst detectors, and other advanced digital instrumentation. This new generation of telescopes and instrumentation share the need for exceptionally sophisticated signal processing algorithms, and we are entering the era of "software enabled radio astronomy". This session will focus on the research challenges and latest approaches in the field of heterogeneous FPGA / CPU / GPU software development, including algorithms for array calibration, beamforming, imaging, and radio frequency interference mitigation.

J.2 *Large N Aperture Arrays*

Eloy de Lera Acedo, Kris Zarb Adami

This session will cover different aspects on the design and operation of large N arrays for modern radio astronomy in the era of SKA (eg. SKA1-LOW, HERA, MWA, LOFAR, etc). The session will cover aspects of both the antenna arrays, RF chains, digital beam forming, science data processing and science goals of these instruments.

J.3 *Pattern Recognition Applications in Radio Astronomy*

Abhi Datta, David Rapetti

With the advent of next generation radio telescopes like the Hydrogen Epoch of Reionization Array (HERA), the Square Kilometer Array (SKA) and the next generation Very Large Array (ngVLA), we expect the radio sky to be surveyed at unprecedented sensitivity. While observations with these telescopes should bring in a paradigm shift in our knowledge of the radio sky, this also comes with unprecedented data volume. For example, the SKA is expected to produce more than tens of terabytes of data per second at its fullest capability. Manual processing of this amount of data is not feasible. Hence, automation in data processing and the use of pattern recognition and machine learning techniques to extract the wealth of scientific information from such a Big Data set are critical. Machine learning algorithms such as support vector machines (SVM), K-nearest neighbors (KNN), decision trees, neural networks and deep neural networks are already in use in radio astronomy. This session will focus on the recent advances, challenges and future prospects of this field of research.

J.4 *Novel Instrument Concepts and Observational Challenges*

Douglas Bock, Richard Bradley

This session is designed to capture new work that may NOT fit into other sessions. Novel ideas that can be applied to instruments, signal processing, or observational strategies that have the potential for improving measurements are welcome, including requests for specialized instrumentation or techniques that could solve a challenging astronomical measurement requirement.

J.5 *Detecting Hydrogen Near and Far*

Jackie Hewitt, Eloy de Lera Acedo

The first detection of radio emission from neutral hydrogen In an astronomical source, in this case our Galaxy, was accomplished through the pioneering work of Ewen and Purcell in 1951. Since then, the 1.4 GHz line of neutral hydrogen has served as a tracer of astronomical phenomena on many scales. With the recent development of large low frequency radio arrays, there is renewed interest in using this technique to explore a variety of topics at a wide range cosmological redshifts, including for example detecting the first generation of stars and characterizing dark energy. This session will focus on the design and construction of instrumentation aimed at neutral hydrogen studies in the modern cosmological context.

J.6 *Instruments for Education*

Glen Langston, Kevin Bandura

Progress in radio communications and radio astronomy depends on education of the next generation of engineers and scientists. This session is focused on new and existing instruments enabling students to study the universe with radio techniques. Emphasis is placed on simple instrument designs the students can build. Presenters will describe groups operating these instruments, providing strong connections between technology development and scientific discoveries. The session covers topics of hardware design, curricula for education, student motivation, observing plans and large-scale research projects enabled by distributed groups of researchers.

J.7 *Mm wave / sub-mm Wave Science and Technology*

Pepe Cernicharo, Juan Daniel Gallego, Rolf Gusten

Special Sessions:

S-JACEFG – *Applications for pattern recognition methodologies*

This special interdisciplinary session, dedicated to an important new area of study, is designed to share ideas and experiences among the URSI Commissions. We would like to have one or two presentations from each of the participating Commissions that provide an overview or tutorial on how pattern recognition methodologies are being used or the types of problems for which it might be applied to areas of research within the Commission.

S-EACFJ - *Spectrum Management and Utilization*

Workshops:

JB - *Polarimetry of advanced antenna systems in radio astronomy*

JG - *3-D ionospheric models for radio interferometric calibration*

GJEFH - *Space Weather*

The AT-RASC will also include a Young Scientist Program and Student Paper Competition. Please see http://www.atrasc.com/homepage.php for additional information.

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.

2020 URSI General Assembly and Scientific Symposium (2020 URSI GASS)
Rome, Italy

The site for the next URSI General Assembly and Scientific Symposium has been chosen! Stay tuned for details. If you like to organize a session or workshop at the 2020 URSI GASS please let me know.

Book Shelf

Jacob W.M. Baars and Hans J. Kärcher
Radio Telescope Reflectors - Historical Development of Design and Construction.
Published by Springer. 01.12.2017: Astronomy ans Space Science Library, vol. 447, 275 pp.
ISBN 978-3-319-65147-7
From the publisher's page:
"This book demonstrates how progress in radio astronomy is intimately linked to the development of reflector antennas of increasing size and precision. The authors describe the design and construction of major radio telescopes as those in Dwingeloo, Jodrell Bank, Parkes, Effelsberg and Green Bank since 1950 up to the present as well as millimeter wavelength telescopes as the 30m MRT of IRAM in Spain, the 50m LMT in Mexico and the ALMA submillimeter instrument. The advances in methods of structural design and coping with environmental influences (wind, temperature, gravity) as well as application of new materials are explained in a non-mathematical, descriptive and graphical way along with the story of the telescopes. Emphasis is placed on the interplay between astronomical and electromagnetic requirements and structural, mechanical and control solutions. A chapter on management aspects of large telescope projects closes the book. The authors address a readership with interest in the progress of engineering solutions applied to the development of radio telescope reflectors and ground station antennas for satellite communication and space research. The book will also be of interest to historians of science and engineering with an inclination to astronomy."

Submitted by R. Bradley and J. Baars

Activities Spotlight

Radio Science and Commission J

Background for Radio Science

Radio Science is a journal published by AGU and Co-sponsored by URSI

Radio Science publishes original scientific contributions on radio-frequency electromagnetic-propagation and its applications. Contributions covering measurement, modelling, prediction and forecasting techniques pertinent to fields and waves - including antennas, signals and systems, the terrestrial and space environment and radio propagation problems in radio astronomy - are welcome. Contributions

may address propagation through, interaction with, and remote sensing of structures, geophysical media, plasmas, and materials, as well as the application of radio frequency electromagnetic techniques to remote sensing of the Earth and other bodies in the solar system.

It can be accessed at: http://agupubs.onlinelibrary.wiley.com/hub/journal/10.1002/(ISSN)1944-799X/. Papers two calendar years and older are available, free, for download. More recent papers are available on subscription, or on payment of a small fee.

Past Commission J related papers appearing in Radio Science

Between 2014 to the present (November 2017): there have been 23 papers published in Radio Science of potential interest to Commission J people covering planetary, meteors and antenna arrays. Six of these papers featured on the Journal cover.

Below are the 23 paper titles published in Radio Science 2014 – 2017 (November).

1. March 2014: All-sky imaging of meteor trails at 55.25 MHz with the first station of the Long Wavelength Array
2. April 2014: The 2013 Chelyabinsk meteor ionospheric impact studied using GPS measurements
3. July 2014: Simulation of radar echoes from Mars' surface/subsurface and inversion of surface media parameters
4. July 2014: Greenland telescope project: Direct confirmation of black hole with sub-millimeter VLBI
   COVER: Conceptual drawing of the beam optics in the receiver cabin for the Greenland telescope project.
5. August 2014: Meteor radar wind over Chung-Li (24.9°N, 121°E), Taiwan, for the period 10–25 November 2012 which includes Leonid meteor shower: Comparison with empirical model and satellite measurements
6. November 2014 Monitoring motion and measuring relative position of the Chang'E-3 rover
7. January 2015: Understanding instrumental Stokes leakage in Murchison Widefield Array polarimetry
   COVER: A photo of an MWA tile
8. July 2015 Power spectrum analysis of ionospheric fluctuations with the Murchison Widefield Array
   COVER: A sample output from the MWA array ionospheric power spectrum analysis.
9. July 2015: Measuring phased-array antenna beampatterns with high dynamic range for the Murchison Widefield Array using 137 MHz ORBCOMM satellites
10. October 2015: A first demonstration of Mars crosslink occultation measurements
    COVER: Mars occultation geometry and profiles.

11. February 2016: A new model of amplitude fluctuations for radio propagation in solar corona during superior solar conjunction
12. February 2016: A comparison of atmospheric effects on differential phase for a two-element antenna array and nearby site test interferometer
13. April 2016: On the feasibility of detecting the ionospheric effects of solar energetic particle events at Mars using spacecraft-spacecraft radio links
14. June 2016: A new angle for probing field-aligned irregularities with the Murchison Widefield Array
    COVER: MWA geometry for observing ionospheric irregularities
15. July 2016: Probing ionospheric structures using the LOFAR radio telescope
16. July 2016: The Five-hundred-meter Aperture Spherical Radio Telescope (FAST) project
17. October 2016: Juno model rheometry and simulation
    COVER: An aerial view of FAST under construction on 26 September 2015
18. February 2017: Chang' E-3 spacecraft surface reflection causes turbulence on VLBI delay
19. April 2017: Development of wideband feed for Kashima 34 m antenna
20. July 2017: Characterizing transient radio-frequency interference
21. September 2017: CLUSIM: A Synthetic Aperture Radar Clutter Simulator for Planetary Exploration
22. October 2017: Temperature Distribution and Influence Mechanism on Large Reflector Antennas under Solar Radiation
23. November 2017: First Detection of Two Near-Earth Asteroids with a Southern Hemisphere Planetary Radar System (Not yet published).

And currently the seventh most cited paper in Radio Science, “The Processing of Electron Density Profiles from the Mars Express MARSIS Topside Sounder” was published in 2013.

The Invitation

Clearly, radio astronomers are familiar with Radio Science, as the articles above testify. This note is a reminder that Radio Science is interested in radio astronomy; in fact, we seek publications on any application of new science that makes use of the radio spectrum. For instance, more recently, as radio astronomy embraces lower operating frequencies the ionosphere is becoming progressively more important and methods to mitigate its effects will be of immediate interest to the ionospheric community. This highlights the wide range of people who will see papers appearing in Radio Science although, granted, these days visibility in search engines is more important. In that respect, *Radio Science is now abstracted in IEEE Xplore giving Radio Science papers wider visibility.*

Here are some examples of topics that fit well in Radio Science; the list is certainly not exhaustive.

- Any papers that have an ionospheric orientation, either exploring the ionosphere in novel ways using radio astronomy techniques, or seeking to avoid ionospheric degradation (scintillation is a strong theme in Radio Science papers);
- RFI mitigation is a pervasive theme across all disciplines represented in Radio Science and the radio astronomy community has wide experience in dealing with it;
- New and innovative antenna array techniques for improved astronomical observations and the development of new radio astronomical facilities;
- New radio techniques for making solar observation, especially including making observations of the solar wind;
- Novel applications of occultation observations exploring planetary atmospheres;
- Propagation applications from deep space to exploring planetary surfaces.

In addition to research papers, Radio Science accepts review papers that emphasize radio science research applications (in radio astronomy for instance) and in October, Radio Science commenced seeking technical papers. These are shorter papers that describe hardware developments, technology, and experimental methods and other technical advances, including computer programs and instrumentation that represent a significant advance and enable new research.

I look forward to receiving many more papers from the radio astronomy community for publication in Radio Science.

Phil Wilkinson
Editor in Chief, *Radio Science*

Photo from the Field

The Greenland Telescope Project has successfully retrofitted its 12-m sub-millimeter antenna at Thule Air Base (TAB) in northwest coast of Greenland. The telescope is completely rebuilt, with many new components, from the ALMA North America Prototype antenna and equipped with a new set of sub-millimeter receivers operating at 86, 230, and 345 GHz, as well as a complete set of instruments and VLBI backends. The telescope is currently under intense testing and will be commissioned for the upcoming global VLBI observations on supermassive blackholes.

Submitted by Ming-Tang Chen

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 to whom I should credit.

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AT-RASC SUPPLEMENT

January 10, 2018

Officers

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Jackie Gilmore

Prepared by R. Bradley, Chair, Commission J, rbradley@nrao.edu

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IMPORTANT ANOUNCEMENT

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February 2018

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Prepared by R. Bradley, Chair, Commission J, rbradley@nrao.edu

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News Items

Greetings Commission J Members!

I would like to express my sincere thanks to our conveners of the 2018 URSI Atlantic Radio Science Conference (2018 AT-RASC) who have worked so diligently to assemble a wonderful set of interesting and informative sessions for you. We received a total of 87 abstracts for the Commission J sessions! Outstanding! I thank all of our members who submitted abstracts – your support of this URSI flagship conference is greatly appreciated. Your registration fees go toward assisting students and young scientists to participate in the URSI Conferences.

This month we highlight a special section in the current issue of the *Radio Science Bulletin* dedicated to the memory of Dr. Gianni Tofani. It traces the history and reviews current status in key areas of radio science technology in radio astronomy. Guest editors P. Bolli, N. D'Amico, and R. Nesti have assembled three invited papers for this issue, with more to come in a later issue. Please see the article below for additional information.

There were two omissions from the the January edition of the Newsletter that must be corrected:

1) In the list of radio astronomy papers published in the *Radio Science* journal - the paper entitled "From MAD to SAD: The Italian experience for the low-frequency aperture array of SKA1-LOW" which was published in the March 2016 issue and also got the cover page

2) The following credits for the beautiful photograph of the Greenland Telescope: "The Greenland Telescope Project is a joint project between the Academia Sinica Institute of Astronomy and Astrophysics and the Smithsonian Astrophysical Observatory, with collaborations with the MIT Haystack Observatory and the National Radio Astronomy Observatory."

The International Council for Science (ICSU) and the World Data System (WDS) are calling upon partner organizations concerned with scientific data stewardship to nominate new members of the Scientific Committee since the current three-year term will expire in June 2018. Please see the article below for additional information. Submission deadline is March 5, 2018. Send me an email, if interested.

I hope you're finding the Newsletters both interesting and informative - your comments and suggestions are always welcome.

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Additional information will appear here as the conference program is assembled.

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Radio Science Bulletin
You may download a copy at http://www.ursi.org/content/RSB/RSB_362_2017_09.pdf

The special section, "Radio Astronomy: A Continuous Demand for Breakthrough Technology" traces the history and reviews the current status of key areas of radio science technology in radio astronomy. Guest Editors, P. Bolli, N. D'Amico, and R. Nesti, have brought us three invited papers in this issue (see "Activities Spotlight").

The tremendous growth in wireless communications has led to a nearly insatiable demand for spectrum. That has led to the need for spectrum sharing. The requirement for radar and wireless communications systems to share spectrum in the 5 GHz band in the US is one example. Methods for doing this are considered in detail in the paper by Mina Labib, Vuk Marojevic, Anthony Martone, Jeffrey Reed, and Amir Zaghloul. They first introduce the general background of spectrum sharing. They then review the regulations related to spectrum sharing and radar systems. This is followed by an overview of the two main tasks associated with spectrum sharing: spectrum awareness and dynamic spectrum access. Detailed approaches are then presented, including cognitive communications systems, cognitive radar, waveform shaping, waveform design, and joint cognition. This paper provides a very nice introduction to of the major issues associated with and an overview of the major solution approaches for spectrum sharing between communications systems and radar.

This issue contains the texts of the speeches given by URSI President Paul Cannon and URSI Secretary General Paul Lagasse at the opening ceremony of the URSI XXXIInd General Assembly and Scientific Symposium (GASS) in Montreal, Canada, August 20, 2017. They contain important information about URSI, including the names of the officers elected for the new triennium.

Stefan Wijnholds' Early Career Representatives column has two reports. The first summarizes the Young Scientist Awards for the Montreal GASS. The second, by Sembiam Rengarajan, gives the winners of the Student Paper Competition at the GASS.

In their Ethically Speaking column, Randy Haupt and Amy Shockley look at the practice of selling bridges. They offer some thoughts on how to identify potential scams.

Özgür Ergül's Solution Box considers an optimization problem involving a nanowire transmission line with a coupler. The example solution, provided by Aşkın Altınoklu and Özgür Ergül, may not be optimum from several standpoints. Other solutions are sought.

In his Telecommunications Health and Safety column, Jim Lin looks at the "sonic health attacks" that have allegedly been made on diplomats in Havana. He suggests that the reported effects could have been caused by acoustic effects resulting from exposure to high-intensity microwave fields. There are some interesting possibilities.

In her Women in Radio Science column, Asta Pellinen Wannberg brings us the story of Iwona Stanislawska, the outgoing Chair of URSI Commission G, and a professor and the Director the Space Research Centre of the Polish Academy of Sciences. She provides an interesting perspective on her career in radio science.

Submitted by R. Stone

Activities Spotlight

Preface to the Special Section
"*Radio Astronomy: a continuous demand for breakthrough technology*"

Radio astronomy is a relatively young science: about an average human lifetime has passed since Karl Jansky's measurement campaign took place at Holmdel, New Jersey in the early 1930s , now celebrated as the birth date of Radio Astronomy.

Most people working in the field today can claim to have personally known the pioneers in their countries. In the case of Italy, one such pioneering fellow was Gianni Tofani who passed away in February 2015. He fully devoted his professional life to scientific and technological research in astrophysics, mainly from the wonderful Arcetri hill of his beloved city Florence. Furthermore, his management style was highly respected, bringing him to held leadership positions such as the Director of the Institute of Radio Astronomy.

Among his memberships to different scientific councils, Gianni was also President of the Italian section of URSI, and it is here, in a Special Section of this journal, that we celebrate his memory and acknowledge his contributions to the field.

The Editors of this Special Section have worked closely with Gianni over the past twenty years and have appreciated his professional and human qualities. It has been easy and satisfying to receive enthusiastic “Yes” when calling for a contribution to this session from worldwide authors, not only top quality researchers in their respective fields but also, mainly, very good friends. The Editors wish to kindly thank them all for their valuable contributions, which show complementary perspectives of technological advances in radio astronomy.

Due to the high number of papers constituting this Special Section, it will be divided in two issues of the *Radio Science Bulletin*. The first part, published in this issue, opens with two remembrances of Gianni Tofani from distinguished authors, A. van Ardenne (ASTRON, The Netherlands) and G. Pelosi (University of Florence, Italy). Then, several different technological topics applied to the radio astronomical research are authoritatively encompassed and reviewed: from mechanical engineering to digital and analog electronics, from very low frequency receiving systems to submillimeter wavelengths cameras, from metrology to signal processing techniques. However, there is a common thread among all of them: developing advanced technology for improving the knowledge of the Universe. This was exactly what Gianni Tofani pursued throughout his professional life. In this issue, we have the following papers:

J. W.M. Baars (MPIfR, Germany) and H. J. Kärcher (MT Mechatronics, Germany), “Seventy years of Radio Telescope Design and Construction”

R. F. Bradley (NRAO, USA), “The Precision Array for Probing the Epoch of Reionization (PAPER): A Modern Scientific Adventure”

P. F. Goldsmith (JPL, USA), “Submillimeter Heterodyne Focal Plane Arrays for High Resolution Astronomical Spectroscopy”

The next issue will contain contributions on the Sardinia Radio Telescope, the Square Kilometer Array, and the Atacama Large Millimeter Array respectively from N. D'Amico (INAF, Italy), P. Diamond (SKA Organization, UK) and L. Testi (ESO, Germany).

Submitted by P. Bolli(1), N. D’Amico(2,3), and R. Nesti(1)

(1) Italian National Institute for Astrophysics, Osservatorio Astrofisico di Arcetri, Firenze, Italy

(2) Italian National Institute for Astrophysics, Osservatorio Astronomico di Cagliari, Cagliari, Italy

(3) Università degli Studi di Cagliari, Dipartimento di Fisica, Cagliari, Italy

Request for Nominations: Scientific Committee of the World Data System

On behalf of Professor Sandy Harrison – the Chair of the World Data System (WDS, http://www.icsu-wds.org/) Scientific Committee – I would like to bring to your attention that the term of the current Scientific Committee will expire in June 2018 and several members will not be able to continue serving on the Committee.

Therefore, the International Council of Sciences (ICSU) and the World Data System would like to call their respective members, partners organizations concerned with scientific data stewardship to nominate new members of the Scientific Committee. Following the recommendation from the ICSU General Assembly, nominations of early career and female scientists or experts are strongly encouraged.

The Scientific Committee is the governing body of the WDS as defined in its Constitution (https://www.icsu-wds.org/organization/constitution_and_bylaws). It is composed of internationally recognized and leading researchers and experts in all aspects of scientific data. Members are appointed in their personal capacity normally for a three-year term renewable once by the ICSU Executive Board with attention to geographical, disciplinary and gender balance. In addition, at least four members are drawn from representatives of WDS Member Organizations. The list of current committee members are available at https://www.icsu-wds.org/organization/scientific-committee

Roles of the Scientific Committee Member:

- To ensure that the WDS supports ICSU's mission and objectives
- To define, develop and prioritize plans for the WDS
- To establish and oversee the review of existing and new members
- To establish and maintain a mechanism for oversight of WDS activities
- To facilitate cooperation and integration with relevant national, regional and international programmes, organizations, and institutions
- To mobilize funds for the implementation of WDS and related activities of the SC and Working Groups
- To publicize and promote the activities of WDS

Responsibilities of Scientific Committee Members:

- Attend face-to-face meetings twice a year, usually in Paris and Tokyo (travel support provided by ICSU and WDS International Programme Office) as well as monthly web conferences
- Represent WDS at relevant meetings around the world
- Guide and convene WDS Working Groups and appropriate work plans
- Assist in mobilizing financial and human resources for WDS

Submitted by Mustapha Mokrane, Executive Director

Photo from the Field

In order to explore new techniques for the instrumental calibration of radio astronomical low-frequency aperture array, an UAV-mounted artificial test source has been developed within a collaboration between Italian research institutes (INAF, CNR-IEIIT and the Politecnico di Torino). The main target of this system will be the huge aperture array SKA1-LOW. In the meantime, in April 2016, a measurement campaign was performed in the Netherlands on LOFAR (Low Frequency Array), built and operated by ASTRON, to collect reliable data on the response of the individual antennas including the coupling effects with other antennas and with the terrain. The picture shows the hexacopter mounting a dipole to illuminate the Low Band Antenna array of LOFAR (visible in the background) during the taking off.

