Union Radio-Scientifique Internationale — International Union of Radio Science

U.R.S.I.

Monthly Newsletter of International URSI Commission J – Radio Astronomy

January 2019

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

Happy New Year Commission J Members!

This year marks the 100 year anniversary of of URSI! There are plans for the centenary book which URSI aims to publish in time for the URSI GASS in 2020. The goal of this book is to contain articles from each and every Member Committee and each and every Commission. Each article would include some historical context, something about contemporary activities, and something about the future. Commission J is actively looking for a lead author – if you are interested please contact me immediately.

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. On behalf of URSI and the organizing committee, thank you for supporting AP-RASC 2019!

I continue 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 the phased-array feed (PAF) being developed for the Green Bank Telescope. I thank B. Shillue, K. Warnick, and D. J. Pisano for giving us a nice overview of the project, including its history, technical challenges, and future activities.

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

100 Years URSI

1919 U.R.S.I. 2019

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
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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

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J09: The Early Universe (EoR Experiments and Related Results)
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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: Joseph Lazio, Heino Falcke, Yuri Kovalev
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

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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

Cryogenic PAF for the Green Bank Telescope

In March 2017, the FLAG phased array receiver (*F*ocal, *L*-Band *A*rray Receiver for the *G*BT) demonstrated the best sensitivity reported to date for a radio astronomy phased-array feed. The measured system temperature over efficiency was 25.4 +/- 2.5 K at 1350 MHz. The receiver consists of 19 dual-polarized dipole elements and formed seven simultaneous beams in each polarization, with T_{sys}/η comparable to the existing GBT L-band single pixel reciever. Commissioning results for this receiver have been published by D.A. Roshi, et al. in the Astronomical Journal [1].

History and Prior Work

PAF receivers have in the last 20 years gone from concept to prototype to fully deployed receivers on radio antennas. Rick Fisher and Rich Bradley of NRAO published an early work on phased array feeds for radio astronomy which was notable for establishing many of the primary considerations for PAFs on large reflector systems [2]. They laid out guidelines for the design and analysis of PAF receivers and began working on early room temperature demonstrators. During the following years, work continued at NRAO in this area, and a collaborative relationship was begun with the Brigham Young University (BYU) Radio Astronomy Systems group led by Brian Jeffs and Karl Warnick. The BYU group had been conducting R&D for radio astronomy leveraging PAFs for improved field-of-view, survey speed, and application to interference mitigation. BYU's work led to several publications presenting a new approach to modeling and beamforming and important early proof-of-concept demonstrations [3].

Two ambitious radio astronomy PAF projects were conceived and developed from 2006 to the present by SKA development groups at CSIRO (Australia) and ASTRON (Netherlands). These eventually were funded as the PAF Chequerboard array of the Australia SKA Pathfinder project (ASKAP) and the APERTIF PAF of the Westerbork Synthesis Radio Telescope. Both PAF receivers are used in a synthesis array, with a multi-element receiver on each dish, and the projects' status is that ASKAP is in use for scientific observations and APERTIF is in the process of commissioning [4,5].

North American PAF development work meanwhile focused mainly on single dish applications (at L-band), taking advantage of the large telescopes at Green Bank Observatory and the Arecibo Observatory [6,7]. These early U.S. efforts yielded a best result in terms of T_{sys}/η of 45.5 deg K.

A significant new effort to improve the performance of the single dish PAF receiver was initiated in 2013 as a collaboration between the "Beamformer" initiative, a joint development project of West Virginia University, BYU, and the Green Bank Observatory, and the NRAO Central Development Laboratory (CDL). The Beamformer group was funded by a National Science Foundation Advanced Technologies and Instrumentation Grant for *"Collaborative Research: Wide-Field L-band Focal Plane Array Beamformer for Pulsar, Diffuse Hydrogen, and Fast Transient Surveys on the GBT,"* with WVU as the scientific lead and

BYU over the correlator-beamformer digital back end. Green Bank Observatory had several roles, including project coordination led by Richard Prestage, project site host, and instrumentation support. The NRAO CDL team focused on receiver instrumentation development, electromagnetic modeling and beamforming. This collaboration produced and commissioned the FLAG PAF receiver and digital signal processing.

FLAG instrumentation development included several improvements over previous PAF prototypes:

1. Increased inter-element spacing and a larger cryogenic dewar to reduce mutual coupling and optimize the dish illumination
2. Second generation GBT (GBT2) dipoles optimized for efficiency over the receiver bandwidth
3. Custom designed, mechanically stable silicon-germanium cryogenic low noise amplifiers with low noise temperature (4.85 K median)
4. A custom, highly integrated 40-channel downconverter with 8-bit digitizers and digital photonic link packaged to fit directly behind the PAF cryostat
5. A 40-input-channel ROACH-2 based polyphase filterbank signal processor backend with 512 frequency bins and 150 MHz of processing bandwidth
6. A complete GPU-based signal processor for calibration, beamforming, correlation, and pulsar and transient searches