Submitted by P. Bolli

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 to whom I should credit.

Monthly Newsletter of International URSI Commission J – Radio Astronomy

March 2018

Officers

Chair: Richard Bradley
Vice-Chair: Douglas Bock
ECRs: Stefan Wijnholds
Jacki Gilmore

Prepared by R. Bradley, Chair, Commission J, rbradley@nrao.edu

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News Items

Greetings Commission J Members!

Preparations continue for the 2018 URSI Atlantic Radio Science Conference (2018 AT-RASC). All of the submitted abstracts have been reviewed by the Commission officers. Activities associated with the Student Paper Competition and Young Scientist Award are completed. We are now ready to assemble the program. I'm aware of several scheduling conflicts that occur toward the end of the week so I'll do my best to arrange the schedule to alleviate potential problems. Also, there will be a short session on Photonics in Radio Astronomy included in the program – it was proposed too late to be included in the official announcement.

This month we highlight the NRAO/AUI Archives for radio astronomy. This is a wonderful resource for not only historians of science but also active researchers who seek a historical perspective for their work. The archives extend far beyond NRAO activities and includes information from a wide variety of sources. Archivist Ellen Bouton has generously provided an overview of the Archive for this edition of the Newsletter, including several links to websites for further information.

I appreciate the wonderful comments I've been receiving about the Newsletter. It is my pleasure to bring this to you each month. I welcome your ideas, articles, news, photos, etc. - I need your help to keep it interesting and informative.

Submitted by R. Bradley

2018 URSI Atlantic Radio Science Conference (2018 AT-RASC)

28 May – 1 June 2018, ExpoMeloneras Convention Centre, Gran Canaria

Abstract submission closed

Registration is now open

https://mailchi.mp/intec/at-rasc-2018-registration-is-now-open?e=6dc54cab9b

J.1 *Software Enabled Radio Astronomy*
Richard Prestage, Cedric Viou, Alessandra Zanichelli

J.2 *Large N Aperture Arrays*
Eloy de Lera Acedo, Kris Zarb Adami

J.3 *Pattern Recognition Applications in Radio Astronomy*
Abhi Datta, David Rapetti

J.4 *Novel Instrument Concepts and Observational Challenges*
Douglas Bock, Richard Bradley

J.5 *Detecting Hydrogen Near and Far*
Jackie Hewitt, Eloy de Lera Acedo

J.6 *Instruments for Education*
Glen Langston, Kevin Bandura

J.7 *Mm wave / sub-mm Wave Science and Technology*
Pepe Cernicharo, Juan Daniel Gallego, Rolf Gusten

Special Sessions:

S-JACEFG – *Applications for pattern recognition methodologies*
S-EACFJ - *Spectrum Management and Utilization*
S-J - Photonics in Radio Astronomy

Workshops:

JB - *Polarimetry of advanced antenna systems in radio astronomy*
JG - *3-D ionospheric models for radio interferometric calibration*
GJEFH - *Space Weather*

Additional information will appear here as the conference program is assembled.

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. A possible RFI mitigation workshop associated with this meeting is being discussed.

2020 URSI General Assembly and Scientific Symposium (2020 URSI GASS)
Rome, Italy

The site for the next URSI General Assembly and Scientific Symposium has been chosen! Stay tuned for details. If you like to organize a session or workshop at the 2020 URSI GASS please let me know.

Activities Spotlight

NRAO/AUI Archives
Initial design discussions for the VLA? Reber's financial records for construction of his Wheaton antenna? 85 foot telescope log books for Frank Drake's 1960 Ozma observations? Doc Ewen writing about detecting the HI line? Ron Bracewell's notes and correspondence from his years at Cambridge? John Findlay's materials on Project West Ford? Woody Sullivan's 1971-1988 interviews of 255 radio astronomers? Early discussions about a millimeter-wavelength array? Nan Deiter's recollections of her time at Harvard in the 1950s? GBT design and construction? The creation of NRAO? We have it all (and much more) in the National Radio Astronomy Observatory/Associated Universities Inc. Archives.

Started in 2003, the NRAO/AUI Archives actively seeks out, collects, organizes, preserves, and provides access to institutional records, personal papers, multimedia materials, and oral histories of enduring value which document NRAO's historical development, institutional history, instrument construction, and ongoing activities, including its participation in multi-institutional collaborations. As the national facility for radio astronomy, the Archives also includes materials on history and development of radio astronomy in the United States, particularly if such materials are in danger of being lost or discarded by other institutions or individuals.

NRAO has facilities in multiple US locations, as well as at ALMA sites in Chile; the Archives for all of NRAO are in a dedicated space in Charlottesville at NRAO/North American ALMA Science Center (NAASC). Since we were starting from nothing, our first concern was records of NRAO – 17 full file cabinets of back Director's Office files that had been stored in an unheated, uncooled attic storage space for years. A grant from the American Institute of Physics, Center for the History of Physics, funded the organization, processing, and indexing of NRAO records from our organization and founding through 1979, a time period covering the tenure of our first two Directors, Otto Struve and David Heeschen. More back files came to us from Tucson, from the warehouse in Green Bank, and from a storage area at the VLA site, and material continues to come to the Archives as files move from active to inactive status.

In 1995 Grote Reber donated materials to NRAO, 95 packing crates shipped to Green Bank, where they were opened and sorted by Reber, visiting for several weeks, and NRAO staff. Much of what he sent was old radio and electronic equipment, but the shipment included ~100 linear

feet of documents: correspondence, drawings, construction records, reports, photographs, notes, papers, and research materials. Reber's papers were transferred to the Archives in 2003, and a gift from the Reber estate funded their processing and allowed us to scan most of the material, see http://www.nrao.edu/archives/Reber/reber.shtml.

John Kraus, Ohio State Professor of Electrical Engineering and Astronomy for most of his career, was an antenna expert and build several radio telescopes, including an array of 96 helices completed in 1953, as well as "Big Ear," a fixed parabolic reflector, measuring 110 by 21 meters. After his 2004 death, Kraus' personal and professional papers (http://www.nrao.edu/archives/Kraus/kraus.shtml) were donated to the NRAO/AUI Archives by his son. In 2008 Ron Bracewell's family donated his radio astronomy papers (http://www.nrao.edu/archives/Bracewell/bracewell.shtml), including records from his time in Cambridge, at CSIRO, and his years at Stanford.

After completing his book, Cosmic Noise: A History of Early Radio Astronomy (Cambridge 2009) Woody Sullivan donated the 30 years' worth of research materials for the book, including 188 audio tapes for the extensive set of interviews he conducted between 1971 and 1988 with 255 radio astronomers around the world. Many of these interviews have been digitized and posted on the Web, and we continue to work towards making the full set available (http://www.nrao.edu/archives/Sullivan/sullivan.shtml).

Other collections (some large, some small) include papers of Donald C. Backer, Alan H. Barrett, Robert L. Brown, Bernard F. Burke, Marshall H. Cohen, Mark A. Gordon, David S. Heeschen, David E. Hogg, Kenneth I. Kellermann, Morton S. Roberts, Arthur M. Shalloway, A. Richard Thompson, James S. Ulvestad, Paul A. Vanden Bout, and Gart Westerhout.

The Archives also includes Web resources: writings on their work with accompanying photos by Nannielou Hepburn Dieter Conklin and H.I. (Doc) Ewen, an oral interview with Cambell M. Wade on the early VLA project and site search, and notes from early radio astronomy courses taught by H.C. van de Hulst (1951) and Kevin Westfold (1958).

Finding aids for all our collections are all on the Web, see http://www.nrao.edu/archives/ for an overview, and we have an online catalog, http://jump2.nrao.edu/dbtw-wpd/textbase/archivesearch.htm . Both the online catalog and the finding aids include links to those materials that have been scanned. We hope you will explore our holdings! Contact Ellen Bouton, Archivist (archivist@nrao.edu) for further information.

Submitted by E. Bouton

Photo from the Field

Should someone inform the operator that these antennas are not pointing properly? No, they're working just fine! This is ASKAP, a radio telescope being built by the CSIRO in Murchison Shire, 370km northeast of Geraldton in Western Australia. It's a network of 36 antennas, each 12 metres in diameter. While most radio telescopes see just one patch of sky at a time, ASKAP's phased-array feeds see 36 different patches of sky simultaneously. This is great for finding Fast Radio Bursts (FRB)s because the more sky you can see, the better chance you have of finding them. Normally, ASKAP dishes all point in the same direction for making images or to find faint FRBs. To find lots of FRBs we need to cast an even wider net. Here we see ASKAP antennas during fly's-eye observing. All the antennas point in different directions.

Photographer: Kim Steele, Curtin University.

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.

Monthly Newsletter of International URSI Commission J – Radio Astronomy

April 2018

Officers

Chair:	Richard Bradley	ECRs:	Stefan Wijnholds
Vice-Chair:	Douglas Bock		Jacki Gilmore

Prepared by R. Bradley, Chair, Commission J, rbradley@nrao.edu

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News Items

Greetings Commission J Members!

The program for the 2018 URSI Atlantic Radio Science Conference (2018 AT-RASC) is now available at http://www.atrasc.com/content/booklet.pdf Please check the website periodically for updates. A summary of the Commission J program is given below. I did what I could to avoid schedule conflicts that were known to occur toward the end of the week, including travel to the AAS Meeting in Denver, CO that begins on June 3. While I don't advocate parallel sessions, running two Commission J sessions in parallel Monday – Wednesday was the compromise. I apologize, in advance, for any inconvenience this may cause. I hope to see you at the AT-RASC.

One of the topics in our Activities Spotlight series will be radio astronomy from space. This month we highlight low frequency opportunities targeting cosmology. David Rapetti and Jack Burns have written a nice synopsis of the activities with lots of links for further study.

It is my pleasure to bring this newsletter to you each month. I welcome your ideas, articles, news, photos, etc. - I need your help to keep it interesting and informative.

Submitted by R. Bradley

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Abstract submission closed

Register at https://mailchi.mp/intec/at-rasc-2018-registration-is-now-open?e=6dc54cab9b
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AT-RASC - Commission J Program

Monday	***Room 9***	***Room 12***
AM	J1-1 (5)	J6 (4)
PM1	J1-2 (6)	J8-1 (5)
PM2	J1-3 (4)	J8-2 (2)

Tuesday	***Room 9***	***Room 12***
AM	J5-1 (6)	S-JB-1 (5)
PM1	J5-2 (4)	S-JB-2 (4)
PM2	---------- Poster Session ---------	

Wednesday	***Room 9***	***Room 12***
AM	J2-1 (5)	J3 (6)
PM1	J2-2 (5)	J4 (6)
PM2	J2-3 (4)	S-J (5)

Thursday	***Room 9***
AM	J9-1 (6)

NOTE: Number in parenthesizes indicates the number of papers within a given session

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J1 Software Enabled Radio Astronomy (15)
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J5 Detecting Hydrogen Near and Far (10)
J6 Instruments for Education (4)
J7 Mm wave / sub-mm Wave Science and Technology (cancelled)
J8 Radio Telescopes (7)
J9 Radio Astronomy (6)

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S-JACEFG – Applications for pattern recognition methodologies (now part of J3)
S-JB Polarimetry of Advanced Antenna Systems in Radio Astronomy (8)
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Rome, Italy
The site for the next URSI General Assembly and Scientific Symposium has been chosen! Stay tuned for details. If you like to organize a session or workshop at the 2020 URSI GASS please let me know.

Activities Spotlight - Low Radio Frequency Astronomy Opportunities from Space

After more than a decade searching for a signal from the Cosmic Dawn, the EDGES (Experiment to Detect the Global Epoch of reionization Signature) collaboration recently published a breakthrough observation of a 78 MHz absorption trough (Bowman, Rogers, Mozdzen, Monsalve & Mahesh, 2018, Nature 555, 67). In combination with NASA's renewed interest in lunar exploration, this result opens up an exciting landscape of opportunities for low radio frequency missions either in low lunar orbit or on the far side surface of the Moon. In addition to avoiding ionospheric contamination, the Moon would serve as an effective shield against Radio Frequency Interference (RFI) from the Earth and solar emissions (Burns et al., 2017, ApJ, 844, 33). Such radio telescopes would provide a new window to neutral hydrogen (HI) cosmology with precision and frequencies inaccessible from the ground.

The hyperfine spin-flip transition line of HI represents a powerful tool to study unexplored eras of the Early Universe such as the Dark Ages, when no astrophysical objects had yet formed, the Cosmic Dawn, when the first stars, galaxies and black holes appeared, and the Epoch of Reionization (EoR), before the vast majority of hydrogen became ionized by energetic photons from those first luminous objects. By observing the sky-averaged (global) 21-cm brightness temperature as a function of frequency (which through the expansion of the Universe can be directly translated into redshift or time), EDGES finds a profile consistent with these epochs. The Wouthuysen-Field effect, caused by the first stellar Lyman-alpha photons, coupled the spin with

the gas temperature. According to the EDGES results, this process started about 180 million years after the Big Bang. When stars began dying, X-ray heating from the gas accreting into stellar remnants such as black holes and neutron stars reversed the absorption of CMB photons into emission, creating a well-predicted trough, with a width now measured by EDGES of about 100 million years.

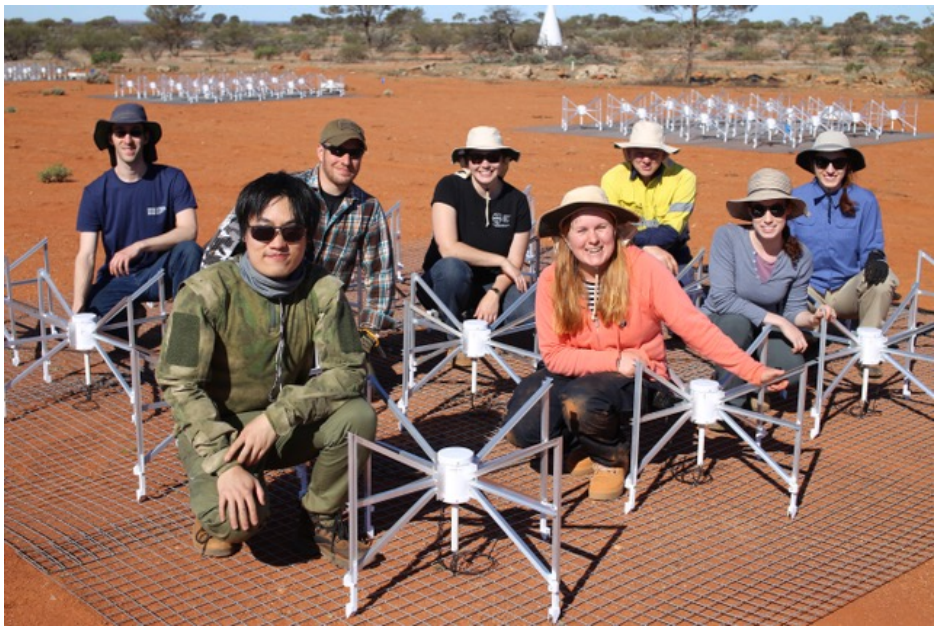
However, the shape of the EDGES spectrum and its large amplitude cannot be fit by current standard astrophysical models. For this reason, the confirmation of these measurements from ground and space-based experiments is now even more crucial. A companion paper to that of EDGES (Barkana, 2018, Nature 555, 71) proposes interactions between baryons and dark matter particles (see also Tashiro, Kadota & Silk, 2014, PRD 90, 083522, and Muñoz, Kovetz & Ali-Haïmoud, 2015, PRD 92, 083528) to explain the size of the amplitude. For velocity-dependent, Rutherford-like interactions, this possibility has recently been shown to be strongly constrained by multiple observations and experiments, with only a small fraction (below ~1%) of a millicharged dark matter subcomponent being still viable to produce the observed signal (see e.g. Muñoz & Loeb, 2018, arXiv:1802.10094; Barkana, Outmezguine, Redigolo & Volansky, 2018, arXiv:1803.03091; Berlin, Hooper, Krnjaic & McDermott, 2018, arXiv:1803.02804). In addition to Barkana (2018), a detailed analysis combining 21-cm astrophysics and dark matter modelling (Fialkov, Barkana & Cohen, 2018, arXiv:1802.10577) calculated a wide range of spectral shapes including an additional, associated smoking-gun feature for baryonic-dark matter scattering at lower frequencies ($\lesssim$10 MHz). Being in the Dark Ages, this is a predicted purely cosmological signal, unaltered by astrophysical objects.

Since such a low-frequency range is unavailable from the ground (below Earth's ionospheric cutoff of $\lesssim$15MHz), this critical signature to distinguish models of exotic physics is planned to be sought from space. For such a detection, the SmallSat mission concept DAPPER (Dark Ages Polarimeter PathfindER), to be located in a low frozen lunar orbit, is being designed to take advantage of a novel technique developed for and tentatively tested with the prototype of the Cosmic Twilight Polarimeter (CTP). The latter is a ground-based dual radio antenna experiment that utilizes the rotation of the earth to induce and measure polarization of the foregrounds, due to their anisotropy compared with the large beam (Nhan, Bradley & Burns, 2017, ApJ, 836, 1). This allows a clean separation between the isotropic, unpolarized 21-cm signal and large beam-weighted induced polarized foregrounds, as demonstrated using realistically simulated data, a pattern recognition plus information criteria code (pylinex), and a likelihood including Stokes parameters (Tauscher, Rapetti, Burns & Switzer, 2018, ApJ, 853, 187).

NASA's SSERVI Network for Exploration and Space Science (NESS) team is developing lunar mission concepts such as DAPPER, and single or array of radio telescopes to be telerobotically deployed from NASA's planned Lunar Orbital Platform-Gateway in the Moon's orbit. In addition to Dark Ages and Cosmic Dawn observations, NESS also is researching low radio frequency arrays to image Coronal Mass Ejections as well as for investigations of the magnetospheres and space weather environments in extrasolar planets (see for instance the upcoming AAS meeting-in-a-meeting on "Low Radio Frequency Observations from Space" organized by NESS).

Submitted by David Rapetti and Jack O. Burns

Photo from the Field



This month's photo is of the students who helped build the Murchison Widefield Array (MWA-II) upgrade. Lots of information, images, and videos of the instrument and research are available at http://www.mwatelescope.org/

Submitted by Miguel Morales

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.

Monthly Newsletter of International URSI Commission J – Radio Astronomy

May 2018

Officers

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Vice-Chair: Douglas Bock
ECRs: Stefan Wijnholds
Jacki Gilmore

Prepared by R. Bradley, Chair, Commission J, rbradley@nrao.edu

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News Items

Greetings Commission J Members!

The 2018 URSI Atlantic Radio Science Conference (2018 AT-RASC) is upon us!
The complete program is available http://www.atrasc.com/content/booklet.pdf A brief summary of the Commission J program is given below.

Commission J has one finalist in the AT-RASC Student Paper Competition. Many excellent papers were submitted and the competition is stiff. If you're attending the AT-RASC, please attend the student presentations to show support for all of these fine new researchers. A portion of your registration fee helps in providing travel support for students and Young Scientists attending the Conference.

A couple of our members are unable to attend the Conference due to illness - our thoughts are with you for a speedy and complete recovery.

The Activities Spotlight this month shines on the South African Radio Astronomy Observatory (SARAO) Human Capital Development Program, created in 2005 to develop a workforce of highly skilled engineers, scientists, technicians, and artisans to build, operate, and use the South African telescope facilities. Our Early Career Representative Jacki Gilmore kindly made the arrangements for this article, which includes a synopses of the program and testimonials from three former students. I thank Jacki and Vivienne Rowland for the nice overview of this successful program.

It is my pleasure to bring this newsletter to you each month. I welcome your ideas, articles, news, photos, etc. - I need your help in keeping it interesting and informative.

Submitted by R. Bradley

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Please consult the on-line program for room information

AT-RASC - Commission J Program

Monday

AM	J1-1 (5)	J6 (4)
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PM2	---------- Poster Session ---------	

Wednesday

AM	J2-1 (5)	J3 (6)
PM1	J2-2 (5)	J4 (6)
PM2	J2-3 (4)	S-J (5)

Thursday

AM	J9-1 (6)

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Activities Spotlight - SARAO
Human Capital Development Programme - Creating excellence in radio astronomy

The South African Radio Astronomy Observatory (SARAO) Human Capital Development Programme (HCD) was started in 2005 to ensure that a sustainable and demographically representative workforce of highly skilled engineers, scientists, technicians and artisans would be available to build, operate, and use the SKA and MeerKAT radio telescope facilities, as well as other local radio astronomy experiments.

To date, the programme has provided funding to 1,054 postdoctoral fellows, postgraduate and undergraduate students studying science and engineering degrees, and to FET students training to be artisans. In addition, the programme is funding five Research Chairs at South African universities, as well as a large number of faculty positions, research fellows, and visiting professors.

From a sample of 246 HCD alumni, 38 are currently employed in university positions in South Africa, and 18 in positions in universities elsewhere in Africa. In addition, 62 alumni are employed by SARAO, as scientists, engineers, technicians and artisans. In total, including alumni employed in industry and at other National Facilities, the HCD programme has added 173 individuals to the South African knowledge economy.