Challenges Commissioning the New Receiver

The commissioning proceeded in stages. With all new instrumentation, firmware, and software, the first tests of the system often included difficult troubleshooting. The front end cryogenics worked well but there were problems with overheating in the downconverter-digitizer electronics that required re-engineering of the receiver box. The digital fiber link used an unformatted bit stream technique in which the link clock and data stream lock were recovered from transmitted, digitized Gaussian noise. The first commissioning tests revealed an instrumental instability in which these digital streams would randomly lose lock. This was initially only observed on the telescope, and the troubleshooting involved testing elevation dependencies, cable and connector integrity, and signal amplitude dependencies to no avail. Attempts to reproduce the problem via ground testing were unsuccessful. The various electronics subassemblies were then retested individually. A voltage offset in the A-D converters was found and repaired but this alone could not have caused the problem. Finally, it was discovered that there were intermittent low frequency oscillations in the LNAs that, when coupled with ADC offsets, were the likely cause of the problem. The LNA low frequency oscillation was fixed by changing the bypassing on the LNA PCB, and by adding ferrite filtering to the voltage bias distribution. After these issues had been resolved, successful telescope testing ensued. The PAF receiver and digital downconverter were first commissioned successfully demonstrating seven simultaneous beams in each of two polarizations.

Further commissioning tests then demonstrated the digital backend with real-time correlator and beamformer. Work on the beamformer was predominantly done by students at BYU and WVU. BYU engineering students worked on the hardware and firmware developments, while astronomy students at WVU wrote the software for data collection and analysis. The teams collaborated on commissioning and early science observations in 2017 and 2018. These included observations of a known pulsar and HI maps of a nearby galaxies (see figures).

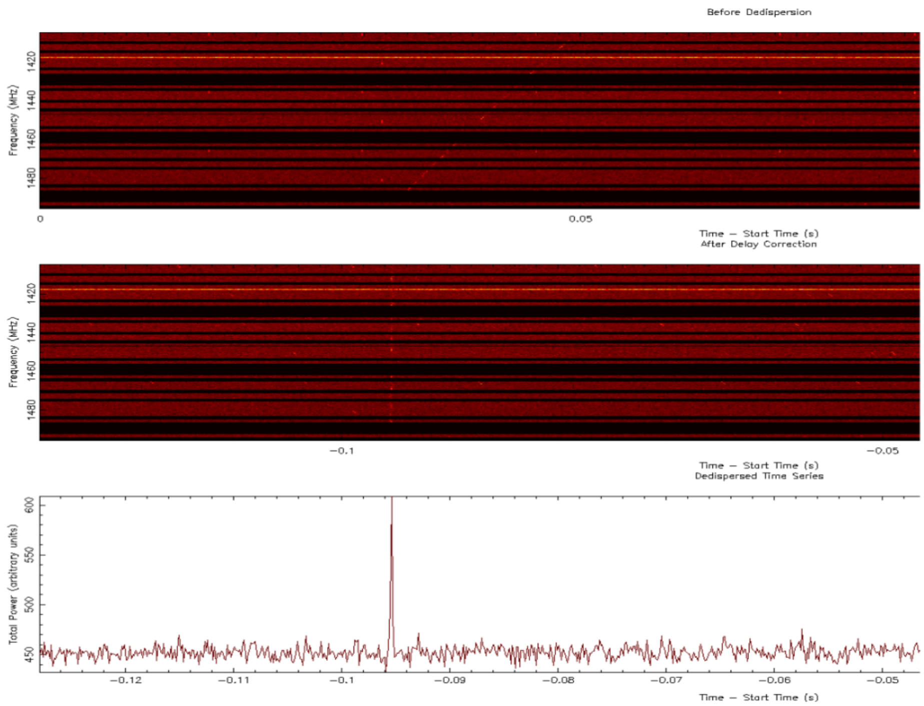


Figure 1 - The detection of a giant pulse from B1937+21 in one of the FLAG beams using the new beamformer.

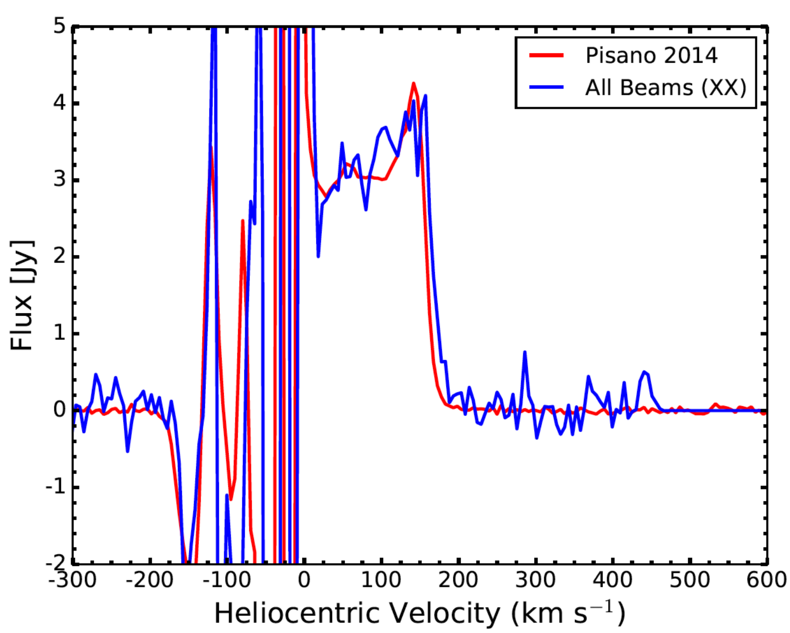


Figure 2- The atomic neutral hydrogen (HI) spectrum of the galaxy NGC 6946 from FLAG (blue) as compared to previous observations with the GBT (red). The agreement between the fluxes for the two receivers shows how well FLAG is working

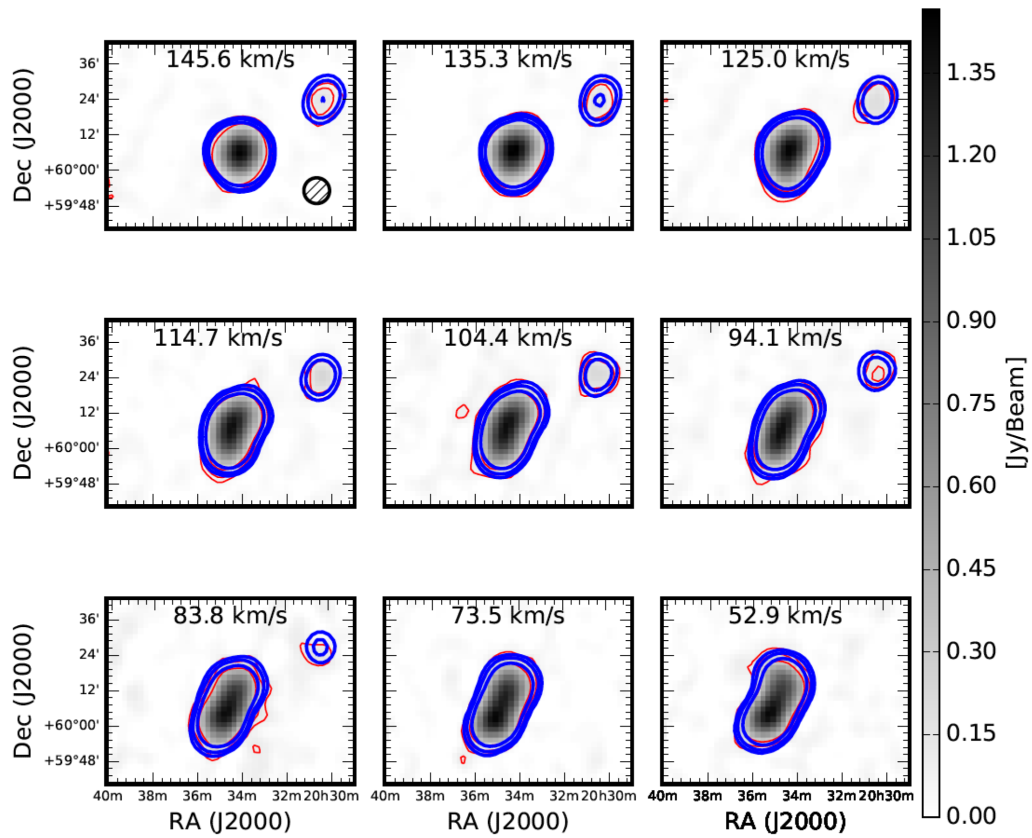


Figure 3 - Maps of HI as a function of velocity from FLAG (blue) and the existing GBT receiver (red). The agreement between the two datasets illustrate the excellent performance of FLAG. The existing data took 10 hours to collect, while the FLAG map was made in 30 minutes of observing.

Next Steps for North American PAF Development

With the successful commissioning of the FLAG receiver and the completion of the Beamformer backend, it is expected that the instrument will be available for GBT shared risk observations in upcoming semesters. Obtaining scientific validation of the FLAG/Beamformer system will be an important milestone for the technology. Cornell University, BYU, the University of Central Florida, and the Arecibo Observatory are now working on a new initiative funded under an NSF Mid-scale instrumentation grant, a 40-beam PAF called the Advanced Cryogenic L-band Phased Array Camera (ALPACA) for the Arecibo Radio Telescope.

When research on array feeds began more than 20 years ago, progress was slow. Early PAF prototypes had poor noise performance and low sensitivity. Strong collaborations between universities and research facilities, both within the U.S. and internationally, along with methodical prototype development and careful measurements and performance characterization, helped to overcome these challenges. The design process had to be adapted to account for antenna mutual coupling effects often ignored in other fields with less stringent performance requirements, and methods for experimental characterization of complex, digitally beamformed arrays were developed [8]. These developments have brought the technology to the point that PAFs are now in use for wide-field astronomical observations.