In addition to its contribution to the local economy, the HCD programme has also “contributed” 52 graduates into the international research and university sector. These figures may seem small, however, this is from a small sample of the alumni, as HCD is still in the process of tracking all it’s alumni.

“We must remember that each one of the HCD alumni is more than just a data point, it is a person, who, without the support of SARAO, may not be in the position they are in today. That is 246 success stories, 246 people working in research and development, and in turn many of them training and developing the next generation of scientists and engineers,” says Kim de Boer, Head of the HCD Programme at SARAO. “It is really gratifying to see these young people working in the fields they love, especially because we have known and supported many of them since they were at undergraduate or honours level.”

From the onset, the HCD programme has partnered with local universities and colleges to support academically excellent young people, to obtain the skills and qualifications needed by the radio astronomy sector. In addition, the programme has always provided financial support which is competitive with industry, and which covers the full cost of studying, so that the student’s focus in on their studies and research. Adopting these principles has ensured a higher than average graduation rate at all the academic levels supported by the programme, as well as a high throughput rate of students moving to the next academic level.

Graduation rates

Level	Graduation rate
Doctorate	79%
Masters	85%
B.Sc Honours	95%
Undergraduate (B.Sc and B.Eng)	85%
Bachelor of Technology	81%
National Diploma	71%

Throughput rates

B.Sc to B.Sc Honours	83%
National Diploma to B.Tech	80%
B.Sc Honours / B.Eng to Masters	44%
Masters to Doctoral	39%
Doctoral to Postdoctoral	28%

Tyrone van Balla from the Digital Backend Team at SARAO, joined the organisation as a Young Professional Development (YPD) recruit in 2015. He studied Electrical Engineering at the

University of Cape Town and specialised in electronics focusing on hardware and software development.

“Being part of the YPD programme at SARAO provided me with an opportunity to work on an industry leading project while at the same time finding the most suitable direction for my career as engineer. The work was and continues to be challenging, engaging and stimulating and SARAO fosters a culture of continued learning and provides many opportunities for further development. Working on the MeerKAT radio telescope array has been a rewarding and humbling experience and has provided me with a solid foundation for my future career in engineering,” says Van Balla.

Benjamin Hugo, a Junior Software Developer at SARAO, completed a Masters degree in Computer Science at the University of Cape Town in 2016 working on profiling and accelerating interferometric imaging algorithms. The same year he joined the Radio Astronomy Research Group at SARAO, where works primarily on imaging software.

“I consider it a great privilege to have had the opportunity to join an organisation where a diverse set of engineering and science skills are required on a day-to-day basis to overcome the very challenging problems that accompany such a massive infrastructure project undertaking.”

“In my opinion this project is surely ranked up there as one of the largest-ever infrastructure development projects undertaken in our country in the last half century. It has and will have a significant contribution to the science and engineering capacity of the country. It is a great honour to participate in this effort. My three years have taught me a host of software development and data processing skills that can be applied in many other contexts,” says Hugo.

He is currently studying towards his PhD focusing on galaxy cluster evolution and profiling and parallelizing pipelines.

Palesa Nombula, a current YPD student in the Commercialisation Unit at SARAO, joined the organisation in January 2018. She is currently studying towards her Masters degree in Astrophysics, focusing on Cosmology and cleaning the HI intensity mapping with machine learning techniques.

“Being part of this programme is a great transition from being a student to being a working professional. I have been challenged enough to learn what my abilities are, I have been able to evaluate my ability and potential in my field of occupation. The environment is safe enough for learning but also competitive enough to push me towards achieving my goals. One has to be well

organised to deal with the pressure of working and studying - it has been a big adjustment but very rewarding," says Nombula.

For more information visit http://www.ska.ac.za/students/

Submitted by Vivienne Rowland from the SARAO office and Jacki Gilmore

Photo from the Field

Attendees at the 2017 SARAO Human Capital Development Programme Postgraduate Bursary Conference held in Cape Town

Photo supplied by of the SARAO/HCD bursary program office

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Prepared by R. Bradley, Chair, Commission J, rbradley@nrao.edu

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News Items

Greetings Commission J Members!

I would like to express my sincere thanks to the URSI Atlantic Radio Science Conference organizers and Commission J session chairs / conveners who made the 2018 AT-RASC an incredible success. In addition, I thank all of you who travelled to Gran Canaria to not only present your talks and posters but also to discuss the latest findings with colleagues, meet up with old friends, or perhaps form new ones - without your support it simply would not have been possible. See the "Activities Spotlight" section below for more information.

We congratulate Jan-Willem Steeb (Stellenbosch University) of Commission J who won first prize in the AT-RASC Student Paper Competition! Strong technical reviews of his excellent paper, "Mitigation of Non-Narrowband Radio Frequency Interference," combined with high scores by the Commission judges for his well-delivered presentation gave Jan-Willem the edge over the other contestants. Well done!

All of the finalists in the AT-RASC Student Paper Competition deserve a round of applause. The competition was excellent, providing quite a challenge for the judges. I highly encourage all of you who advise graduate students to get them involved in the next competition (AP-RASC). It is an important learning experience for all of the students, regardless of the outcome.

We now turn our attention to the Pacific Radio Science Conference (AP-RASC) scheduled for early 2019. Vice-Chair Douglas Bock will help organize the Commission J program in close collaboration with Indian National Committee representatives. Of course, we will include details in the Newsletter as the program unfolds. The flagship conferences of URSI are great venues to hold topical workshops. Take the initiative and make it happen - contact us for details!

There is a bit of news from the URSI Board – see note from W. Baan.

It is my pleasure to bring this newsletter to you each month. I welcome your ideas, articles, news, photos, etc. - I need your help in keeping it interesting and informative.

Submitted by R. Bradley

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

9 -15 March 2019, New Delhi, India

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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.
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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

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

Rome, Italy

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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
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Single Dish Instruments
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Historical Radio Astronomy
Conveners: Richard Wielebinski, Ken Kellermann, Richard Schilizzi

Receivers and Radiometers: Design and Calibration
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Digital Signal Processing Hardware
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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

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News From the Board

A New Journal

URSI will start a new 'Radio Science Letters' journal (name not fixed yet) that will be open access and online only. For time being 4 page Letters will be considered from all URSI Commissions. First Call for papers expected in 2019.

URSI-Related Workshops and Conferences

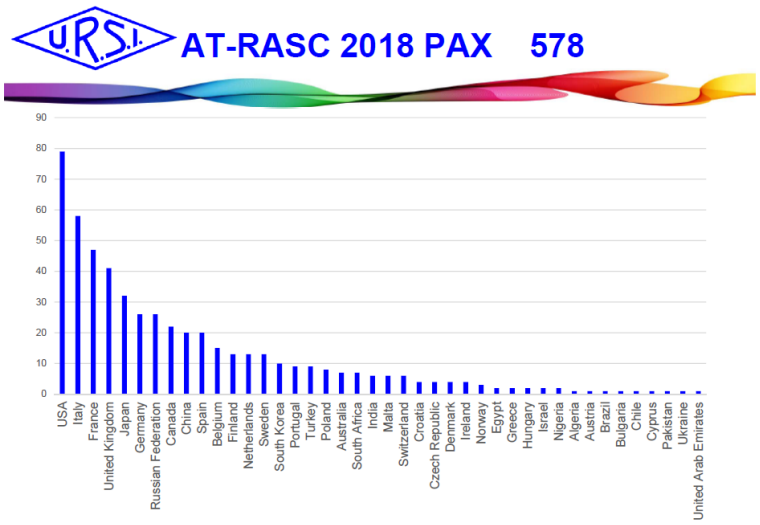
URSI will continue to (technically and or financially) support URSI-related workshops and conferences. Requests of support for meetings in 2019 are to be submitted to URSI by November 1, 2018 upon which URSI will identify/publicize those that will be supported. Commission Chairs will be consulted in the selection process.

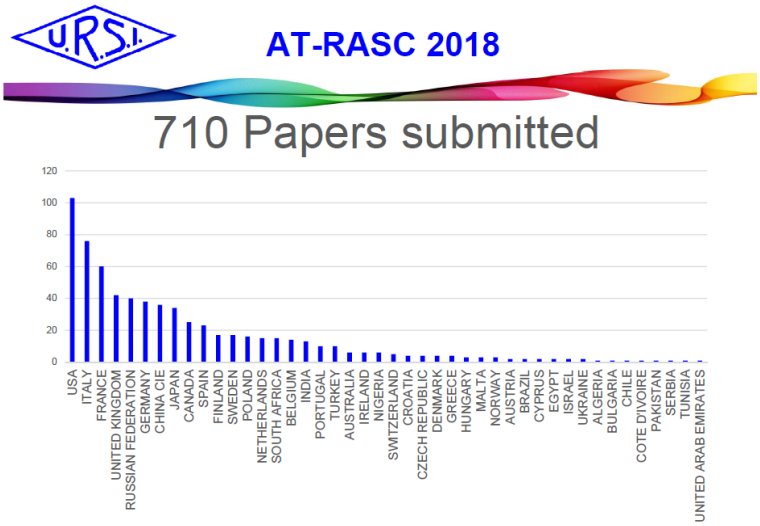
Submitted by W. Baan

Activities Spotlight - The 2018 URSI Atlantic Radio Science Conference in Perspective

The interdisciplinary nature of our URSI conferences is becoming increasingly important. Our modern research environment has evolved into fragmented areas of concentration and the number of highly specialized technical workshops and publications we encounter today all reinforce this growing trend. On the other hand, URSI conferences, such as the recent AT-RASC, provide unique opportunities for all of us to broaden our horizons. This is especially important for our young researchers where URSI can help them become scientists, awakening to the realization that their work isn't isolated at all, but part of a broader framework where ideas, techniques, and solutions fostered for one area have applications in another.

Geographical distribution of all 578 attendees - all URSI Commissions





Geographical distribution of the 710 papers submitted to the conference from all Commissions

Geographical distribution of the Young Scientists participating in the Conference from all Commissions.

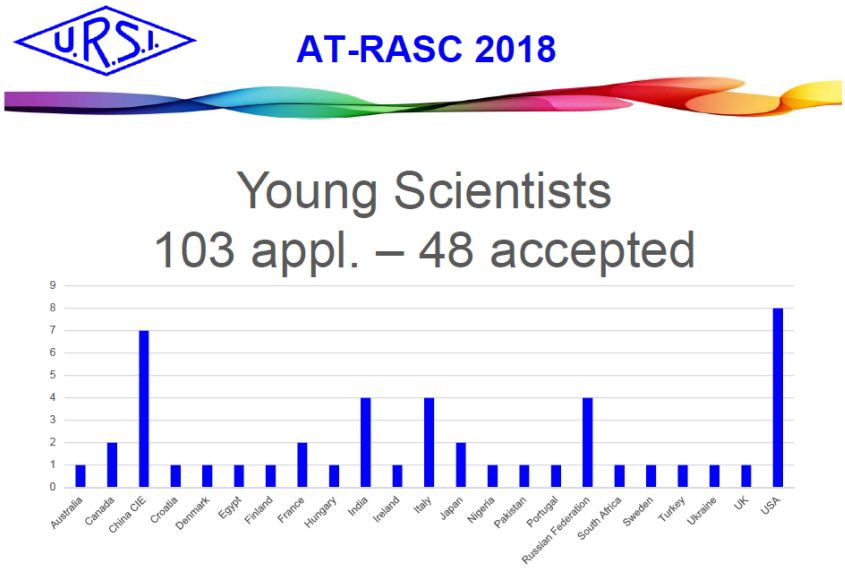


Photo from the Field

Jan-Willem Steeb presenting his work during the Student Paper Competition at the 2018 AT-RASC. By participating in URSI conferences, our young investigators are learning to effectively communicate their work to others, an important element of a successful research endeavour.

Photo supplied by R. Bradley

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.

Monthly Newsletter of International URSI Commission J – Radio Astronomy

July 2018

Officers

Chair: Richard Bradley
Vice-Chair: Douglas Bock
ECRs: Stefan Wijnholds
Jacki Gilmore

Prepared by R. Bradley, Chair, Commission J, rbradley@nrao.edu

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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.

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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 midlattitude, 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*).

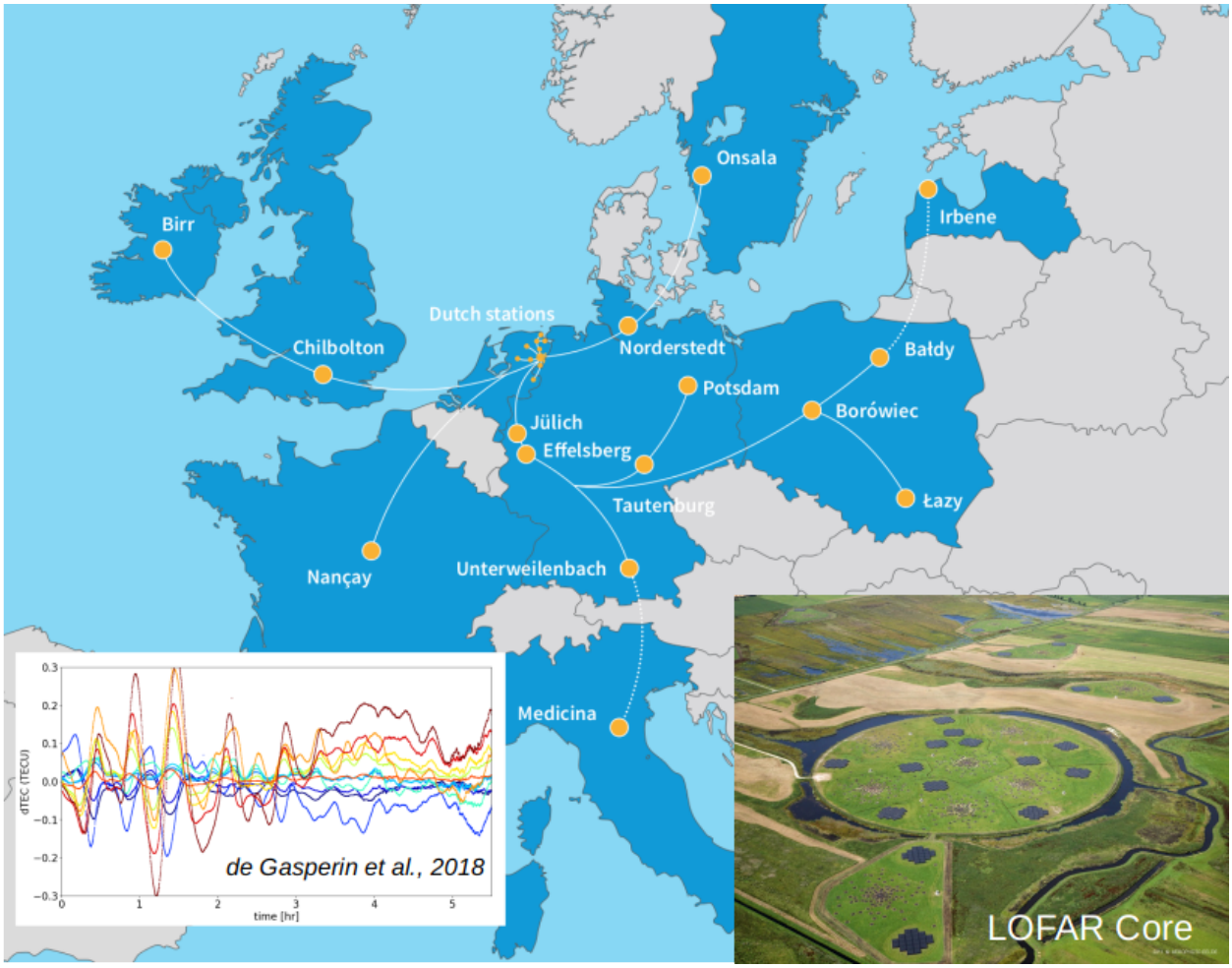
In interferometric mode, the data of all stations are correlated and averaged to typical 1 second time resolution. Since, in this mode the system is only sensitive to the phase difference of a signal arriving at two stations, the measured ionospheric effects are also mainly differential. A linear gradient 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 e-/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

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August 2018

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Jacki Gilmore

Prepared by R. Bradley, Chair, Commission J, rbradley@nrao.edu

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News Items

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The Commission J program for the upcoming Pacific Radio Science Conference (AP-RASC) has been finalized with a very nice set of interesting sessions. Please see the article below for details.

I'm continuing to solicit workshop and session ideas for the 2020 URSI General Assembly and Scientific Symposium in Rome. A working draft of the 2020 GASS Commission J program is given below – we will continue to modify it over the coming months. Your input is welcome and encouraged – consider convening a session – your help is appreciated by the organizers but the personal experience in seeing your session come together at the Symposium is quite rewarding.

Congratulations to the MeerKAT group on achieving an important milestone last month! The official inauguration was held on July 13 at the SKA site and Justin Jonas kindly captured the highlights of this event in a nice article for the Activities Spotlight this month. Some remarkable radio images from MeerKAT are included along with photos of the instrumentation and inaugural activities. Thank you, Jonas, for your contribution to the our Newsletter.

One of the two plenary speakers at the 2019 URSI-USNC meeting in Boulder, CO will be ALMA Director Sean Dougherty. The title of his presentation is "*Atacama Large Millimeter Array (ALMA) in 2030.*" See https://nrsmboulder.org/ for more information.

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.

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Commission J Program

J01: Evolution/Latest Results from uGMRT (Contributions and Felicitation of Govind Swarup)

Prof. Govind Swarup, the father of Radio Astronomy in India, left a career in Stanford, USA and returned to India in January 1962. Over the next several decades, he and his team designed and built several Radio Observatories in India, including the 32 dish interferometer in Kalyan, in Bombay, the Ooty Radio telescope, The Ooty Synthesis Radio Telescope and the Giant Meterwave Radio Telescope. This session will present a historical introduction on Prof. Govind Swarup who will be turning 90 in 2019 and take a look at some of the significant contributions to Radio Astronomy by Prof. Swarup and his group at TIFR and how they established Radio Astronomy research on a firm foundation in India.

Conveners: Subra Ananthakrishnan and Yashwant Gupta

J02: Updates from Existing Radio Astronomy Facilities – I

Radio astronomy has played a predominant role for more than five decades, both in terms of outstanding scientific achievements, and cutting edge technical developments. Major landmarks have been achieved for example in the discovery of the 21cm line of neutral hydrogen and its use in the study of the structure of the Milky Way, the role in discovering radio re-combination lines from ionized hydrogen (H II) regions, the discovery of pulsars, to name a few. Several Radio Astronomy facilities are either in the process or are planning major upgrades. This session aims to provide a platform for the exchange of information regarding the progress of these plans, as well as for each facility to provide an update on their current status as well as of recent exciting new science results made using the facility.

Conveners: Jayaram Chengalur and Douglas Bock

J03: Updates from Existing Radio Astronomy Facilities – II

The vast range of topics encountered in the pursuit of radio astronomy throws open very diverse fields ranging from the cosmic microwave background to radio galaxies, objects in our own solar system, and gravitation. These studies require functioning telescopes and facilities, many of which have been operating for many decades now. Some of these facilities like for example the Ooty Radio Telescope, have provided valuable complimentary data to space based observatories like ASTROSAT to achieve important new insights and breakthroughs in other wavebands like hard X-rays. This session will aim to provide a platform to bring together researchers working on establishing and/using radio astronomy facilities especially in the Asia-Pacific region and facilitate exchange of information regarding their progress and future plans. It will also enable researchers from each facility to provide an update on their current status as well as of recent exciting new science results made using the facility.

Conveners: R Ramesh and Douglas Bock

AP-RASC Commission J Program

J04: VLBI: Current Status and Future Prospects

With new instruments coming on line in the Asia Pacific region, there is growing scope for Very Large Baseline Interferometry (VLBI) between these facilities and the existing radio telescopes. While upgrade of GMRT provides a high sensitivity radio telescope for VLBI and geodesy, new telescopes are being commissioned in Thailand and China. Along-with the existing VLBI networks, such as the Korean and Japanese VLBI network and LBA, and antennas in China as well as the Russia-led Space VLBI mission Radio Astron, these facilities provide a platform for exciting VLBI science in studying extremely high brightness temperatures in active galactic nuclei, super-massive black hole binaries, new ways of probing radio scattering and scintillation in the interstellar medium, star formation and geodesy with both ground based interferometers as well as a space interferometer. This session aims to review recent developments in VLBI science, instrumentation and techniques with an audience of astrophysicists and instrumentation scientists in mind, while looking to future of VLBI in the SKA era. It also aims to bring together representatives of the community for discussions on collaboration for global VLBI efforts in these directions.

Conveners: B C Joshi and Sergeyi Gulyaev

J05: Radio Astronomy Instrumentation & Techniques – I (Rcvr Systems: Analog/Digital/Optical Fibre)

Increased bandwidth, sensitivity and wider field of view are some prime characteristics for new generation of receivers on radio telescopes that are being upgraded or built, such as FAST, MWA, ASKAP, Upgraded GMRT, ORT and MOST, as well as SARAS, SWAN, ELI, CSRH to name a few. In order to meet these demands, there has been plenty of research and development efforts taking place in various labs around the globe. This session aims to focus on progress and advances in receiver and radiometer technology. Suggested topics include design and construction of cryogenically cooled heterodyne and bolometers receivers, receivers with LNAs at ambient temperature for traditional multi-beams and phased array feeds (PAF), radiometers, RFI mitigation using PAFs, narrow band filters, HTS filters etc., technology development in the areas of improved dynamic range, time response, spectral bandwidth, spectral resolution, compactness in size etc. Other topics covered in this session include calibration techniques for single telescopes, interferometers and array receivers. This session will provide a forum for those engaged in these activities to share their experience and understanding, as well as to address and discuss possible solutions to meet the present and future challenges.