Acknowledgment

This material is based in part upon work supported by the National Science Foundation under Grant Nos. #1309815 and #1309832.

The National Radio Astronomy Observatory and the Green Bank Observatory are facilities of the National Science Foundation (NSF) operated under cooperative agreement by Associated Universities, Inc.

References

[1] Roshi, D.A., Shillue, W., Simon, B., Warnick, K.F., Jeffs, B., Pisano, D.J., Prestage, R., White, S., Fisher, J.R., Morgan, M. and Black, R., 2018. Performance of a Highly Sensitive, 19-element, Dual-polarization, Cryogenic L-band Phased-array Feed on the Green Bank Telescope. *The Astronomical Journal*, *155*(5), p.202.

[2] Fisher, J. Richard, and Richard F. Bradley. "Full-sampling array feeds for radio telescopes." *Radio Telescopes*. Vol. 4015. International Society for Optics and Photonics, 2000.

[3] http://www.atnf.csiro.au/projects/askap/news.html

[4] https://www.astron.nl/astronomy-group/apertif/news/apertif-news

[5] Jeffs, B.D., Warnick, K.F., Landon, J., Waldron, J., Jones, D., Fisher, J.R. and Norrod, R.D., 2008. Signal Processing for Phased Array Feeds in Radio Astronomical Telescopes. *J. Sel. Topics Signal Processing*, *2*(5), pp.635-646.

[6] Roshi, D.A., Warnick, et al, 2015, July. A 19 element cryogenic phased array feed for the Green Bank Telescope. In *Antennas and Propagation & USNC/URSI National Radio Science Meeting*, *2015 IEEE International Symposium on* (pp. 1376-1377). IEEE.

[7] Cortes-Medellin, G., Vishwas, A., Parshley, S.C., Campbell, D.B., Perilatt, P., Black, R., Brady, J., Warnick, K.F. and Jeffs, B.D., 2015. A fully cryogenic phased array camera for radio astronomy. *IEEE Transactions on Antennas and Propagation*, *63*(6), pp.2471-2481.

[8] K. F. Warnick, R. Maaskant, M. V. Ivashina, D. B. Davidson, and B. D. Jeffs, *Phased Arrays for Radio Astronomy, Remote Sensing, and Satellite Communications*, Cambridge, UK: Cambridge University Press, 2018

Submitted by B. Shillue, K. Warnick, and D. J. Pisano

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

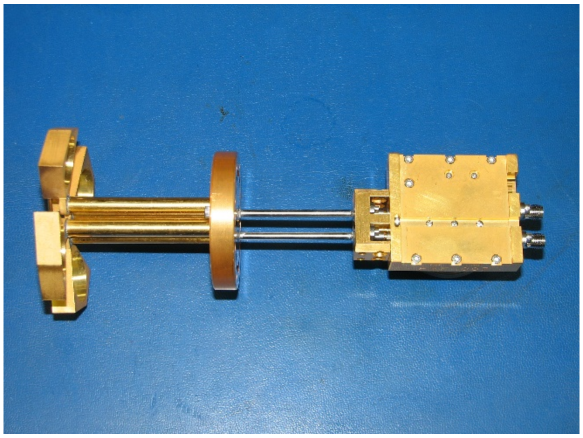
Research professional with expertise in radio-frequency engineering:
https://jobregister.aas.org/ad/a67137b8

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

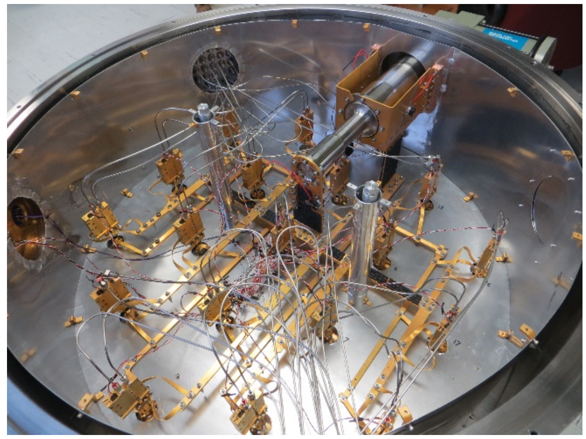
Postdoc in 21cm Data Analysis
https://jobregister.aas.org/ad/e56bb558

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.

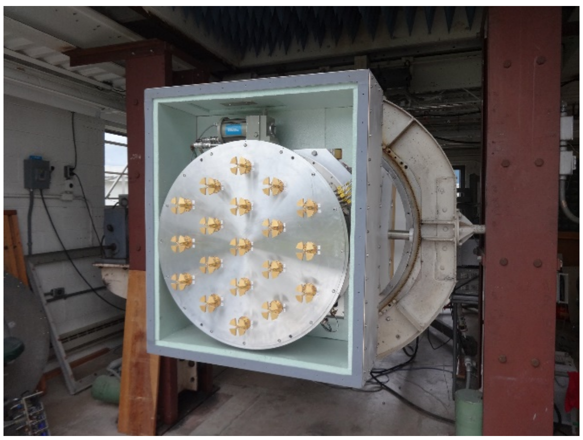
Photos from the Field – PAF Gallery



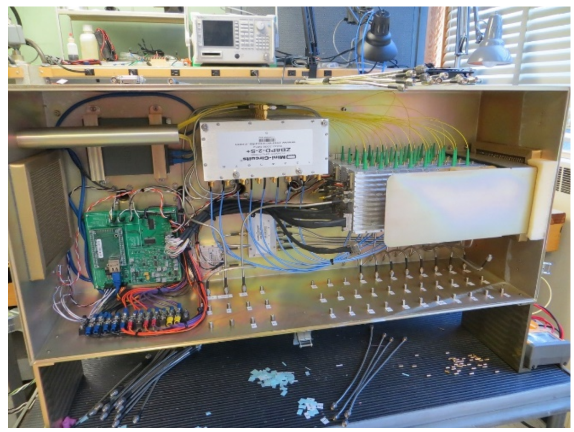
GBT2 Dipole and Low Noise Amplifier



Interior of Cryogenic Dewar



PAF Receiver in Outdoor Test Facility



40-channel Digital Downconverter

Receiver on Crane Hoist

Submitted by B. Shillue, K. Warnick, and D. J. Pisano

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

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This is your last chance to suggest workshop and session ideas for the 2020 URSI General Assembly and Scientific Symposium in Rome. The final draft of the 2020 GASS Commission J program is given below. Your input is needed – consider convening a session!

How far would you go for good data? Our Spotlight this month is on PRIZM - Probing Radio Intensity at high-Z from Marion, a cosmic dawn experiment that has been operating since 2017 on the remote island of Marion. H. Cynthia Chiang takes us on an adventure to this tiny island and describes the low frequency radio astronomy research she is conducting from this location. Thank you, Cynthia, for writing this wonderful article for 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.

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

Cerenkov Telescope Array Symposium
"*Science opportunities with CTA*"
Bologna, 6-9 May 2019

Dear colleagues,

Registration for the First CTA symposium is now open. Participants can register online at http://www.cta-symposium.com/registration. Your registration will be confirmed by the workshop secretary as soon as the registration fee has been received.

The workshop registration fee is 300 Euros before 20 March, 2019 and 350 Euros after this date. A special rate of 200 (250 after 20 March) euros is available for students.

The theme for the First CTA Symposium is "Science opportunities with CTA" and will take place at the historical Teatro Duse in Bologna 6-9 May 2019 (https://www.cta-symposium.com). The meeting specifically addresses the larger Multi-Wavelength/Multi Messenger communities and aims to set up new channels of communication with those communities. It will feature a combination of invited and contributed talks. The preliminary programme is available on the symposium webpage.

We are also opening a call for contributions to the First CTA Symposium in the following areas:

- Cosmic particle acceleration
- Compact objects and relativistic shocks
- Role of cosmic particles in galaxy evolution and star-forming systems
- Gamma rays as cosmic probes
- Fundamental physics
- Multi-wavelength and multi-messenger observations

Or any other topic connected to the scientific possibilities of CTA.

Submit your abstract on http://www.cta-symposium.com/abstract-submission/ - please make your submissions comprehensible to a broad astrophysical audience as some of the attendees may be unfamiliar with the specifics of your field.

The deadline to submit abstracts is February 20, 2019. The scientific organising committee (SOC) will consider the submission for inclusion in the preliminary programme and will notify the authors whether their contribution has been selected for an oral/poster presentation by March 15, 2019.

Confirmed invited speakers include:

Marco Ajello
Roger Blandford
Catherine Cesarsky
Federico Fiuza
Giancarlo Ghirlanda
Gabriele Ghiselini
Francis Halzen
Werner Hofmann
Jamie Holder
Takaaki Kajita
Robert Laing
Julie McEnery
Andrii Neronov
Subir Sarkar
Anatoly Spitkovsky
Rai Weiss
Wolfgang Wild

We look forward to seeing you in Bologna in May.
With best regards,

Stefan Funk
on behalf of the SOC:

Roger Blandford, Kavli Institute of Particle Astrophysics and Cosmology, Stanford University, USA; Catherine Cesarsky, CEA, France; Andrea Comastri, INAF, Italy; Emma de Oña Wilhelmi, University of Barcelona, Spain; Stefan Funk, University of Erlangen, Germany; Jim Hinton, Max Planck Institute for Nuclear Physics, Germany; Giovanni Pareschi, INAF, Italy; David Reitze, California Institute of Technology, USA; Richard Schilizzi, University of Manchester, UK; Christian Spiering, DESY, Germany; Matthias Steinmetz, IAP, Germany; Wolfgang Wild, CTAO, Italy

Of Mice and In-Flight Magazines

H. Cynthia Chiang
Department of Physics, McGill University

It all started with an in-flight magazine: while taking a quick hop across South Africa, one of the airline magazine articles featured a small, little-known island named Marion. The island, which is situated halfway between South Africa and Antarctica, hosts a research base that is operated by the South African National Antarctic Programme. As the article went on to describe, the base had been used primarily for studies in biology, geology, space weather, and a few other research areas. With the combination of extreme remoteness but also the existence of infrastructure, the tantalizing possibility of Marion offering a brand new radio-quiet environment for astronomical observations gradually unfolded during that short plane flight.