Conveners: B Ramesh and S Srikant

J06: Radio Astronomy Instrumentation & Techniques - II (Data Processing: Imaging, Big Data)

Even after about 2 decades, the Giant Metrewave Radio Telescope is still advancing, thanks to the "upgraded-GMRT" project. A near seam-less frequency coverage over 125-1500 MHz with new wide-band receivers has been built with an aim to increase the sensitivity of GMRT. The "upgraded-GMRT", now an SKA pathfinder instrument, will complement several other new space and ground observatories such as ASTROSAT in India, 500 m dia. FAST in China, etc. which will all be useful for discovery in several areas of astrophysics. The future Thirty-Meter-Telescope and the Square Kilometre Array projects, along with the above instruments, will also contribute enormous amount of data that will need sophisticated processing. This session aims to focus on the current trends, key results of imaging and its challenges, and big data handling.

Conveners: Dharam Vir Lal and Veeresh Singh

AP-RASC Commission J Program

JGH7: Recent Scientific Results on Solar, Solar Wind and Space Weather Observations

Observations of the solar corona at radio wavelengths have witnessed somewhat of a revival of late, with interesting new results from the Low Frequency Array (LOFAR) and the Murchison Widefield Array (MWA). In recent times, the Sun has shown an increasingly peculiar behaviour, with solar photospheric fields having continuously reduced over the past two decades or more and interplanetary micro-turbulence levels also having dropped in sync with solar photospheric magnetic fields. This rather unusual situation on the Sun will possibly have significant space weather and climatic effects and which can be studied using a host of ground and space based observatories. Imaging observations at cm and decimetre wavelengths are important in understanding flare energy release and energetic particle propagation and acceleration. Instruments like the Chinese Spectral Radio Heliograph (CRSH) operating between 0.4 and 15 GHz will play an important role in understanding these phenomena. This session aims to provide a platform for solar radio astronomers, plasma physicists, planetary scientists, astrophysicists, and radio scientists to communicate and discuss a wide range of interesting and exciting topics, including the recent progress of radio observations of the Sun, solar wind, and planets, spacecraft measurements, data processing, theories, new technologies and much more.

Conveners: P Subramanian, Yihua Yan and P Janardhan

J08: Recent Scientific Results on Galactic, Extra-Galactic, Star Formation, Transients

Recent years have seen major improvements in imaging the radio sky. In addition to the existing major radio telescopes such as ALMA, JVLA, GMRT, LOFAR and MWA, new facilities are also begun operational. In India, the existing Giant Metrewave Radio Telescope (GMRT) has just finished major upgrade with huge improvement in the sensitivity. MeerKAT in South Africa has just begun operational and in Australia ASKAP is beginning to image radio sky. In this session, updates from all major observatories and exciting science results from both existing and new facilities would be presented. This session also should enable collaboration among scientists.

Conveners: Ishwar Chandra and Kenta Fujisawa

J09: The Early Universe (EoR Experiments and Related Results)

This session aims to provide an update on the study of early universe at radio wavelengths. Study of Cosmic Dark Ages, Cosmic Dawn and Epoch of Re-ionization with the redshifted 21cm signal (redshift > 8) is a major probe to this last frontier of structure formation history. Several ongoing and upcoming radio telescopes are partially or fully dedicated to conduct crucial observations in this field. Major telescopes like the GMRT, LOFAR, MWA, 21CMA, PAPER have been used to observe the fluctuations of redshifted HI 21cm signal from these early epochs of formation of the Universe. Lessons learnt from these experiments forms an essential component of future observations with upcoming telescopes like the uGMRT, SKA and HERA. Similarly, all-sky averaged 21cm signal forms the major science goal another set of radio experiments like the EDGES, SWAN, BIGHORNS, etc. Moreover, the same probe is also utilised to study the evolution of the neutral hydrogen in later redshifts. Such observations about the HI intensity mapping forms major science goal of experiments like TIANLAI, CHIME and SKA.

Conveners: Abhirup Dutta and Tirthankar Roy Choudhury

AP-RASC Commission J Program

J10: Future Radio Astronomy Facilities (including Square Kilometre Array)

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The aim of this session is to focus on the following topics: radio frequency interference (RFI) issues and their mitigation that are of particular importance for observational sciences such as radio astronomy, microwave remote sensing of the Earth, and solar and ionospheric studies, where highly sensitive measurements are necessary.

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***** Draft Program for Commission J – GASS 2020 *****

Sessions:

New Telescopes on the Frontier
Recent and Future Space Missions
Conveners: Joe Lazio
Single Dish Instruments
Very Long Baseline Interferometry
Millimeter/Submillimeter Arrays
Receivers and Radiometers: Design and Calibration
Digital Signal Processing: Algorithms and Platforms
Short-Duration Transients and Pulsars: Observations, Techniques, and Instrumentation
Solar, Planetary, and Heliospheric Radio Emissions (Commissions HJ)
Ionospheric Models and their Validation (Commissions JG)
Characterization and Mitigation of Radio Frequency Interference (Commissions JEFGH)
Spectrum Management (Commissions ECJ)
Historical Radio Astronomy
Conveners: Richard Schilizzi
Latest News and Observatory Reports
Conveners: Rich Bradley and Douglas Bock

Workshops:

Space Weather (Commissions GHJ)

Activities Spotlight - MeerKAT Inaugration

The MeerKAT radio telescope was officially inaugurated on Friday 13th July 2018 by the Deputy President of South Africa, Mr David Mabuza, The event was held at the MeerKAT/SKA telescope site in the Karoo, with the formal proceedings being conducted in the huge dish fabrication shed that provided welcome shelter from the cold winter wind. Until October last year, when MeerKAT antenna #64 was completed, this shed had been the bustling production line for the MeerKAT main reflector sub-assemblies.

The Master of Ceremonies was Phil Mjwara, Director General of the South African Department of Science & Technology, and the Director General of the SKA Organization, Phil Diamond, and the

Managing Director of the South African Radio Astronomy Observatory (SARAO), Rob Adam, were among the speakers preceding the Deputy President's address.

Guests at the inauguration included senior officials in the South African government and the governments of a number of African partner countries, ambassadors from SKAO member countries, members of the Board of the SKAO (the SKAO Board meeting was held in South Africa in the two days immediately prior to the inauguration), international and local radio astronomers with close ties to the SKA and MeerKAT, contractors responsible for the delivery of major telescope subsystems, and SARAO staff members. Directors from various radio astronomy observatories were present, as were the PIs of the MeerKAT Large Survey Projects and providers of MeerKAT guest instrument back-end equipment.

Special guests with a long involvement in the SKA and MeerKAT projects included all of the past South African Ministers of Science and Technology who had overseen the initiation and execution of the MeerKAT project during there respective tenures, Prof Richard Schilizzi, the founding Director of the SKA Project Development Office and past Chair of Commission J, Dr George Nicolson, the Founding Director of HartRAO and the leading figure in the development of radio astronomy in South Africa, and Dr Khotso Mokhele who was CEO of the National Research Foundation when South Africa joined the SKA community and a key initiator of the MeerKAT project (Dr Mokhele was also a major figure in the SALT optical telescope project).

Although the actual telescope was the star of the show, the radio images that were revealed for the first time by Project Scientist Fernando Camilo also attracted huge accolades. These images are products of the very first MeerKAT observations that were conducted just days after the 64-station correlator was deployed.

An iconic image of the Galactic Centre, assembled from a mosaic of about 20 telescope pointings, was used as a backdrop to the stage. This is the most detailed and highest fidelity centimetre-wavelength radio image of the Galactic Centre ever made, showcasing the dynamic range of the MeerKAT resulting from the unblocked aperture, stable electronics, large number of baselines, and the dense central concentration of antennas (the fact that the Galactic Centre passes directly overhead MeerKAT also helped!). Single-dish L-band data from the Green Bank Telescope (provided by Bill Cotton, NRAO) was used to complement the interferometer data in order to provide zero-spacing UV coverage. According to Fernando Camilo, Chief Scientist at SARAO: "We wanted to show the science capabilities of this new instrument. The centre of the galaxy was an obvious target: unique, visually striking and full of unexplained phenomena – but also notoriously hard to image using radio telescopes. Although it's early days with MeerKAT, and a lot remains to be optimized, we decided to go for it – and were stunned by the results."

Other L-band radio images resulting from deep observations of extragalactic fields reveal thousands of new radio galaxies, highlighting MeerKAT's sensitivity and resolution. It is expected that all of the inaugural images will be the subject of journal publications in the near future.

No pulsar data was revealed at the inauguration event, but MeerKAT test observations of known millisecond pulsars have provided indications of impressive pulsar timing capability, primarily ascribed to the sensitivity, processed bandwidth and polarization purity of the telescope.

Although the MeerKAT is providing tantalizing first results, a significant programme of commissioning, debugging and extensions to functionality needs to be conducted in the coming months before the telescope will be ready for open calls for observing time and routine observations. In the interim, test and shared risk observations will continue to ensure that the MeerKAT is performing to specification, allowing the prioritized Large Survey Projects can get started.

A collection of quotes from radio astronomers who attended the event:

"Formal openings of new astronomical facilities can be dull affairs - often the instruments are still several years away from delivering science quality data. South Africa astronomers have bucked that trend with the immediate delivery of fantastic new images of the Galactic Centre and several other distant cosmic radio sources. MeerKAT has undoubtedly hit the ground running, and expectations of major astronomical discoveries being made soon are quite literally... sky high!" – Mike Garrett

"I have watched the development of MeerKAT from its genesis many years ago. It has been a massive achievement by the SARAO team to develop an impressive telescope on a virgin site, starting with such a small team. It was a pleasure to share the day with my South African colleagues, to see the already impressive early images and to contemplate what the future will bring as SKA starts construction." – Phil Diamond

"The MeerKAT launch was a happy affair celebrating the culmination of a visionary project for South Africa and the African continent. The quality of the Galactic Centre image was superb and promises well for exciting results in the future." – Richard Schilizzi

"It was amazing to see the breath-taking image of the galactic centre produced by MeerKAT as a testament to the power of the instrument. It is rare to see such an impressive demonstration at inauguration of these world-class facilities!" – Matthew Bailes

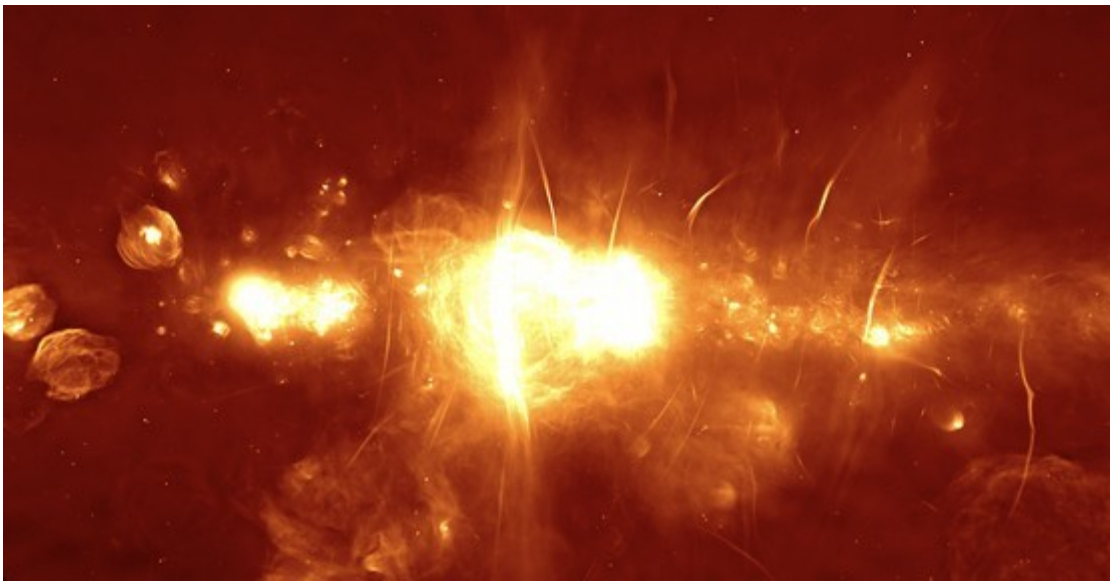
"This is a fantastic achievement. Our South African colleagues did not only build a radio telescope, they build the best. Truly remarkable." – Michael Kramer:

Submitted by J. Jonas

Please see the Photos from the Field section of the Newsletter for several photographs of the radio images, telescope instrumentation, and event activities.

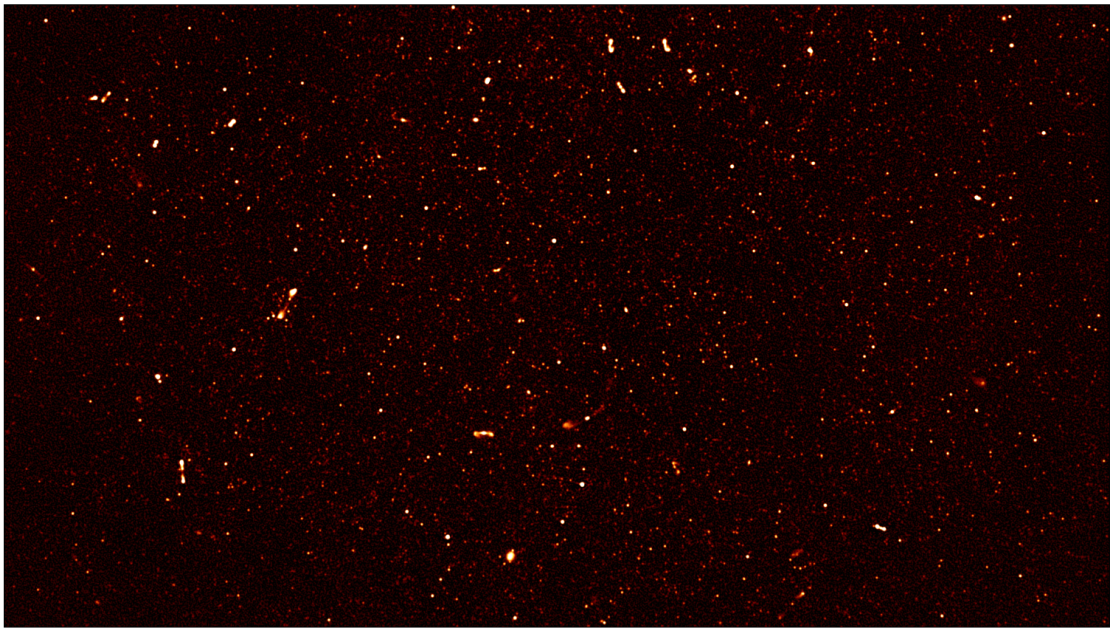
Photos from the Field

An aerial view of the inner core of the MeerKAT telescope. About 54 of the 13.5-meter antennas lie within the 1 km diameter core.



The mosaic L-band radio image of the Galactic Centre region produced from observations made within the first month of MeerKAT commissioning.

A MeerKAT single-pointing L-band image of the radio galaxy Fornax A.

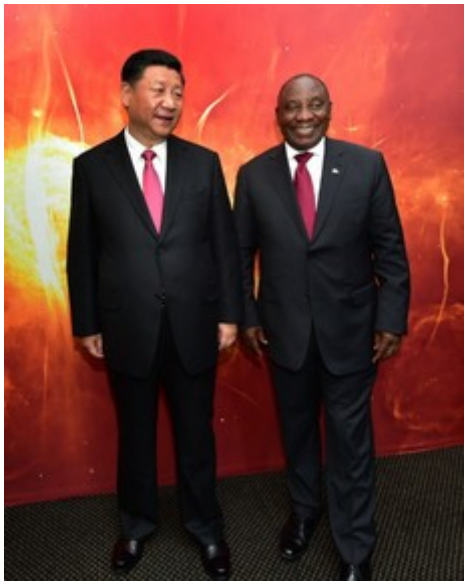


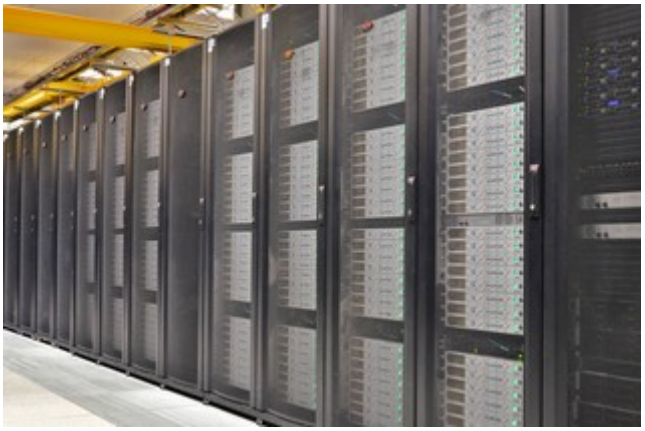
A section of a deep L-band single-pointing observation of a field towards the South Celestial Pole, revealing thousands of new radio galaxies within the MeerKAT primary beam area.

The Chair of the SKAO Board, Catherine Cersarsky, flanked by SKAO Director General, Phil Diamond, and SKA stalwart and past Commission J Chair, Richard Schilizzi. The sight of the MeerKAT core dishes evoked this response from Richard: "The MeerKAT dishes look like a flotilla of sails in the desert. Reminded me of the sails you see in Friesland NL of boats gliding along the canals."

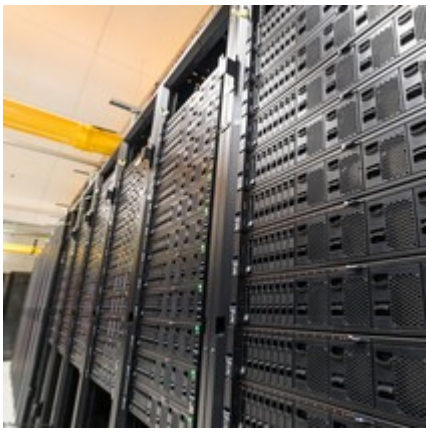
A view of the stage inside the dish construction shed that was used by the speakers at the MeerKAT inauguration. The backdrop to the stage was a large print of the MeerKAT radio image of the Galactic Centre.

Presidents Xi Jinping and Cyril Ramaphosa pose in front of the MeerKAT Galactic Centre image at a joint China-South Africa exhibition of science, technology and innovation in Pretoria that was held two weeks after the MeerKAT inauguration.





A section of the MeerKAT correlator, based on the CASPER architecture and populated with SKARAB (aka ROACH3) FPGA processing nodes.



The MeerTRAP back-end to MeerKAT, provided by Ben Stappers from the University of Manchester and funded by an ERC grant. MeerTRAP will undertake commensal searches for pulsars and fast transients during all of the Large Survey Projects. (Picture credit: Fabian Jankowski)

A small subset of the scientists, engineers and technical staff involved in the design, construction, commissioning and operation of the MeerKAT telescope.

Photos courtesy of J. Jonas

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.

Monthly Newsletter of International URSI Commission J – Radio Astronomy

September 2018

Officers

Chair: Richard Bradley
Vice-Chair: Douglas Bock
ECRs: Stefan Wijnholds
Jacki Gilmore

Prepared by R. Bradley, Chair, Commission J, rbradley@nrao.edu

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News Items

Greetings Commission J Members!

The abstract deadline for the Pacific Radio Science Conference (AP-RASC) is **15 October 2018**! The Conference will be held in New Delhi, India from 09 – 15 March, 2019. A summary of the Commission J sessions is given below. For abstract submission and additional details about the Conference, visit http://aprasc2019.com/ .

I'm continuing to solicit workshop and session ideas for the 2020 URSI General Assembly and Scientific Symposium in Rome. A working draft of the 2020 GASS Commission J program is given below – we will continue to modify it over the coming months. Your input is needed – consider convening a session.

There are two focused meetings being planned that I'd like to bring to your attention. "History of the SKA: 1980s to 2012" will be held from 3-5 April 2019 at Jodrell Bank and the "Cherenkov Telescope Array Science Symposium" will take place in Bologna, Italy from 6-9 May, 2019. Please see the announcements in this Newsletter for details.

One of the two plenary speakers at the 2019 URSI-USNC meeting in Boulder, CO will be ALMA Director Sean Dougherty. The title of his presentation is "*Atacama Large Millimeter Array (ALMA) in 2030.*" See https://nrsmboulder.org/ for more information. The abstract deadline for the 2019 URSI-USNC is **September 17, 2018**.

Our spotlight this month is on the LOFAR Station in Poland that is also being used as a tool for education. Leszek Błaszkiewicz of the Space Radio-Diagnostics Research Center, University of Warmia and Mazury describes how students not only participated in station construction tasks but are also engaged in various activities associated with the station's operation and observing functions. I thank Leszek for this very nice contribution to our Newsletter.

This issue marks the one-year anniversary for the Commission J Newsletter! 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

Plan to present your work at the 2019 AP-RASC in New Delhi, India!

See http://aprasc2019.com/ for details.

Commission J Program

J01: Evolution/Latest Results from uGMRT (Contributions and Felicitation of Govind Swarup)

Prof. Govind Swarup, the father of Radio Astronomy in India, left a career in Stanford, USA and returned to India in January 1962. Over the next several decades, he and his team designed and built several Radio Observatories in India, including the 32 dish interferometer in Kalyan, in Bombay, the Ooty Radio telescope, The Ooty Synthesis Radio Telescope and the Giant Meterwave Radio Telescope. This session will present a historical introduction on Prof. Govind Swarup who will be turning 90 in 2019 and take a look at some of the significant contributions to Radio Astronomy by Prof. Swarup and his group at TIFR and how they established Radio Astronomy research on a firm foundation in India.