At frequencies below ~150 MHz, observations of redshifted 21-cm emission can probe the era of cosmic dawn, when the first stars ignited in the universe. The global 21-cm signal, averaged across the sky, captures the heating processes of these first stars and is expected to have a characteristic ~100 mK dip around a redshift of 20. A possible detection of this global signal was first reported by the EDGES team in early 2018 [1]. If this detection is confirmed, it represents the the opening of a completely new observational window into early times in the universe, allowing us to constrain the thermal history and energy injection processes as the first luminous objects were created.

Measuring the global 21-cm signal from cosmic dawn sounds deceptively simple at first. In order to observe total power at frequencies of tens to hundreds of MHz, one only needs an antenna the size of a coffee table, a handful of amplifiers and filters, digitizers with modest specifications, and a computer or FPGA with fairly unremarkable resource usage. Whenever a story sounds too good to be true, there's always a catch. The fine print, in this case, is that the measurement is dominated entirely by the unholy quartet of systematic errors: astrophysical foregrounds, ionosphere, radio frequency interference, and instrumental effects. As a colleague says, "the instrument is easy, but the experiment is hard." Nevertheless, for the potential payoff of exciting science coming from such a small-scale instrument, who could resist such fun?

The magazine article about the tiny island in the sub-Antarctic seeded the idea for our own team to join the global 21-cm game: Probing Radio Intensity at high-Z from Marion (PRI^{Z}M) is a new cosmic dawn experiment that has been operating since 2017. PRI^{Z}M joins the experimental effort from several teams around the world [2–4] that are attempting to weigh in on the EDGES detection using a variety of instrumental designs and observation locations. The PRI^{Z}M instrument [5] consists of two modified four-square antennas (Figure 1) operating at central frequencies of 70 and 100 MHz, and the system is read out with a SNAP-based[1] back end. The experiment is the first astronomy research that has taken place on

1 https://casper.berkeley.edu/wiki/SNAP

Marion, and with new remote sites comes a plethora of new challenges. Travel to the island is via the S. A. Agulhas II ship only once per year in April, and after the few-day voyage (while being pummeled by 5-m ocean swells), the on-island access window is a mere three weeks before the ship returns to Cape Town. Marion weather is both harsh and unpredictable: temperatures hover a few degrees above freezing, the rain is often relentless, and the wind is even more unforgiving, with sustained speeds often reaching 50 knots or more (and gusts up to 80 or 90 knots). The PRIZM observing site is located about 4 km from the main base, and the daily commute is a one-hour hike in each direction, meandering through mires and fields of ankle-twisting lava rocks. Wind- and weather-proofing the humans and hardware is a fairly conventional requirement, but perhaps the most cruel punishment that Marion inflicts upon scientific equipment is hordes of hungry mice that are eager to fill their stomachs with wire insulation, electrical tape, and heat shrink, to name a few.

Figure 1: The PRIZM 100 MHz antenna with visible front-end electronics, newly rebuilt and installed by MSc student Nivek Ghazi (left) and PhD student Liju Philip (right).

Thankfully, our team managed to keep PRIZM firmly anchored, dry, and (after a few minor electronics casualties and many artful applications of wire mesh cloth, brass scouring pads, and silicone sealant) free of mice. Despite the merciless nature of Marion, the island rewarded us with the gift of an unparalleled, radio-quiet observing location with no visible contamination within the FM band. Analysis of the PRIZM data is in progress, and observations are continuing, thanks to the heroic efforts of our overwintering team members (Figure 2) who spend 13 months at a time living on the island and taking care of our instrument.

Looking ahead to the future, we are beginning to make exploratory measurements to see how low in frequency we can observe from the unique environment of Marion. The few-MHz radio sky is one of the final frontiers of radio astronomy and cosmology, with Grote Reber's measurements [6] from several decades ago still representing the state of the art. Our team installed two LWA antennas[2] at the PRIZM site in 2018 , and the preliminary cross-correlation data show repeatable interference fringes from the sky down to about 10 MHz without any processing or cuts. We will continue to expand the low-frequency antenna installation on Marion, with the hope of gaining a new and improved glimpse of the sky at a few MHz. We are additionally exploring the possibility of new observing sites in the Canadian high Arctic, which are likely to be radio quiet and have the advantage of being accessible more than just once per year. We may have to fend off the occasional polar bear or two, but at least there won't be any pesky mice.

Figure 2: Kagiso Malepe (left; 2017) and Vhuli Manukha (right; 2018), the overwintering engineers from the South African National Space Agency who maintained and operated PRIZM during 13-month stays.

References

[1] J. D. Bowman et al., *An absorption profile centred at 78 megahertz in the sky-averaged spectrum*, Nature, 555, 2018.

[2] D. C. Price et al., *Design and characterization of the Large-Aperture Experiment to Detect the Dark Age (LEDA) radiometer systems*, Monthly Notices of the Royal Astronomical Society, 478, 2018.

[3] S. Singh et al., *SARAS 2: A Spectral Radiometer for probing Cosmic Dawn and the Epoch of Reionization through detection of the global 21 cm signal*, *Experimental Astronomy*, 45, 2018.

[4] B. D. Nhan et al., *A Proof of Concept on Constraining the Foreground Spectrum for Global 21 cm Cosmology through Projection-induced Polarimetry*, submitted to the Astrophysical Journal, 2018 (arXiv:1811.04917).

[5] L. Philip et al., *Probing Radio Intensity at high-Z from Marion: 2017 Instrument, accepted for publication in the Journal of Astronomical Instrumentation, 2019* (arXiv:1806.09531)

[6] G. Reber and G. R. Ellis, *Cosmic radio-frequency radiation near one megacycle*, Journal of Geophysical Research, 61, 1956.

Submitted by Hsin Cynthia Chiang

2 http://www.reeve.com/RadioScience/Antennas/ActiveCrossed-Dipole/LWA_Antenna.htm

Job Postings – Radio Astronomy and Related Fields

HIRAX Postdoctoral Fellowships in Radio Astronomy and Instrumentation

The Astrophysics and Cosmology Research Unit (ACRU) at the University of KwaZulu-Natal (UKZN) is offering a postdoctoral research position in the area of radio astronomy and instrumentation. For more information, see https://acru.ukzn.ac.za/hirax-postdoc-jan2019/

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

One of two Long Wavelength Array (LWA) antennas installed on Marion Island in 2018. The LWA antennas are being used to perform exploratory measurements in a frequency range of 1.2-81 MHz. Preliminary cross-correlation data show repeatable interference fringes from the sky down to about 10 MHz without any processing or cuts. Additional antennas will be installed during the 2019 Marion voyage.

Submitted by Hsin Cynthia Chiang

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.

Union Radio-Scientifique Internationale — International Union of Radio Science

Monthly Newsletter of International URSI Commission J – Radio Astronomy

March 2019

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 Pacific Radio Science Conference (AP-RASC) is occurring this week! On behalf of URSI and the Organizing Committee, thank you for supporting AP-RASC 2019!

We are in search of conveners for the 2020 URSI General Assembly and Scientific Symposium. The 2020 GASS Commission J program is given below. Preparations for the GASS are currently underway so please contact me as soon as possible to volunteer.

Our Activities Spotlight this month is on the the Next Generation Very Large Array (ngVLA). Special thanks to Tony Beasley, Eric Murphy, Rob Selina, Mark McKinnon & the ngVLA Project Team at NRAO for contributing a very nice article that details the overall concept, key science goals, instrument suite, and broader impacts of the ngVLA.

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

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

We are now actively 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.

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

Sessions:

New Telescopes on the Frontier
Recent and Future Space Missions
Conveners: Joseph Lazio, Heino Falcke, and Yuri Kovalev
Single Dish Instruments
Very Long Baseline Interferometry
Millimeter/Submillimeter Arrays
Receivers and Radiometers: Design and Calibration
Convener: Jacki Gilmore
Digital Signal Processing: Algorithms and Platforms
Big data: Algorithms and Platforms
Conveners: Stefan Wijnholds
Short-Duration Transients, FRBs, and Pulsars: Observations, Techniques, and Instrumentation
Power spectrum observations
Solar, Planetary, and Heliospheric Radio Emissions
Historical Radio Astronomy
Conveners: Richard Schilizzi
Latest News and Observatory Reports
Conveners: Rich Bradley and Douglas Bock

Shared Sessions

Radio astronomical characterisation of the ionosphere and related models (Commissions JG)
Characterization and Mitigation of Radio Frequency Interference (Commissions JEFGH)
Some aspects of radio science in space weather (Commissions GHJ)
Conveners: Richard Fallows (J), Iwona Stanislawska (G), Baptiste Cecconi, Patricia Doherty, Willem Baan
Spectrum Management (Commissions ECJ)

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

Rome, Italy

GASS Session Descriptions

Current and Future Space Missions

Convenors: Joseph Lazio, Heino Falcke, & Yuri Kovalev

One of the long-term themes of radio astronomy is to obtain higher angular resolution. The motivations are diverse, from basic considerations such as mitigating source confusion to understanding the physics by which radio sources emit and whether an inverse Compton catastrophe occurs to the potential for imaging the event horizons of black holes.