Conveners: Subra Ananthakrishnan and Yashwant Gupta

J02: Updates from Existing Radio Astronomy Facilities – I

Radio astronomy has played a predominant role for more than five decades, both in terms of outstanding scientific achievements, and cutting edge technical developments. Major landmarks have been achieved for example in the discovery of the 21cm line of neutral hydrogen and its use in the study of the structure of the Milky Way, the role in discovering radio re-combination lines from ionized hydrogen (H II) regions, the discovery of pulsars, to name a few. Several Radio Astronomy facilities are either in the process or are planning major upgrades. This session aims to provide a platform for the exchange of information regarding the progress of these plans, as well as for each facility to provide an update on their current status as well as of recent exciting new science results made using the facility.

Conveners: Jayaram Chengalur and Douglas Bock

J03: Updates from Existing Radio Astronomy Facilities – II

The vast range of topics encountered in the pursuit of radio astronomy throws open very diverse fields ranging from the cosmic microwave background to radio galaxies, objects in our own solar system, and gravitation. These studies require functioning telescopes and facilities, many of which have been operating for many decades now. Some of these facilities like for example the Ooty Radio Telescope, have provided valuable complimentary data to space based observatories like ASTROSAT to achieve important new insights and breakthroughs in other wavebands like hard X-rays. This session will aim to provide a platform to bring together researchers working on establishing and/using radio astronomy facilities especially in the Asia-Pacific region and facilitate exchange of information regarding their progress and future plans. It will also enable researchers from each facility to provide an update on their current status as well as of recent exciting new science results made using the facility.

Conveners: R Ramesh and Douglas Bock

AP-RASC Commission J Program

J04: VLBI: Current Status and Future Prospects

With new instruments coming on line in the Asia Pacific region, there is growing scope for Very Large Baseline Interferometry (VLBI) between these facilities and the existing radio telescopes. While upgrade of GMRT provides a high sensitivity radio telescope for VLBI and geodesy, new telescopes are being commissioned in Thailand and China. Along-with the existing VLBI networks, such as the Korean and Japanese VLBI network and LBA, and antennas in China as well as the Russia-led Space VLBI mission Radio Astron, these facilities provide a platform for exciting VLBI science in studying extremely high brightness temperatures in active galactic nuclei, super-massive black hole binaries, new ways of probing radio scattering and scintillation in the interstellar medium, star formation and geodesy with both ground based interferometers as well as a space interferometer. This session aims to review recent developments in VLBI science, instrumentation and techniques with an audience of astrophysicists and instrumentation scientists in mind, while looking to future of VLBI in the SKA era. It also aims to bring together representatives of the community for discussions on collaboration for global VLBI efforts in these directions.

Conveners: B C Joshi and Sergeyi Gulyaev

J05: Radio Astronomy Instrumentation & Techniques – I (Rcvr Systems: Analog/Digital/Optical Fibre)

Increased bandwidth, sensitivity and wider field of view are some prime characteristics for new generation of receivers on radio telescopes that are being upgraded or built, such as FAST, MWA, ASKAP, Upgraded GMRT, ORT and MOST, as well as SARAS, SWAN, ELI, CSRH to name a few. In order to meet these demands, there has been plenty of research and development efforts taking place in various labs around the globe. This session aims to focus on progress and advances in receiver and radiometer technology. Suggested topics include design and construction of cryogenically cooled heterodyne and bolometers receivers, receivers with LNAs at ambient temperature for traditional multi-beams and phased array feeds (PAF), radiometers, RFI mitigation using PAFs, narrow band filters, HTS filters etc., technology development in the areas of improved dynamic range, time response, spectral bandwidth, spectral resolution, compactness in size etc. Other topics covered in this session include calibration techniques for single telescopes, interferometers and array receivers. This session will provide a forum for those engaged in these activities to share their experience and understanding, as well as to address and discuss possible solutions to meet the present and future challenges.

Conveners: B Ramesh and S Srikant

J06: Radio Astronomy Instrumentation & Techniques - II (Data Processing: Imaging, Big Data)

Even after about 2 decades, the Giant Metrewave Radio Telescope is still advancing, thanks to the "upgraded-GMRT" project. A near seam-less frequency coverage over 125-1500 MHz with new wide-band receivers has been built with an aim to increase the sensitivity of GMRT. The "upgraded-GMRT", now an SKA pathfinder instrument, will complement several other new space and ground observatories such as ASTROSAT in India, 500 m dia. FAST in China, etc. which will all be useful for discovery in several areas of astrophysics. The future Thirty-Meter-Telescope and the Square Kilometre Array projects, along with the above instruments, will also contribute enormous amount of data that will need sophisticated processing. This session aims to focus on the current trends, key results of imaging and its challenges, and big data handling.

Conveners: Dharam Vir Lal and Veeresh Singh

AP-RASC Commission J Program

JGH7: Recent Scientific Results on Solar, Solar Wind and Space Weather Observations

Observations of the solar corona at radio wavelengths have witnessed somewhat of a revival of late, with interesting new results from the Low Frequency Array (LOFAR) and the Murchison Widefield Array (MWA). In recent times, the Sun has shown an increasingly peculiar behaviour, with solar photospheric fields having continuously reduced over the past two decades or more and interplanetary micro-turbulence levels also having dropped in sync with solar photospheric magnetic fields. This rather unusual situation on the Sun will possibly have significant space weather and climatic effects and which can be studied using a host of ground and space based observatories. Imaging observations at cm and decimetre wavelengths are important in understanding flare energy release and energetic particle propagation and acceleration. Instruments like the Chinese Spectral Radio Heliograph (CRSH) operating between 0.4 and 15 GHz will play an important role in understanding these phenomena. This session aims to provide a platform for solar radio astronomers, plasma physicists, planetary scientists, astrophysicists, and radio scientists to communicate and discuss a wide range of interesting and exciting topics, including the recent progress of radio observations of the Sun, solar wind, and planets, spacecraft measurements, data processing, theories, new technologies and much more.

Conveners: P Subramanian, Yihua Yan and P Janardhan

J08: Recent Scientific Results on Galactic, Extra-Galactic, Star Formation, Transients

Recent years have seen major improvements in imaging the radio sky. In addition to the existing major radio telescopes such as ALMA, JVLA, GMRT, LOFAR and MWA, new facilities are also begun operational. In India, the existing Giant Metrewave Radio Telescope (GMRT) has just finished major upgrade with huge improvement in the sensitivity. MeerKAT in South Africa has just begun operational and in Australia ASKAP is beginning to image radio sky. In this session, updates from all major observatories and exciting science results from both existing and new facilities would be presented. This session also should enable collaboration among scientists.

Conveners: Ishwar Chandra and Kenta Fujisawa

J09: The Early Universe (EoR Experiments and Related Results)

This session aims to provide an update on the study of early universe at radio wavelengths. Study of Cosmic Dark Ages, Cosmic Dawn and Epoch of Re-ionization with the redshifted 21cm signal (redshift > 8) is a major probe to this last frontier of structure formation history. Several ongoing and upcoming radio telescopes are partially or fully dedicated to conduct crucial observations in this field. Major telescopes like the GMRT, LOFAR, MWA, 21CMA, PAPER have been used to observe the fluctuations of redshifted HI 21cm signal from these early epochs of formation of the Universe. Lessons learnt from these experiments forms an essential component of future observations with upcoming telescopes like the uGMRT, SKA and HERA. Similarly, all-sky averaged 21cm signal forms the major science goal another set of radio experiments like the EDGES, SWAN, BIGHORNS, etc. Moreover, the same probe is also utilised to study the evolution of the neutral hydrogen in later redshifts. Such observations about the HI intensity mapping forms major science goal of experiments like TIANLAI, CHIME and SKA.

Conveners: Abhirup Dutta and Tirthankar Roy Choudhury

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Spectrum Management (Commissions ECJ)
Historical Radio Astronomy
Conveners: Richard Schilizzi
Latest News and Observatory Reports
Conveners: Rich Bradley and Douglas Bock

Workshops:

Space Weather (Commissions GHJ)

Meeting and Workshop Announcements

Registration open for a meeting on the History of the SKA: 1980s to 2012

Dear colleagues,
We would like to draw your attention to a meeting on the History of the SKA from the 1980s to 2012, to be held from 3 to 5 April 2019 at the SKA Organisation Headquarters at Jodrell Bank. More information, including a registration form, is available at
https://indico.skatelescope.org/event/518/

Richard Schilizzi, Ron Ekers, and Peter Hall
(Convenors)

1st International Cherenkov Telescope Array Symposium - Exploring the High-Energy Universe with CTA
May 6-9, 2019 - Bologna, Italy

==========

The first CTA Science Symposium will focus on the novel investigations CTA will bring to the field and its synergies with other wavebands and messengers. It will also cover instrument characteristics, analysis tools and opportunities for guest investigators and how coordinated observations with CTA will have a significant impact on the exciting new era of multi-wavelength and multi-messenger astrophysics. The symposium is a unique opportunity to gather the scientific community to stimulate discussion and promote collaboration in the study of the high-energy Universe.

CTA will be the largest and most advanced ground-based observatory for gamma-ray detection at the energies from 20 GeV up to 300 TeV, beyond the current energy frontier for gamma-ray astrophysics. With more than 100 telescopes located in the northern and southern hemispheres, CTA will use its unprecedented accuracy and sensitivity to reveal an entirely new and exciting view of the turbulent sky furthering our knowledge about the high-energy Universe. Learn more about CTA at http://www.cta-observatory.org .

- Join us!
Pre-register now to get further information about the meeting: http://www.cta-symposium.com
No payment is needed at this point. Feel free to forward this information to anyone who might be interested.

- Venue
The Symposium will be held at Bologna's magnificent Teatro Duse (http://www.teatrodusebologna.it/la-sala/), one of the oldest theatres in the city. Located in the historic centre and housed in the Palazzo del Giglio the theatre has been used since the mid-seventeenth century.

We look forward to seeing you in Bologna!

Stefan Funk and Jim Hinton for the SOC.

Activities Spotlight - LOFAR Single Station as the Tool in Student's Education

1. The LOFAR Telescope

The LOFAR (Low-Frequency Array) radio telescope is a relatively new instrument, arranged as an interferometer, composed currently of 51 stations located in different parts of Europe [1]. The map the LOFAR station's locations is presented on Figure 1. Each station consist of up to 3264 omnidirectional dipole antennas (in full configuration). The antennas are divided into two separate types: Low Band Antennas (LBA) operating in the frequency range from 10 to 90 MHz and High Band Antennas (HBA) which are able to receive signals at the frequency from 110 to 240 MHz. HBA antennas are grouped in 16 pairs of dipoles in special tiles (see Figure. 2). Signals from individual dipoles are sampled at a clock rate of 200 MHz and, after this digitizing process which takes place in the field (inside the especially equipped container), generates up to 10 Gbits/s of raw data that is sent through a dedicated network to the analysis system. In additional, the beamforming process, which is based on adding artificial delays to the signal from individual dipoles, lets us point the instrument towards an interesting part of the sky.

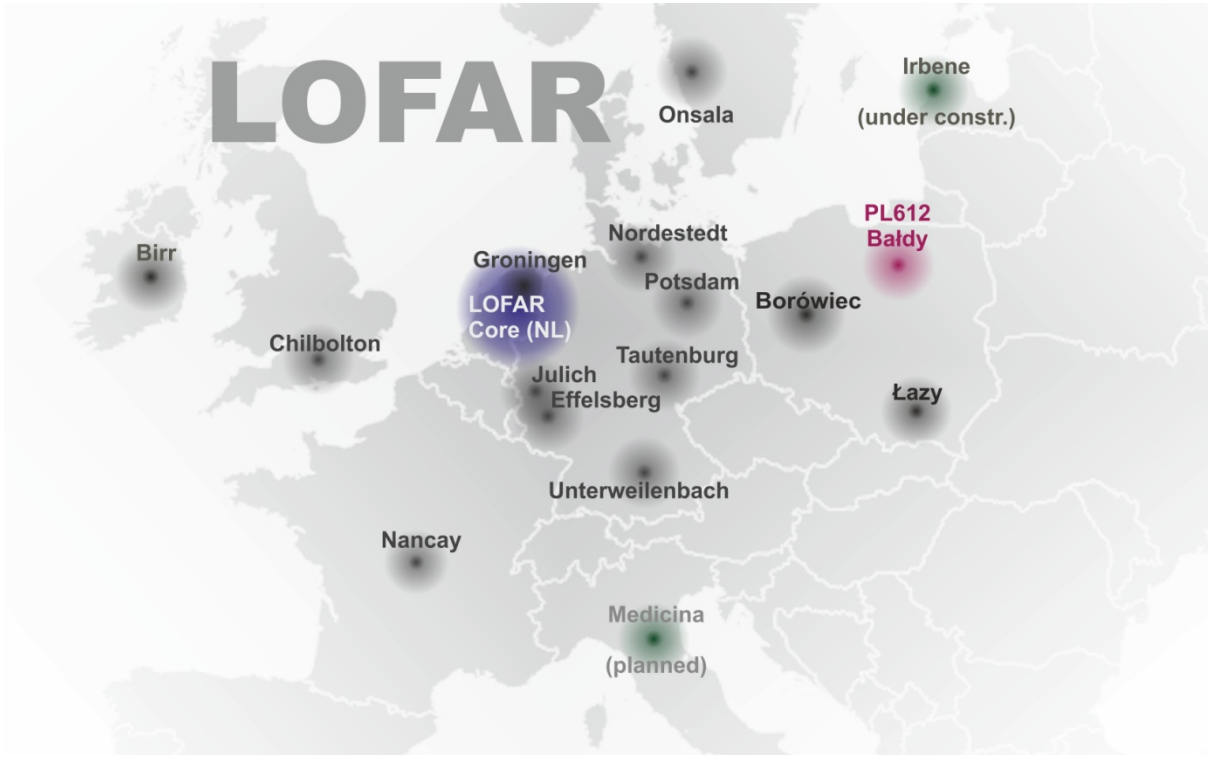

Figure 1. The map of existing, constructed and planned LOFAR station across the Europe. All stations are arranged in three forms: core stations, remote stations located in Netherlands and International stations in a few countries in Europe.

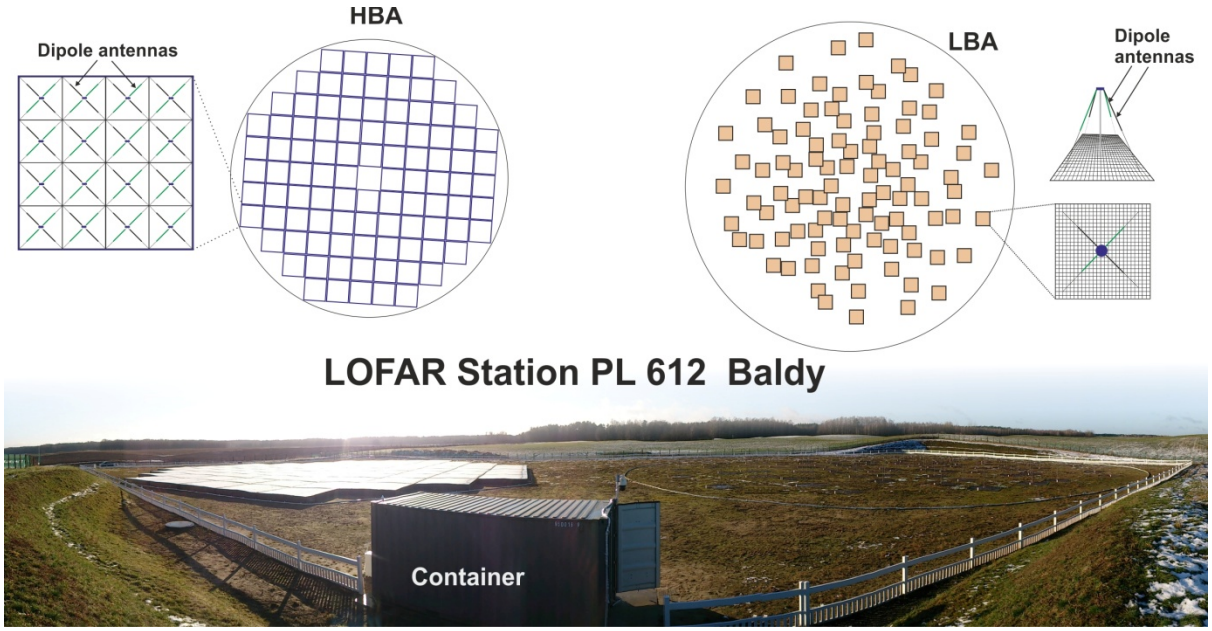

Figure 2. Configuration of **ILT** Station in Bałdy, Poland. Many of the stations, depending on the configuration, are used both in interferometric observations within the International LOFAR Telescope (ILT) as well as individually in a local mode.

The LOFAR gives a wide field of possibilities for scientific, technical and educational implementations. In this short article, I focus on the single mode of the LOFAR station in Bałdy, enumerated in system as the PL612), some strictly scientific applications, which has already been described [2, 3], as well as some the technical aspects of PL612 station [4].

2. LOFAR single station as a tool in education.

The LOFAR telescope is a digital instrument, where its main role is played not only by antennas but also computers and information systems that provide the students of engineering, IT, and science, a unique opportunity to join not only in the field of scientific research but to learn about many aspects of the work of modern radio astronomy equipment.

It can be used in the process of student's teaching in several thematic areas as follows:

i) phased array antennas, their figuration and principle of operation,

ii) massive datasets online transmission and analysis,

iii) radio astrophysical topics, particularly solar physics, space weather and pulsar observations.

In the case of Bałdy LOFAR station, the process of teaching and work with students started at the very beginning stage of telescope existing.

2.1 Building the station

The PL612 station was the first where the elements have been assembled on the field in a specially prepared tent. Earlier, each tile was assembled in the Netherlands and transported on a truck. 96 tiles needed at least 48 lorries plus a few more for cables and other elements. To our place all elements of the antennas have been transported by only 17 lorries. Most of them were EPS elements (kind of Styrofoam) arranged on pallets. Folding the tiles manually required hard work - dozens of delicate elements, electronics and cables in a small space.

Figure 3. The process of assembling of HBA antennas and transporting ready tiles to the right place at the field. In both activities the huge roles were played by students.

All the work was done by students trained by technicians from ASTRON. Figure 3 presents the tiles' assembling as well as the ready element transport.

Students were not only involved in tile assembling they also helped in field preparation, geodetical measurements, and cabling the container - during three days we have put plenty of cables into the right

connectors of back-end systems. It was a hot summer and the container was out of power, so air condition did not work that time.

Such way of engaging students has resulted in practical knowledge about dipole antennas as well as phase arrays antennas, controlling techniques, back-ends systems and other aspects. After this practices two students decided to stay with the team as PhD students.

2.2 Providing the observations

PL612 station routinely observes since the beginning of 2016, executing the ILT program (then the control is on the ASTRON observer's side) and also in off-ILT mode (usually from Friday, 9 UT to Monday, 9 UT) - then we realize the program set by the local administrator. In our station we put particular stress on recording the signal from pulsars [2, 4] and catch dynamical spectra of the Sun [3] as well as observing the ionospheric scintillation of bright sources like eg. Cas A or Cyg A.

Although the list of sources and observational parameters are prepared earlier as an input system files, the observations need not only to be switched on, but must also be controlled. For this kind of work students are very suitable. The observing activity teaches not only technical aspects of system but also responsibility for the task entrusted.

2.3 Software developing

LOFAR is the digital instrument and IT systems are present at every stage of work and signal processing. This academic year two students of Information from the Faculty of Mathematics and Computer Sciences are realising their engineering works. First of them is focused on the observation scheduling system, whose main task will be automatic allocation of targets in the space of observation time for the best result (the sources must be high enough above the horizon for the best possible signal-to-noise ratio [4]) and preparing of the system input files. The second student is working on automatic software system for pre-processing of pulsar data recorded during observations and preparing reports after each observing session. Both programs are created in Python language, and they will be supported by the web browser.

The great number of tasks related to the functioning of the LOFAR telescope allows us to think that in the following years, the cheery students will find a lot of opportunities for development and learning, and at the same time, perform useful work.

Another area where IT students are also helpful is assistance in looking after the computer systems (servers, disc systems etc.) related to LOFAR work.

2.4 Other works done by students

PL612 LOFAR station is located about 25 km from the city and university campus. Daily visits are therefore not organized, but the station must be checked regularly. We have got security office located nearby as well as high quality camera serviced by a university guard. Fortunately, this camera gives us opportunity to check state of antennas. And this is daily routine for students - manual camera steerage and checking if any of the antennas (especially LBA) are damaged.

We also used students of geodesy to create a map of terrain around the station. This was important when evaluating certain structures recorded in the dynamic spectra of the Sun. We were not sure, are they real signals or only kind of EM interference due to reflections?

3. Public presentation and popularization

Finally, it should be mentioned that LOFAR also has a powerful potential in the field of science popularizing, which in the case of PL612 and other stations, is implemented through open days, demonstrations, and public lectures. There is a possibility of visiting the antennas area and in this case students usually guides groups of interested persons. Also during the occasion, like for example, science festivals, students strongly support the academic staff and present popularizing knowledge to all interested in astronomy.

References:

1. M. van Haarlem, M. W. Wise, A. W. Gunst, G. Heald, J. P. McKean, J. W. T. Hessels, A. G. de Bruyn, R. Nijboer, J. Swinbank, R. Fallows, and 191 coauthors, "LOFAR: The LOw-Frequency Array", *Astronomy & Astrophysics* **556**, A2, 2013, doi: 10.1051/0004-6361/201220873.

2. L. Błaszkiewicz**, W.** Lewandowski, A. Krankowski, J. Kijak, O. Koralewska**,** and B. Dąbrowski, "*Prospects for Scrutiny of Pulsars with Polish Part of LOFAR*" , *Acta Geophys***. 64**, vol. 1, 2016, pp 293-315, doi: 10.1515/acgeo-2015-0038.

3. B. Dąbrowski, A. Krankowski L. Błaszkiewicz, and H. Rothkaehl, "Prospects for space weather research with the Polish part of the LOFAR telescope", *Acta Geophys*., **64**, vol.3, 2016, pp 825-840, doi: 10.1515/acgeo-2016-0028.

4. L. P. Błaszkiewicz, W. Lewandowski, A. Krankowski, J. Kijak, A. Froń, T. Sidorowicz, B. Dąbrowski, K. Kotulak, M. Hajduk, *"PL612 LOFAR station sensitivity measurements in the context of its application for pulsar observations."* Adv. Space Res. (2018), https://doi.org/10.1016/j.asr.2018.06.047

Submitted by:

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1 A. Krankowski, B. Dąbrowski, M. Hajduk, T. Sidorowicz, A. Froń (PHD Student), K. Kotulak (PHD Student) and K. Śniadkowska (PHD Student).

Photo from the Field

Generations of radio astronomy come together in our photo this month! In the foreground, researchers from MIT and UVA (including CHAMP* students) are assembling HERA feed prototypes for evaluation at the Green Bank Observatory. These feeds are Vivaldi antennas developed at the University of Cambridge, UK. This work was conducted in July of this year. The Green Bank Telescope (GBT) boldly stands in the background while the vintage 140-Ft telescope peers above the treeline in the distance.

* CHAMP = CAMPARE-HERA Astronomy Minority Partnership

Photo courtesy of J. Hewitt

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

Monthly Newsletter of International URSI Commission J – Radio Astronomy

October 2018

Officers

Chair: Richard Bradley
Vice-Chair: Douglas Bock
ECRs: Stefan Wijnholds
Jacki Gilmore

Prepared by R. Bradley, Chair, Commission J, rbradley@nrao.edu

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News Items

Greetings Commission J Members!

The abstract deadline for the Pacific Radio Science Conference (AP-RASC) is 15 October 2018! The Conference will be held in New Delhi, India from 09 – 15 March, 2019. Commission J sessions are given below. For abstract submission and additional details about the Conference, visit http://aprasc2019.com/ .

I'm continuing to solicit workshop and session ideas for the 2020 URSI General Assembly and Scientific Symposium in Rome. A working draft of the 2020 GASS Commission J program is given below – we will continue to modify it over the coming months. Your input is needed – consider convening a session.

Our spotlight this month is on Project-Based Learning (PBL) in radio astronomy. Glen Langston shares his experiences in developing a PBL program for students to build and operate a small radio telescope designed to measure and map neutral hydrogen in our galaxy. I thank Glen and the GBO/WVU PBL team for contributing this interesting article to our Newsletter.

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

***** ABSTRACT DEADLINE: 15 October 2018! *****

See http://aprasc2019.com/ for details. The Commission J sessions are listed below.

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Conveners: Abhirup Dutta and Tirthankar Roy Choudhury

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EACFJ-8: EM Spectrum Allocation and Management
Conveners: Anjana Jain, Tasso Tzioumis and Jean-Benoit Agnani

JOS: Any Other Aspect of Radio Astronomy

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.

***** Draft Program for Commission J – GASS 2020 *****

Sessions:

New Telescopes on the Frontier
Recent and Future Space Missions
Conveners: Joe Lazio
Single Dish Instruments
Very Long Baseline Interferometry
Millimeter/Submillimeter Arrays
Receivers and Radiometers: Design and Calibration
Digital Signal Processing: Algorithms and Platforms
Short-Duration Transients and Pulsars: Observations, Techniques, and Instrumentation
Solar, Planetary, and Heliospheric Radio Emissions (Commissions HJ)
Ionospheric Models and their Validation (Commissions JG)
Characterization and Mitigation of Radio Frequency Interference (Commissions JEFGH)
Spectrum Management (Commissions ECJ)
Historical Radio Astronomy
Conveners: Richard Schilizzi
Latest News and Observatory Reports
Conveners: Rich Bradley and Douglas Bock

Workshops:

Space Weather (Commissions GHJ)

Meeting and Workshop Announcements

**** Registration open for a meeting on the History of the SKA: 1980s to 2012 ****

Dear colleagues,
We would like to draw your attention to a meeting on the History of the SKA from the 1980s to 2012, to be held from 3 to 5 April 2019 at the SKA Organisation Headquarters at Jodrell Bank. More information, including a registration form, is available at
https://indico.skatelescope.org/event/518/

Richard Schilizzi, Ron Ekers, and Peter Hall
(Convenors)

1st International Cherenkov Telescope Array Symposium - Exploring the High-Energy Universe with CTA
May 6-9, 2019 - Bologna, Italy

==========

The first CTA Science Symposium will focus on the novel investigations CTA will bring to the field and its synergies with other wavebands and messengers. It will also cover instrument characteristics, analysis tools and opportunities for guest investigators and how coordinated observations with CTA will have a significant impact on the exciting new era of multi-wavelength and multi-messenger astrophysics. The symposium is a unique opportunity to gather the scientific community to stimulate discussion and promote collaboration in the study of the high-energy Universe.

CTA will be the largest and most advanced ground-based observatory for gamma-ray detection at the energies from 20 GeV up to 300 TeV, beyond the current energy frontier for gamma-ray astrophysics. With more than 100 telescopes located in the northern and southern hemispheres, CTA will use its unprecedented accuracy and sensitivity to reveal an entirely new and exciting view of the turbulent sky furthering our knowledge about the high-energy Universe. Learn more about CTA at http://www.cta-observatory.org .

- Join us!
Pre-register now to get further information about the meeting: http://www.cta-symposium.com
No payment is needed at this point. Feel free to forward this information to anyone who might be interested.

- Venue
The Symposium will be held at Bologna's magnificent Teatro Duse (http://www.teatrodusebologna.it/la-sala/), one of the oldest theatres in the city. Located in the historic centre and housed in the Palazzo del Giglio the theatre has been used since the mid-seventeenth century.

We look forward to seeing you in Bologna!

Stefan Funk and Jim Hinton for the SOC.

Activities Spotlight

Experience with Student-Constructed Telescopes for Radio Astronomy

Glen I. Langston[(1)], Sue Ann Heatherly[(2)], Kevin Bandura[(3)]

Project-Based Learning (PBL) is known to motivate students and is a better model real-world engineering experience than school lectures. Our group has worked with high school students and teachers to design a Radio Astronomy PBL experience. We've designed, documented construction and operated Radio Telescopes intended for use by high schools, colleges, hobbyists and other *Science Aficionados*. Optimum PBL experiences need a balance of simple initial instructions, combined with more open-ended questions to challenge participants.

We first designed and constructed several versions of our own telescopes, to confirm that a sensitive telescope was within the reach of the participants' skills and budgets. The designs were documents on-line in advance. Materials and tools were purchased before the participants arrived. We're encouraging all *Science Aficionados*, (i.e. participants) to add to the http://OpenSourceRadioTelescopes.org web site. Pictures of students' designs and instructions for the first two student-constructed telescopes are there. We're encouraging everyone to add to the PBL documentation, by signing up for a Wiki account. We've incorporated lessons-learned into improved documentation in the LightWork memo series. Our goal is to encourage *Science Aficionados* to improve these documents. The intent is to build a community so that other students can take advantage of new capabilities, growing the areas of study in this PBL experience. It is well known that teamwork, and the required documentation of efforts, are critical for real-world engineering projects.

A radio telescope has a fairly large number of components. The basic telescope overview is now documented in *LightWork* Memo 14 and Memo 15. We're looking forward to more contributions to the memos!

After the initial telescope designs were created, the materials were tested with two different groups. The first project was lead by Sue Ann Heather of the Green Bank Observatory (GBO), and involved 20 rising college freshmen, who were entering West Virginia University that fall. **Figure 1** shows some of the students in the four-week program; these students were given an overview of how a radio telescope works and shown the example radio telescopes that we'd created. They were then given all the material, a few rudimentary guides and told to go to work. They had access to two-by-fours, plywood, reflective foam board, reflective bubble wrap, drills, and power-saws. A critical part of a well functioning telescope is a very sensitive amplifier chain, with a factor of a million gain. These parts were purchased in advance for a cost of about $200 per telescope.

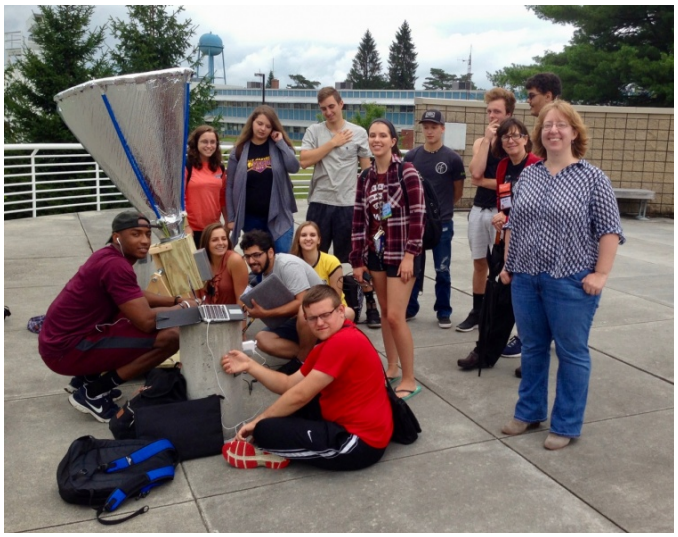

Figure 1: West Virginia University students, and several co-authors, with their student-built radio telescope, named Alexander, in operation at the Green Bank Observatory (GBO) in West Virginia. The horn-shaped telescope was constructed from bubble wrap, and other commercially available parts and electronics. The Students observed our Milky Way Galaxy, using GnuRadio software modified by the authors. This software is optimized for observation of neutral hydrogen atoms at 1420.4 MHz.

The students reported learning a lot from their experience, notably how science and engineering projects are actually done. Their telescopes had unique design features that were later incorporated into our standard documentation. The telescopes were not initially as sensitive as the telescopes we'd built in advance and a significant amount of time was taken in reworking a number of design choices. In the end, with some consultations, their telescopes worked! In future, we will give more step-by-step guides, so the students can spend more time with the observations and mapping the Milky Way Galaxy.

Dr. Kevin Bandura, of West Virginia University Lane School of Engineering, was supported by a National Science Foundation grant to work with high school teachers. He had also previously built a telescope and had made a number of significant improvements to the radio frequency electronics. Ten teachers participated in their eight week program on the basics of electronics and digital signal processing, culminating in soldering of parts onto a very sensitive custom amplifier board. Dr. Bandura was able to reduce the cost of the amplifiers significantly, by mass production and custom assembly. The electronics development and telescope construction was completed in Week 6 and the teachers went to GBO to test their telescopes. The teachers each built their own telescope following a design that they developed as a group (See "Photo from the Field" section of the Newsletter).

Both these PLB experiences were successful for the participants. The teachers are working on lesson plans for use by other teachers leading Radio Astronomy Projects.

In order to become a radio astronomer the students and teachers need a number of skills, including the basics of software-defined radio (SDR), some "Maker Skills", including using saws and drills, and some Python data reduction. **Figure 2** shows the observer interface, created using Gnu-radio companion

(GRC) software. The students only need to operate the observing software, but several of them found building their own new observer interfaces both possible and enjoyable.

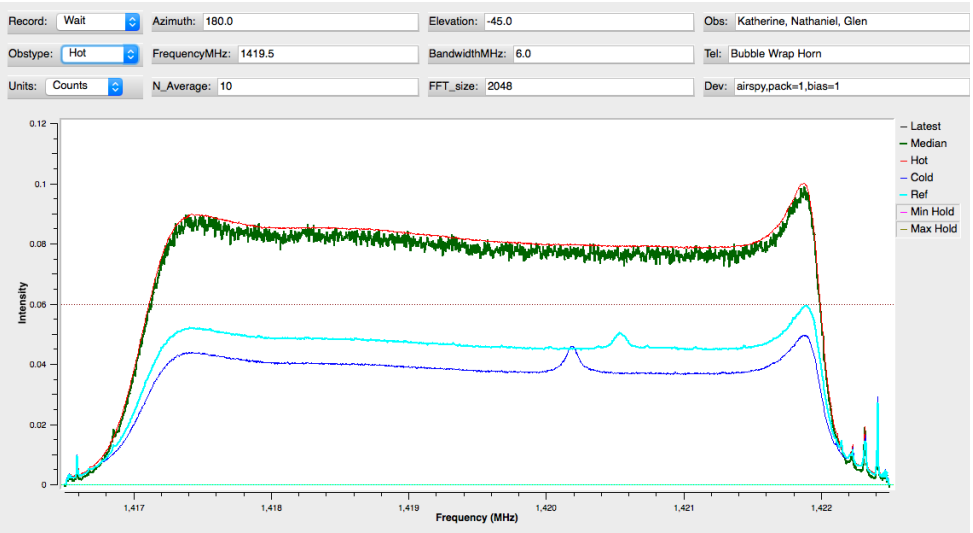

Figure 2: Plot of Raw Intensity (counts) versus Frequency in MHz for spectra selected using the RA_Integrate block. The RA_Integrate block is used to confirm proper operation of the telescope. The observer inputs the direction the telescope is pointing and frequency setup information. The plots show intensity versus Frequency (MHz). The intensity axis has three possible units, 1) counts, 2) power in dB and 3) calibrated intensity in Kelvins. This plot shows the intensity in counts. The little peaks near 1420.4 MHz are due to galactic hydrogen, which is clearly visible in these observations. Each of these observations are only a few seconds long. The thick green lines shows a short duration hot load observation, when the telescope was pointed at the ground. The long duration average hot load signal is the thin red line.

The observer interface is built with Gnu-radio Companion, a graphical programming tool. **Figure 3** shows all the processing blocks used to create the interface shown in Figure 2. The user can create and share these blocks for use by others. This interface requires installation of Gnuradio and several system tools, all free. The interface itself is available for free from Github (http://github.com/glangsto/gr-nsf).

Finally, the collected data must be viewed and understood. The telescope is very sensitive and good observations can be taken in just a few minutes. All the collected data are written to ASCII files, so the users can directly examine the observations. With some Python plotting programs the data can be averaged, calibrated and displayed. **Figure 4** shows a comparison of 10 minutes of data taken with the telescope pointed at different elevations.

Radio Astronomy is within reach of high school students and teachers. With an investment of time motivated students can discover our Milky Way Galaxy from their own back yard.

Figures 2, 3 and 4 are from LightWork Memo 20. More construction details are available from the WIKI.

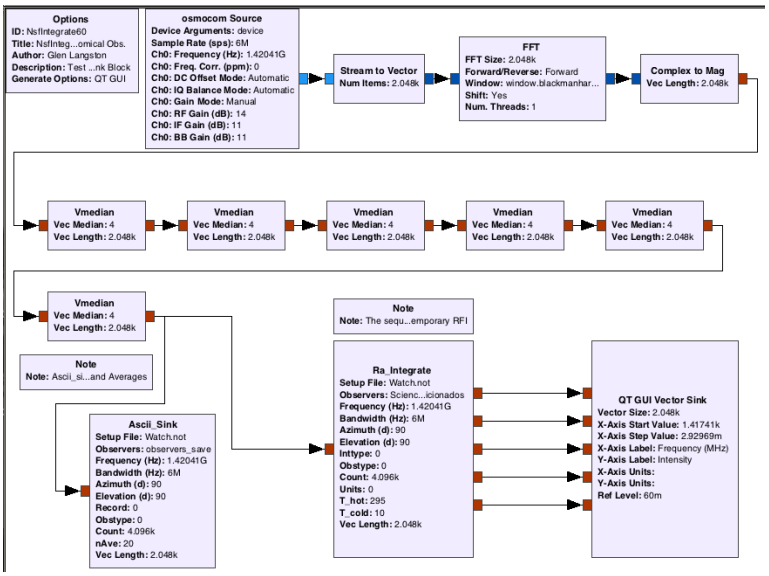

Figure 3: GRC visual program for Radio Telescope Observations. The data flow is simple, from the OSMOSDR source, on the top left, through a block to create a complex vector and a Fourier Transform. The data rate is reduced via a sequence of 6 Vector Median blocks, each that take 4 input vectors and produce a single output vector. These 6 blocks reduce the data rate from one new spectrum every 0.0003 seconds to one spectrum every 1.4 seconds. This reduces the CPU load for plotting and averaging so that all data may be captured with a modest multi-core computer. The filtered data are fed to the data writing block, Ascii_Sink and also to the RA_Integrate block and plotter to monitor the observations.

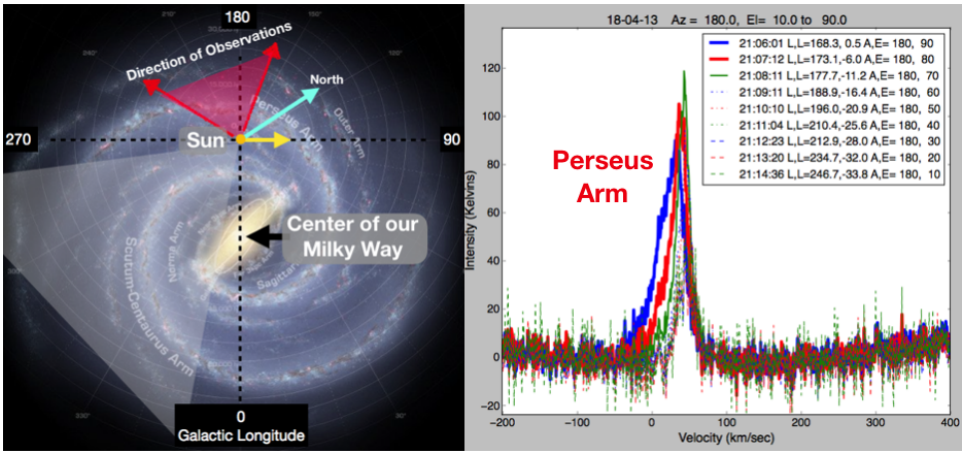

Figure 4: Overview of our place in the Milky Way Galaxy (Left) and 10 Minutes of Observations of the Perseus Arm. The sketch at left shows our Sun (and us) far from the center of the Milky Way. The image was drawn as if we are way above our galaxy. Our galaxy is a disk and the coordinate of the center of our galaxy is at Galactic Longitude = 0. The galactic longitude, latitude coordinates are centered on us. The plot at right shows 9 beautiful minutes of data. With some research, you can figure out that you've discovered the Perseus Arm of our Galaxy. The plot shows calibrated intensity (Kelvins) versus the velocity of the hydrogen measured. The observations were taken with telescope Azimuth=180 degrees, and different Elevations (A,E =). The GRC block calculates the Longitude and Latitude (L,L=) for the time of the observations (21:06 to 21:15 UTC).

The above article was submitted by Glen Langston on behalf of the Project-Based Learning group at GBO / WVU. Contact information is provided below:

(1) National Science Foundation, Alexandria, VA, e-mail: glangsto@nsf.gov

(2) Green Bank Observatory, Green Bank, WV, e-mail: sheather@nrao.edu

(3) West Virginia University, Morgantown, WV, e-mail: kmbandura@mail.wvu.edu

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Photo from the Field

It's an educational experience for teachers, too! Kevin Bandura (WVU) with one of a dozen high school teacher-constructed radio telescopes as part of the GBO/WVU Project-Based Learning group. These telescopes were prototypes for telescopes to be constructed throughout the United States as part of a science and engineering education project. This project is supported by the U.S. National Science Foundation.

Photo courtesy of G. Langston

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

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Jacki Gilmore

Prepared by R. Bradley, Chair, Commission J, rbradley@nrao.edu

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News Items

Greetings Commission J Members!

The abstract deadline for the Pacific Radio Science Conference (AP-RASC) has passed. The Conference will be held in New Delhi, India from 09 – 15 March, 2019. A list of the Commission J sessions are given below. There are a total of 117 abstract submissions for Commission J. On behalf of URSI and the organizing committee, thank you for supporting AP-RASC 2019!

I'm continuing to solicit workshop and session ideas for the 2020 URSI General Assembly and Scientific Symposium in Rome. A working draft of the 2020 GASS Commission J program is given below – we will continue to modify it over the coming months. Your input is needed – consider convening a session!

Beginning with this issue, a new section for job postings will appear in the Newsletter. If your organization has an opening for a position that may be of interest to Commission J members please send me the title, short description, and link for additional information. I will only post positions by request from URSI members. It's also important to inform me when the position has been filled!

Detecting pulsars for a hobby? Yes! Our spotlight this month is on the impressive work of Hannes Fasching, OE5JFL, a radio amateur from Braunau, Austria who is doing just that for personal edification and enjoyment. In his own words, Hannes describes how he got started, the results of his observations, and what he has learned along the way. I thank Hannes for kindly sharing this fascinating story with us.

Martin Ewing (AA6E) and I (WB3DZC) invite anyone working in astronomy (all wavelengths), including students and retirees, who is or would like to be connected with the ham radio world to join our "Radioastronomy-hams" group at https://groups.io/g/radioastronomy-hams .

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

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Conveners: Anjana Jain, Tasso Tzioumis and Jean-Benoit Agnani

JOS: Any Other Aspect of Radio Astronomy

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.

***** Draft Program for Commission J – GASS 2020 *****

Sessions:

New Telescopes on the Frontier
Recent and Future Space Missions
Conveners: Joe Lazio
Single Dish Instruments
Very Long Baseline Interferometry
Millimeter/Submillimeter Arrays
Receivers and Radiometers: Design and Calibration
Digital Signal Processing: Algorithms and Platforms
Short-Duration Transients and Pulsars: Observations, Techniques, and Instrumentation
Solar, Planetary, and Heliospheric Radio Emissions (Commissions HJ)
Ionospheric Models and their Validation (Commissions JG)
Characterization and Mitigation of Radio Frequency Interference (Commissions JEFGH)
Spectrum Management (Commissions ECJ)
Historical Radio Astronomy
Conveners: Richard Schilizzi
Latest News and Observatory Reports
Conveners: Rich Bradley and Douglas Bock

Workshops:

Space Weather (Commissions GHJ)

Meeting and Workshop Announcements

**** Registration open for a meeting on the History of the SKA: 1980s to 2012 ****

Dear colleagues,
We would like to draw your attention to a meeting on the History of the SKA from the 1980s to 2012, to be held from 3 to 5 April 2019 at the SKA Organisation Headquarters at Jodrell Bank. More information, including a registration form, is available at
https://indico.skatelescope.org/event/518/

Richard Schilizzi, Ron Ekers, and Peter Hall
(Convenors)

1st International Cherenkov Telescope Array Symposium - Exploring the High-Energy Universe with CTA
May 6-9, 2019 - Bologna, Italy

==========

The first CTA Science Symposium will focus on the novel investigations CTA will bring to the field and its synergies with other wavebands and messengers. It will also cover instrument characteristics, analysis tools and opportunities for guest investigators and how coordinated observations with CTA will have a significant impact on the exciting new era of multi-wavelength and multi-messenger astrophysics. The symposium is a unique opportunity to gather the scientific community to stimulate discussion and promote collaboration in the study of the high-energy Universe.

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- Join us!
Pre-register now to get further information about the meeting: http://www.cta-symposium.com
No payment is needed at this point. Feel free to forward this information to anyone who might be interested.

- Venue
The Symposium will be held at Bologna's magnificent Teatro Duse (http://www.teatrodusebologna.it/la-sala/), one of the oldest theatres in the city. Located in the historic centre and housed in the Palazzo del Giglio the theatre has been used since the mid-seventeenth century.

We look forward to seeing you in Bologna!

Stefan Funk and Jim Hinton for the SOC.

Activities Spotlight

Measuring Pulsars using Amateur Radio Equipment

Hannes Fasching, OE5JFL, Braunau, Austria

I made my radio amateur license back in 1970, and after starting activities on shortwave I went up in frequency to VHF/UHF and finally became interested in space communication. Since 35 years I am very active on EME (earth-moon-earth), means contacting other stations by signal reflection off the moon. For optimizing equipment it is essential to measure for example sun noise, radio galaxies and moon noise which is rather weak. This way I became interested in radio astronomy, and finally a couple of years ago radio amateur from Italy, Mario Natali, who developed pulsar observation planning software, convinced me to try to receive pulsars.

A massive star can collapse into a neutron star at the end of its life after a supernova explosion. The diameter is reduced to around 20km, and the rotation speeds up to a period of around one second or only milliseconds. If the direction of the magnetic axis is different from the rotational axis, a strong electromagnetic beam is radiated in direction of the magnetic axis. If the beam by accident hits the earth, we can observe a pulse on each rotation of the pulsar.

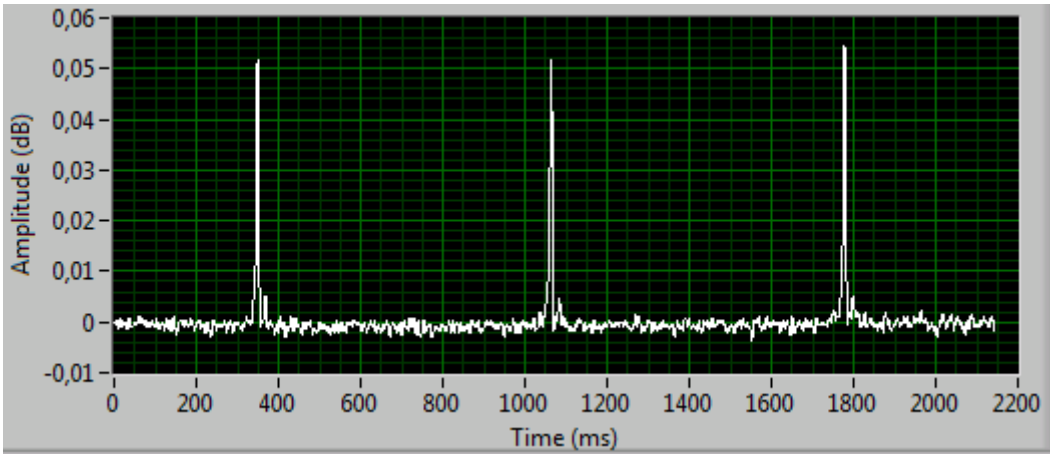
7,3m offset dish, used for receiving pulsars on 420MHz and 1292MHz

More detailed information can be found at: https://en.wikipedia.org/wiki/Pulsar
Because the pulsars are several thousands of light years away, their signals arriving at the earth are very weak. The unit of flux density is Jansky, 1 Jy=10-26 W/(m2*Hz). The strongest pulsar provides 1500 mJy on 400 MHz, this is about the same flux as a candle light up at the moon produces down on earth! To hear the pulses unprocessed in real time, a dish antenna with 100m

diameter would be necessary. To detect pulsars with amateur radio equipment (in my case a 7,3m diameter offset dish built by myself), the solution is to record the signal over a long time and large bandwidth, and afterwards make the pulses visible by special software using a procedure named folding.

While searching and reading a lot, I came across the webpage of Mr. Andrea Dell'Immagine, also a radio amateur. He is measuring the strong pulsar B0329+54 with a rather small antenna on a regular base, and provided me software he had written for recording and analyzing, and he was very helpful also for doing the first steps. His webpage: http://iw5bhy.altervista.org/

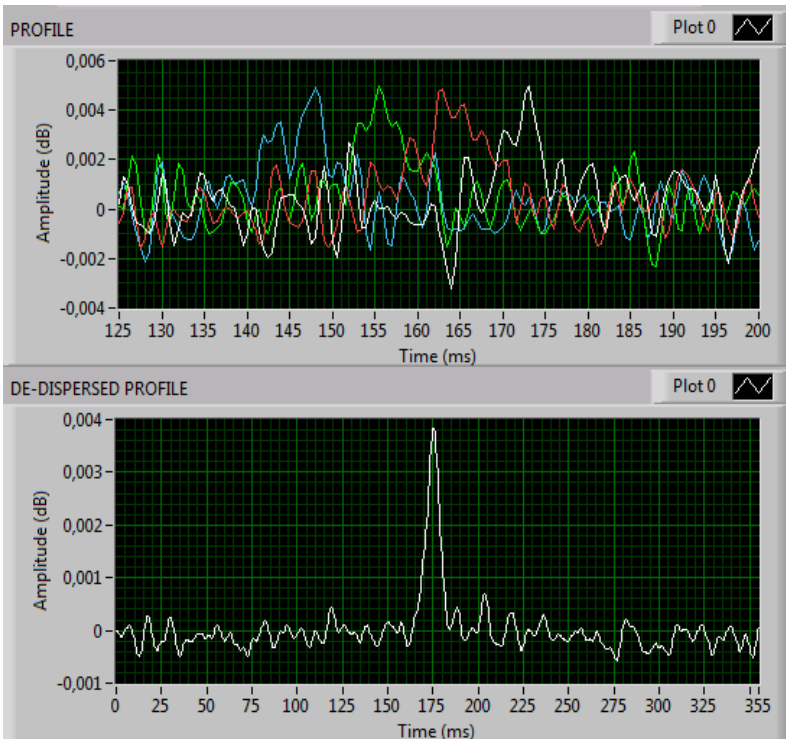
Two years ago I had the first success detecting B0329+54, both on 420MHz and on 1292MHz.



Three pulses of B0329+54, received on 420MHz

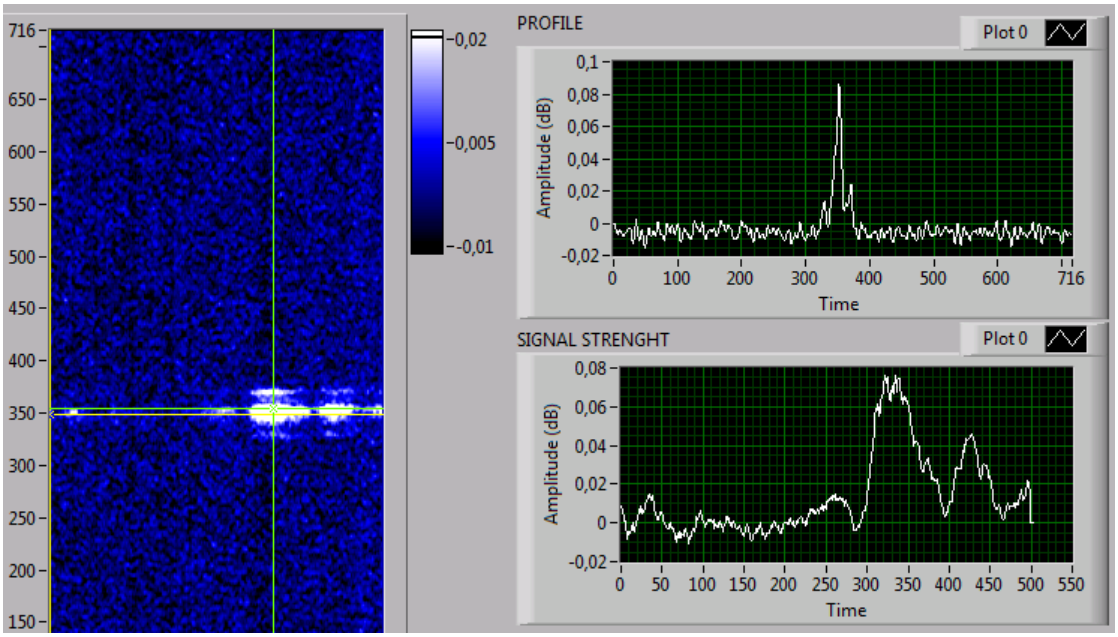
Step by step I detected more, following a list with candidates worth to try. Sometimes I had to be very patient, often the result was uncertain and I had to repeat the observation several times before I could consider the detection to be positive. Up to now I could detect 54 pulsars, the weakest on 420 MHz was B0626+24 with 31mJy, on 1292MHz B1845-01 with 8,6mJy only, that is 50 times lower radiation compared to the strongest.

For me it was very interesting to see and learn about the different characteristics of the various pulsars. The B1933+16 for example has remarkable high dispersion. This has to be taken into account by software during folding.



Separation of 4 frequency channels by dispersion of pulsar B1933+16

Especially on 1292MHz scintillation can wipe out the signal over hours, a little bit later we see enhancement, example B0329+54.



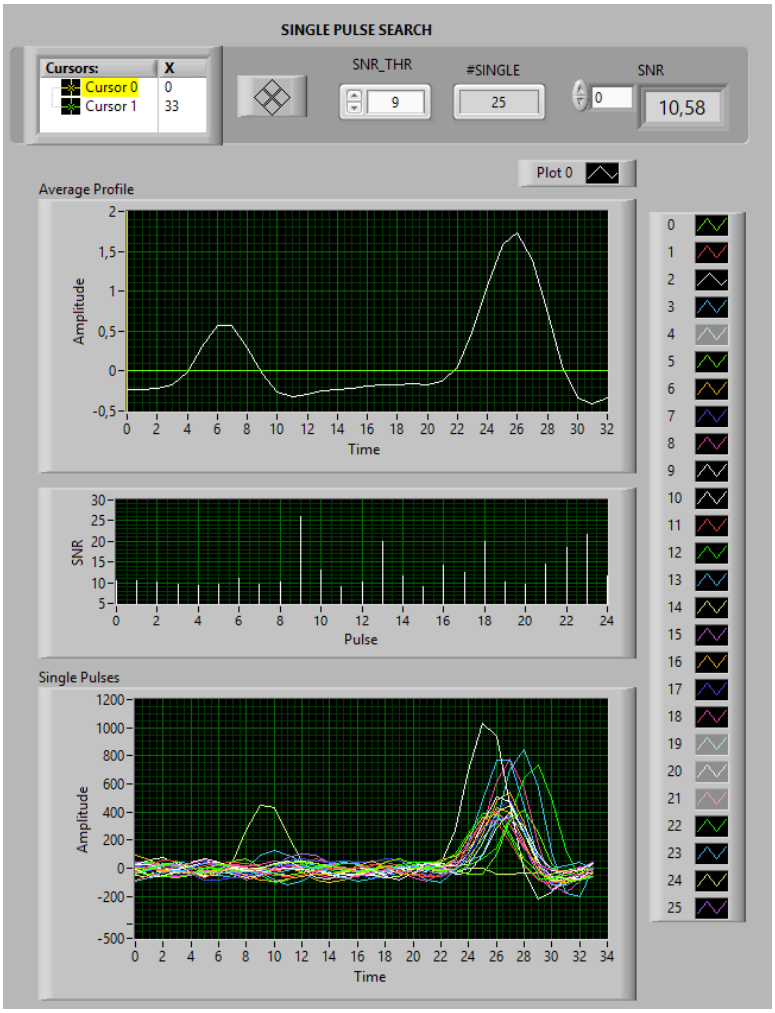
Scintillation of B0329+54 on 1292MHz, observation time 5 hours

The reception of the Crab-pulsar B0531+21 was one of the highlights! This young pulsar exists since a supernova explosion in 1054, which was observed on earth as a star even visible at daylight for about two years. It rotates 30 times per second, is highly dispersed (3 ms per channel is the same as the pulse width) and its slowdown in rotation speed is remarkable.

Beside the main pulse the Crab pulsar has an interpulse which is varying in strength.

The Crab pulsar is also known for its giant radio pulse emission. Andrea Dell'Immagine wrote very good software to search for giant pulses in recorded files. Analyzing a 6 hours observation with low interference, I found more than 20, and even one giant pulse at the phase of the interpulse was found, a very rare event. I estimate the peak flux level of the best observed giant pulse to be between 1000Jy and 2000Jy, means an increase of around 300 times above average!

Encouraged by the success with the 7,3m diameter dish, I gave my additional 3m dish a try as well. On 420MHz I could detect 4 pulsars, with positive result for the B0329+54 on every attempt, that pulsar was also detected on 1292MHz.



Crab pulsar B0531+21 giant pulses, received on 420 MHz

More detailed information can be found on my webpage: https://qsl.net/oe5jfl/pulsar/pulsar.htm

Submitted by Hannes Fasching

Job Postings – Radio Astronomy and Related Fields

Square Kilometer Array

Signal Processing Domain Specialist (Manchester, UK)
https://recruitment.skatelescope.org/domain-specialist-signal-processing/

Arizona State University – 3 Positions

Research professional with expertise in radio-frequency engineering:
https://jobregister.aas.org/ad/a67137b8

Postdoc in Radio Instrumentation and/or Signal Processing
https://jobregister.aas.org/ad/6f5685cb

Postdoc in 21cm Data Analysis
https://jobregister.aas.org/ad/e56bb558

If your organization has an opening for a position that may be of interest to Commission J members please send the title, short description, and link for additional information to R. Bradley. Positions will only be posted by request from URSI members.

Photo from the Field

A 1.4 GHz 19-element, dual-polarization, cryogenic phased array feed (PAF) receiver for the Robert C. Byrd Green Bank Telescope (GBT), developed as part of FLAG (Focal L-band Array for the GBT) project. This receiver has the lowest reported beamformed system temperature normalized by aperture efficiency of any phased array receiver to date (see Roshi et al. 2018 for further details).

Submitted by A. Roshi

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

Monthly Newsletter of International URSI Commission J – Radio Astronomy

December 2018

Officers

Chair: Richard Bradley
Vice-Chair: Douglas Bock
ECRs: Stefan Wijnholds
Jacki Gilmore

Prepared by R. Bradley, Chair, Commission J, rbradley@nrao.edu

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News Items

Greetings Commission J Members!

The abstract deadline for the Pacific Radio Science Conference (AP-RASC) has passed. The Conference will be held in New Delhi, India from 09 – 15 March, 2019. A list of the Commission J sessions are given below. I have personally read all 117 abstracts and all have been accepted – the breadth and depth of the work is quite amazing. On behalf of URSI and the organizing committee, thank you for supporting AP-RASC 2019!

I'm continuing to solicit workshop and session ideas for the 2020 URSI General Assembly and Scientific Symposium in Rome. A working draft of the 2020 GASS Commission J program is given below – we will continue to modify it over the coming months. Your input is needed – consider convening a session!

What can one do with an old radio telescope that is scientifically obsolete? In the 1990's, the future of the 25 meter Dwingeloo radio telescope in the Netherlands was uncertain, but in 2007, it was rescued by the C.A. Muller Radio Astronomie Station (CAMRAS) foundation. This month, our Activities Spotlight shines on the truly impressive work of this volunteer organization that transformed the 25 meter into a powerful instrument for radio science education and public outreach activities. I thank Cees Bassa, Daniel Estévez, and Tammo Jan Dijkema of CAMRAS for sharing their story with us.

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

***** Abstract submission deadline has passed *****

See http://aprasc2019.com/ for details. The Commission J sessions are listed below.

J01: Evolution/Latest Results from uGMRT (Contributions and Felicitation of Govind Swarup)
Conveners: Subra Ananthakrishnan and Yashwant Gupta

J02: Updates from Existing Radio Astronomy Facilities – I
Conveners: Jayaram Chengalur and Douglas Bock

J03: Updates from Existing Radio Astronomy Facilities – II
Conveners: R Ramesh and Douglas Bock

J04: VLBI: Current Status and Future Prospects
Conveners: B C Joshi and Sergeyi Gulyaev

J05: Radio Astronomy Instrumentation & Techniques – I (Rcvr Systems: Analog/Digital/Optical Fibre)
Conveners: B Ramesh and S Srikant

J06: Radio Astronomy Instrumentation & Techniques - II (Data Processing: Imaging, Big Data)
Conveners: Dharam Vir Lal and Veeresh Singh

JGH7: Recent Scientific Results on Solar, Solar Wind and Space Weather Observations
Conveners: P Subramanian, Yihua Yan and P Janardhan

J08: Recent Scientific Results on Galactic, Extra-Galactic, Star Formation, Transients
Conveners: Ishwar Chandra and Kenta Fujisawa

J09: The Early Universe (EoR Experiments and Related Results)
Conveners: Abhirup Dutta and Tirthankar Roy Choudhury

J10: Future Radio Astronomy Facilities (including Square Kilometre Array)
Conveners: Divya Oberoi and Ramesh Bhat

EFGHJ-6: Upcoming Areas in Interference and Interference Mitigation
Conveners: Hanna Rothkaehl, Uttama Ghosh Dutta and Stefan Wijnholds

E07: RFI Mitigation in Radio Astronomy
Conveners: Subra Ananthakrishnan, Kaushal Buch and Tasso Tzioumis

EACFJ-8: EM Spectrum Allocation and Management
Conveners: Anjana Jain, Tasso Tzioumis and Jean-Benoit Agnani

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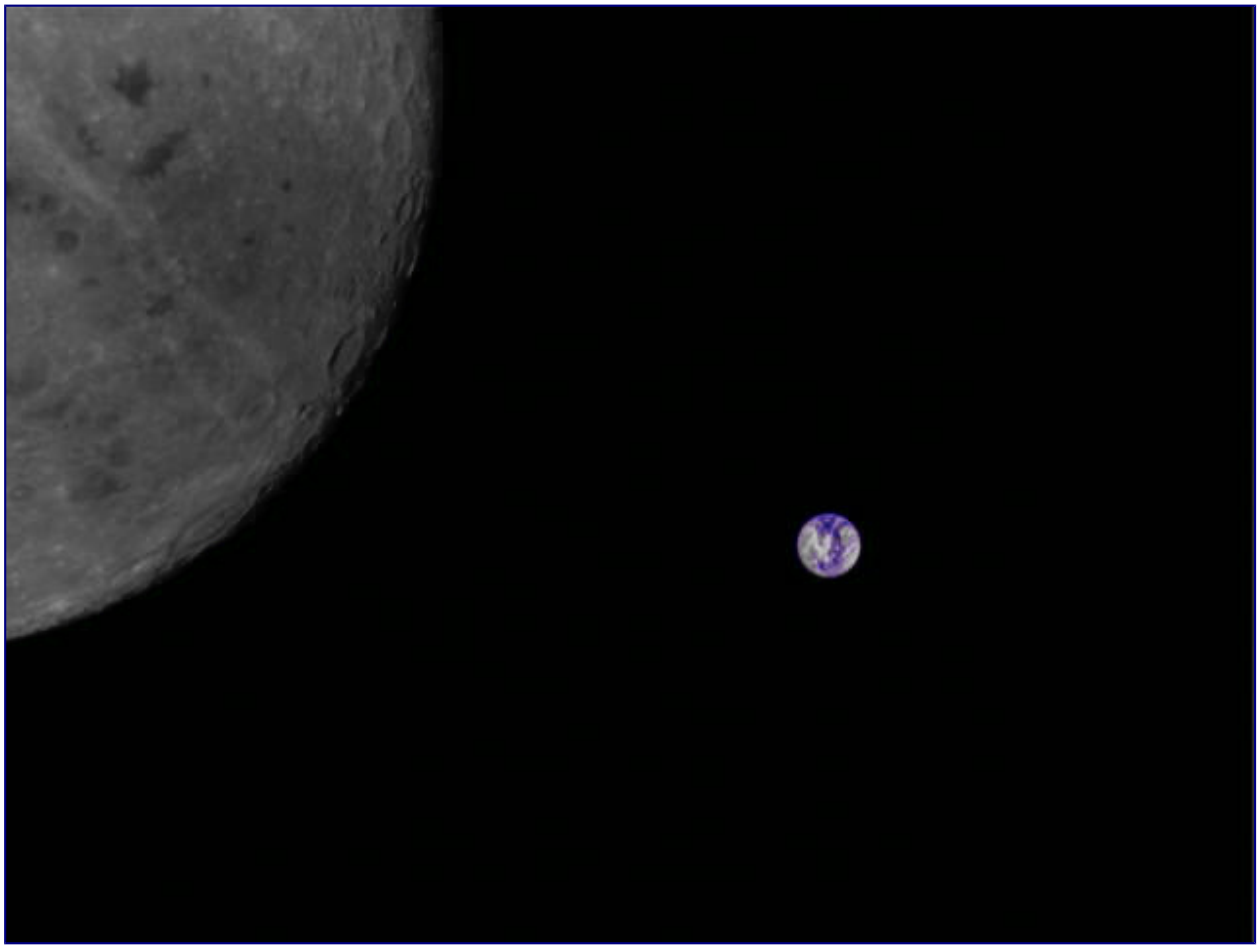
Activities Spotlight

Downlink and amateur radio experiments with the lunar satellite DSLWP-B

Cees Bassa, *Daniel Estévez*, *Tammo Jan Dijkema*

During the first weeks of October and November, radio amateurs all around the world have worked together to get the Chinese Longjiang-2 spacecraft to take several images of the Earth and the far side of the Moon. Radio commands were generated by MingChuan Wei in China, transmitted to the spacecraft by Reinhard Kühn in Germany, after which they were received by the spacecraft in lunar orbit. In turn, the spacecraft transmitted the images back to Earth, where they were picked up by radio amateurs in Germany, Latvia, North America and the Netherlands.



The Earth and far side of the Moon as seen by the Chinese Longjiang-2 lunar orbiting spacecraft. MingChuan Wei, Harbin Institute of Technology

Since 25 May 2018, the Chinese Longjiang-2 (also known as DSLWP-B) microsatellite has been orbiting the Moon. The satellite is aimed at studying radio emissions from stars and galaxies at very long wavelength radio waves (wavelengths of 1 to 30 meters). These radio waves are otherwise blocked by the Earth's atmosphere, while the lunar environment offers protection from Earth-based and human-made radio interference. Longjiang-2 was launched to the Moon together with an identical twin, Longjiang-1 (DSLWP-A), together acting as a radio interferometer to detect and study the very long wavelength radio waves by flying in formation in lunar orbit.

Besides the scientific instruments, both Longjiang satellites carry a VHF/UHF amateur radio transmitter and receiver (a transceiver) built and operated by the Harbin Institute of Technology. The Longjiang-2 transceiver also includes an onboard student camera, nicknamed the *Inory Eye*. The Harbin team built on experience gained with the Earth-orbiting LilacSat-1 and LilacSat-2 nanosatellites, which allow radio amateurs to receive satellite telemetry, relay messages and command and download images taken with an onboard camera.

While receiving signals from satellites in low Earth orbit requires only relatively simple antennas, doing so for satellites in orbit around the Moon (a thousand times more distant), is much harder. To this end Longjiang-1 and 2 transmit signals in two low data-rate, error-resistant, modes; one using digital modulation (GMSK) at 250 bits per second, while the other mode (JT4G) switches between four closely spaced frequencies to send 4.375 symbols per second. This latter mode was developed by Nobel-prize winning astrophysicist Joe Taylor and is designed for radio amateurs to relay messages at very low signal strengths, typically when bouncing them off the surface of the Moon.

During the trip to the Moon in the days after the 20 May 2018 launch of Longjiang-1 and 2, radio amateurs were able to receive GMSK telemetry from both satellites, as they were still close to the Earth. Due to a malfunction of the thruster control logic required for the spacecraft to make course corrections, contact with Longjiang-1 was lost on 22 May. Fortunately, Longjiang-2 did arrive in a 357-by-13704 kilometer elliptical orbit around the Moon on 25 May.

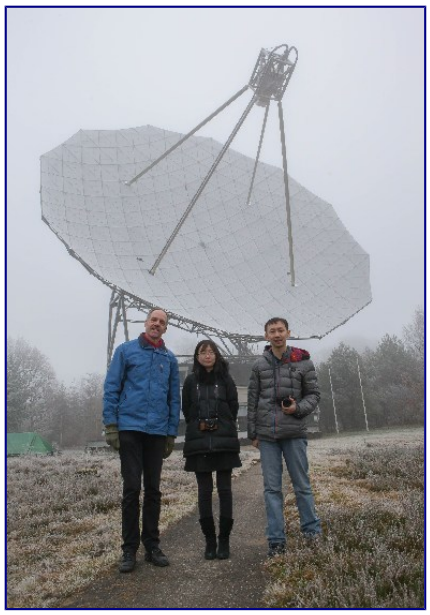
Since then, many radio amateurs have been able to receive transmissions from Longjiang-2. Usually, the transceiver is powered on for 2-hour sessions at a time, during which GMSK telemetry is transmitted in 16-second bursts every 5 minutes. After some testing sessions in early June, the JT4G mode was activated, with 50 second transmissions every 10 minutes.

Specialized open source software (gr-dslwp) written by MingChuan Wei and the Harbin team enables radio amateurs to decode telemetry as well as image data and upload it to the Harbin website.

The JT4G mode has allowed radio amateurs with small yagi antennas to detect signals from Longjiang-2 (using custom software written by Daniel Estévez).

In the Netherlands, we have been using the Dwingeloo radio telescope, a 25m dish, to receive UHF signals from Longjiang-2. Due to the large sensitivity of the telescope, the GMSK and JT4G digital signals can easily be decoded. The Dwingeloo radio telescope is currently in use by radio amateurs, but has a long history as a radio telescope. It was built in 1956 as the largest radio telescope at that time. The

telescope has a long history of discoveries, in particular of the galaxies Dwingeloo 1 and 2. Scientifically obsolete in 1990's, it was taken over by the CAMRAS foundation in 2007. The telescope was declared a national monument, and was fully restored in 2012. The Dwingeloo radio telescope is now maintained and used by volunteers for various purposes, including outreach, radio astronomy, art and amateur radio applications. A few examples of the latter, many of which are led by Jan van Muijlwijk PA3FXB: the telescope has assisted in rescuing several cubesats (BEESAT-3, e-st@r II, Triton-1, INSPIRE-2, UNSW-EC0), and the telescope is one of the largest stations to do Moonbounce experiments. The combination of these two activities make the DSLWP mission fit in very well. Due to the very wide orbit of the satellite and the narrow beam of the 25-meter dish, adjustments were needed to point the dish towards the satellite instead of the Moon. In fact, during the downlink of one the Earth and Moon images, the separation between the two was about 2 degrees.



Left: The Dwingeloo Telescope: Jan van Muijlwijk PA3FXB (CAMRAS), Hu Chaoran (BG2CRY), MingChuan Wei (BG2BHC), preparing the mission at the Dwingeloo Telescope in December 2017. The Dwingeloo dish is in fact transparent, but covered in snow here. Photo: Harry Keizer

Right: The setup used by Reinhard Kühn (DK5LA) for the command uplink. Photo: Reinhard Kühn

Since the student camera is fixed to the satellite, whose solar panel remains pointed towards the Sun, careful planning was required to take the picture. MingChuan Wei and Daniel Estévez predicted that during the first weeks of October and November the orientation of the orbit, Moon, Sun and Earth meant that the Longjiang-2 camera would be able to, for the first time, take images of the Earth and Moon simultaneously.

To arrange taking the pictures, Reinhard Kühn (DK5LA) used his array of yagi antennas to command Longjiang-2 to take an image and transmit it back to Earth. The commands Reinhard sent were generated by MingChuan Wei from the Harbin team that built the Longjiang satellites. The Dwingeloo telescope, as

well Robert Mattaliano in North America, Mike Rupprecht in Germany and Imants Tukleris in Latvia were able to receive and decode the packets with image data and upload it to the Harbin telemetry portal

The image data was transmitted using SSDV encoding, originally designed by radio amateur Philip Heron for balloon transmissions. Because of the low data rate, downloading a 640-by-480 pixel image is slow and takes between 10 and 20 minutes. During earlier attempts to take and download images of the Earth and the lunar surface, the lunar surface and Earth were over exposed, so commands to adjust the exposure time and take new images were uplinked. On the morning of 9 October the orientation of the satellite, Earth, Moon and Sun was predicted to be optimal, and a picture was automatically taken when the transceiver was powered on by the satellite computer. On 10 October, when the Moon was visible from Europe and the transceiver was again active, Reinhard sent the commands to download this image. As the image was transmitted back to Earth, many were anxiously awaiting the lines of the image to be filled in to see if the picture actually contained the Earth. Around 14:40UTC it was clear that we had the blue Earth in the image, resulting in a flurry of Twitter activity by many happy radio amateurs! Since some of the lines were missing, Wei sent Reinhard the commands to retransmit the image to download it again and fill in the missing parts.

The resulting image, after some slight color corrections, shows the far side of the Moon, with several prominent craters being easily identifiable. The fully illuminated disk of the Earth shows blue oceans, cloud patterns, and some landmasses, which, based on the time the image was taken, are most likely Africa and Australia.

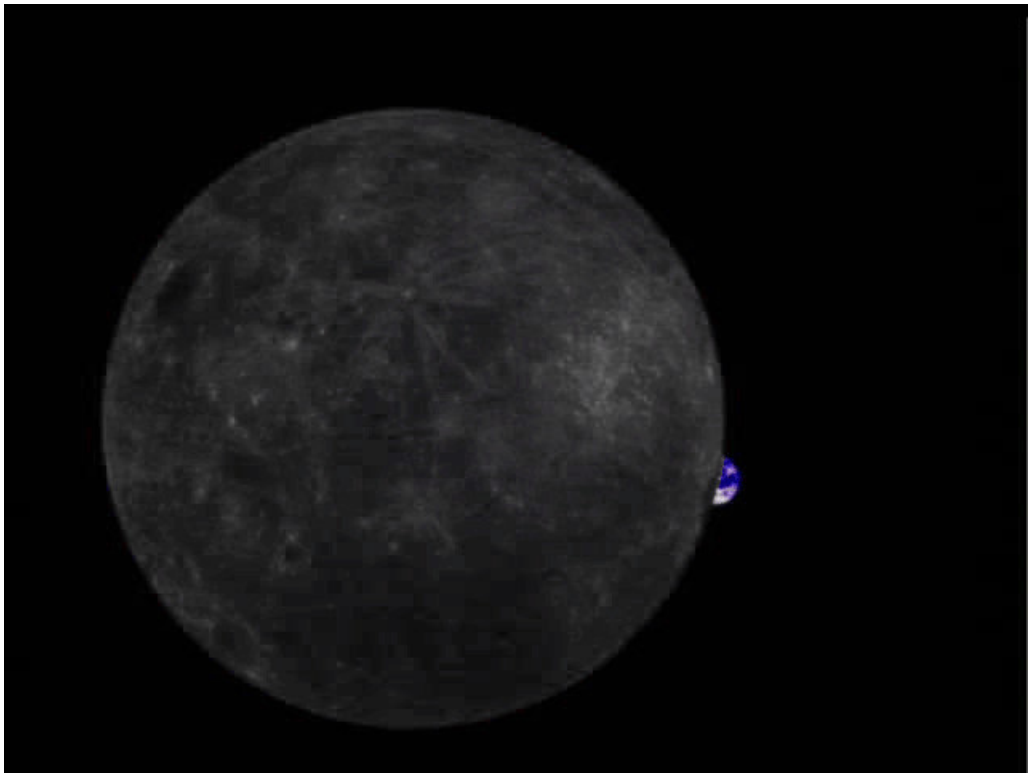
Downloading this image from Longjiang-2 was, without a doubt, the highlight of this project so far, and a great reward for spending a dozen observing sessions in the Dwingeloo telescope, sometimes in the middle of the night, while communicating by email and twitter with radio amateurs spread across the globe to combine efforts and share results.

Some other images of the Moon and the Moon and Earth were taken between 10 and 15 October and downloaded during the following days. In 7 November the situation of the Moon, the Earth and the satellite was such that the Moon would pass in front of the Earth, hiding it from view for several minutes. A series of images was taken that shows the Earth disappearing and reappearing behind the lunar disc.

Besides taking and downloading images, radio amateurs have been busy doing all sorts of scientific experiments with Longjiang-2. One of these experiments has been VLBI (Very Long Baseline Interferometry). This involves recording the radio signal transmitted by the satellite from two distant points on Earth, using radio receivers that are time-synchronized by GPS. In this way, the difference in the times of arrival of the signal to the receivers can be measured. The measurements can then be used to perform precise determination of the orbit of Longjiang-2 around the Moon.

The first VLBI experiment was performed on 10 June, recording the signal transmitted by Longjiang-2 using the 25m radio telescope in Dwingeloo and a 12m dish in Shahe, Beijing, China. The analysis of this experiment showed that the distance to Longjiang-2 could be measured with a precision of around 50km, and its velocity with a precision of 0.3m/s. This is rather good considering the limitations of the VLBI experiment, which is done on a low-bitrate communications signal, rather than on a signal intended

specifically for ranging. The measurements obtained by VLBI were in good agreement with the official orbit determination made by the Chinese Deep Space Network. The second VLBI experiment was performed on 21 October, using ground stations in Dwingeloo, Shahe and Harbin. The data has not been processed yet. These have been the first VLBI observations performed by radio amateurs ever.

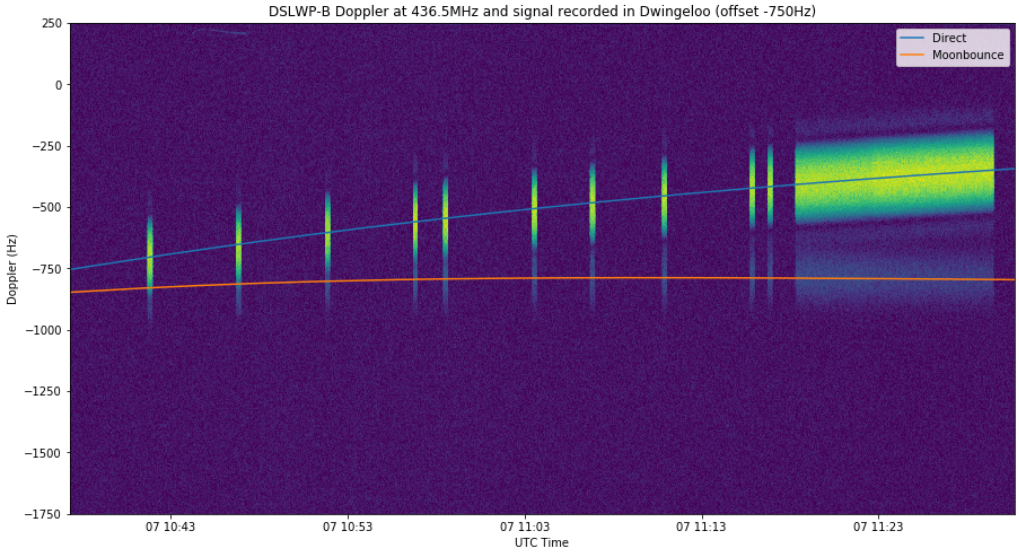


The Earth hiding behind the Moon: One of a series of nine images showing the Moon passing in front of the Earth. MingChuan Wei, Harbin Institute of Technology

Another experiment has been the study of the reflections of the radio signal from Longjiang-2 on the surface of the Moon, which we call the Moonbounce signal. This started when we noted that a weaker copy of the signal could be seen, at a different frequency, in the recordings made at Dwingeloo, as shown in the figure below.

The analysis of the Doppler of this weaker signal showed that it was compatible with a reflection on the surface of the Moon. This kind of reflection has regularly been observed in several of the recordings of the radio signal made at Dwingeloo.

Several studies surrounding the Moonbounce signals have been done: the calculation of the spot on the lunar surface where the reflection takes place each time (assuming that most of the reflection is specular); the measurement of the Doppler spread, which is caused by the signal reflecting diffusely over different parts of the lunar surface; and the calculation of the cross-correlation between the direct and Moonbounce signals, which can be used to measure the extra distance traveled by the reflected signal.



Moonbounce signal from Longjian-2: The waterfall of the signal recorded in Dwingeloo clearly show the fainter Moonbounce signal below the stronger direct signal. Daniel Estévez

Also, we have been able to decode one of the JT4G transmissions from Longjiang-2 by using the signal reflected off the Moon. Since JT4G was originally designed for amateur radio communications by bouncing signals off the Moon (a mode which is called EME or Earth-Moon-Earth), it is very robust in this kind of propagation conditions. While JT4G and similar signals are routinely used by amateur radio operators around the world for Earth-Moon-Earth communication, this is the first reported case of a Satellite-Moon-Earth communication.

More information about these experiments can be found in Daniel Estévez's blog. The team of radio amateurs involved in the Longjiang-2 activities are already thinking about new images to take and new experiments to perform. Since the satellite is still going strong, who knows what the future will bring.

An earlier version of this article appeared as guest blog on planetary.org

References:

DSLWP-B info by Harbin Institute of Technology: http://lilacsat.hit.edu.cn/wp/?page_id=844
CAMRAS Dwingeloo radio telescope: https://www.camras.nl/
DSLWP-B at Daniel Estévez's blog: https://destevez.net/tag/dslwp/
Twitter:Cees Bassa @cgbassa, Tammo Jan Dijkema @tammojan, Daniel Estévez @ea4gpz, MingChuan Wei @bg2bhc

Job Postings – Radio Astronomy and Related Fields

University of Virginia

Assistant or Associate Professor in Astronomy (Astronomical Instrumentation)
https://jobregister.aas.org/ad/808842c2

Square Kilometer Array

Signal Processing Domain Specialist (Manchester, UK)
https://recruitment.skatelescope.org/domain-specialist-signal-processing/

Arizona State University – 3 Positions

Research professional with expertise in radio-frequency engineering:
https://jobregister.aas.org/ad/a67137b8

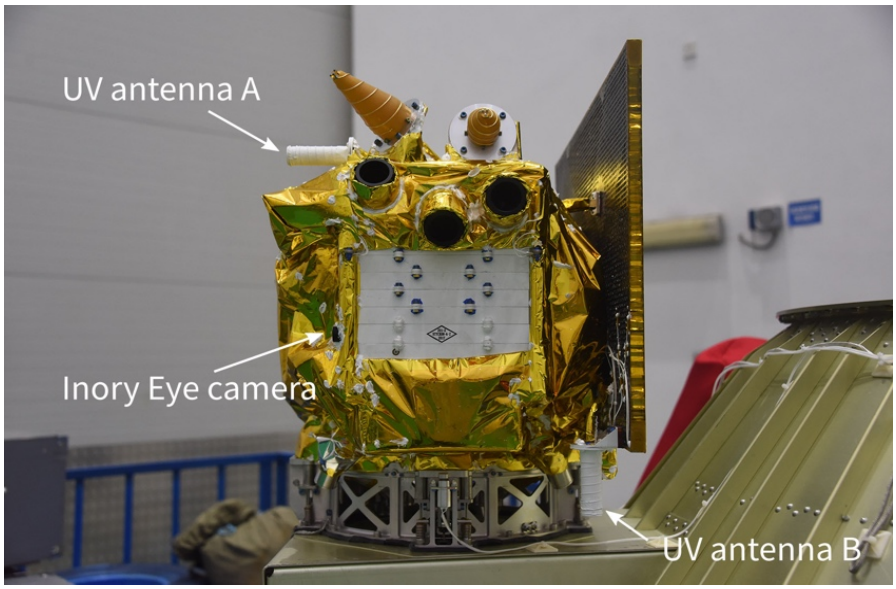
Postdoc in Radio Instrumentation and/or Signal Processing
https://jobregister.aas.org/ad/6f5685cb

Postdoc in 21cm Data Analysis
https://jobregister.aas.org/ad/e56bb558

If your organization has an opening for a position that may be of interest to Commission J members please send the title, short description, and link for additional information to R. Bradley. Positions will only be posted by request from URSI members.

Photo from the Field

Discovering the Sky at Longest Wavelengths Pathfinder (DSLWP)



Side view of the DSLWP-B satellite, with some parts of the relevant payload highlighted. The height of the satellite is about 50cm, it weighs roughly 45kg. MingChuan Wei BG2BHC.

Submitted by Cees Bassa, Daniel Estévez, Tammo Jan Dijkema

For more information about the spacecraft see: https://space.skyrocket.de/doc_sdat/dslwp-a.htm DSLWP-B was sent to lunar orbit about six months prior to the Chang'e-4 mission to the far side of the moon, scheduled for launch on December 8. It was a secondary payload with the Chang'e-4 data relay satellite Queqiao. https://www.nature.com/articles/d41586-018-07562-z provides additional information on the Chang'e-4 mission, which includes a radio spectrometer, built by the Chinese Academy of Sciences, that will collect electromagnetic data between 0.1 and 40 MHz to create a map of the low frequency radiation from the sky.

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