Following initial pioneering work using a Tracking and Data Relay Satellite System spacecraft and the successful VLBI Space Observatory Programme (VSOP)/HALCA mission, there is a resurgence of interest in space-based antennas for radio astronomy, motivated by a number of recent, current, and potentially near-term missions and instruments. A likely incomplete list includes

- The successful RadioAstron mission;
- The Netherlands-China Low-Frequency Explorer (NCLE) experiment on the Chang'e 4 orbiter;
- A radio astronomy payload on the Chang'e 4 lander;
- The Sun Radio Interferometer Space Experiment (SunRISE), currently in an extended Phase A study for consideration as a constellation of small spacecraft;
- Multiple NASA Astrophysics concept studies for space-based radio telescopes; and
- Multiple concepts for one or more millimeter-wavelength space-based interferometers.

Further, while there has been historical activity by the United States, Japan Russia, and Europe, there is growing interest and capability such as from China. Moreover, the possibility of commercial launch opportunities may reduce the cost of future missions, increase the availability of launch options, or both.

This Commission J session would provide an opportunity to review the science results from the RadioAstron mission and the NCLE experiment as well as look to the future possibilities for space-based radio astronomy experiments and missions.

Meeting and Workshop Announcements

Cerenkov Telescope Array Symposium

“*Science opportunities with CTA*”

Bologna, 6-9 May 2019

Abstract submission deadline has passed!

Dear colleagues,

Registration for the First CTA symposium is now open. Participants can register online at http://www.cta-symposium.com/registration. Your registration will be confirmed by the workshop secretary as soon as the registration fee has been received.

The workshop registration fee is 300 Euros before 20 March, 2019 and 350 Euros after this date. A special rate of 200 (250 after 20 March) euros is available for students.

The theme for the First CTA Symposium is “Science opportunities with CTA” and will take place at the historical Teatro Duse in Bologna 6-9 May 2019 (https://www.cta-symposium.com). The meeting specifically addresses the larger Multi-Wavelength/Multi Messenger communities and aims to set up new channels of communication with those communities. It will feature a combination of invited and contributed talks. The preliminary programme is available on the symposium webpage.

Contributions to the First CTA Symposium in the following areas:

- Cosmic particle acceleration
- Compact objects and relativistic shocks
- Role of cosmic particles in galaxy evolution and star-forming systems
- Gamma rays as cosmic probes
- Fundamental physics
- Multi-wavelength and multi-messenger observations

Or any other topic connected to the scientific possibilities of CTA.

The scientific organising committee (SOC) will consider the submission for inclusion in the preliminary programme and will notify the authors whether their contribution has been selected for an oral/poster presentation by March 15, 2019.

Confirmed invited speakers include:

Marco Ajello
Roger Blandford
Catherine Cesarsky
Federico Fiuza
Giancarlo Ghirlanda
Gabriele Ghiselini
Francis Halzen
Werner Hofmann
Jamie Holder
Takaaki Kajita
Robert Laing
Julie McEnery
Andrii Neronov
Subir Sarkar
Anatoly Spitkovsky
Rai Weiss
Wolfgang Wild

We look forward to seeing you in Bologna in May.
With best regards,

Stefan Funk
on behalf of the SOC:

Roger Blandford, Kavli Institute of Particle Astrophysics and Cosmology, Stanford University, USA; Catherine Cesarsky, CEA, France; Andrea Comastri, INAF, Italy; Emma de Oña Wilhelmi, University of Barcelona, Spain; Stefan Funk, University of Erlangen, Germany; Jim Hinton, Max Planck Institute for Nuclear Physics, Germany; Giovanni Pareschi, INAF, Italy; David Reitze, California Institute of Technology, USA; Richard Schilizzi, University of Manchester, UK; Christian Spiering, DESY, Germany; Matthias Steinmetz, IAP, Germany; Wolfgang Wild, CTAO, Italy

The Next Generation Very Large Array (ngVLA)

A.J. Beasley, E. Murphy, R. Selina, M. McKinnon & the ngVLA Project Team (NRAO)

Over the past decade, the National Radio Astronomy Observatory (NRAO) Jansky Very Large Array (JVLA) and the jointly-operated Atacama Large Millimeter/submm Array (ALMA) have led the way in establishing the scientific importance and unique relevance of centimeter and millimeter-wavelength radio astronomy. For more than four decades, the NRAO has kept the JVLA at the forefront of radio astronomy, supporting the global research community through innovative technical and algorithmic development of an instrument originally built in the 1970s. To explore new science opportunities that have emerged over the past two decades, the NRAO, in close consultation with the global scientific community and a group of international partners, are now developing a concept for a more powerful instrument - currently known as the next-generation Very Large Array (ngVLA).

Based on science and operational requirements solicited from the astronomical community, the ngVLA will operate at centimeter wavelengths (25 to 0.26 centimeters, corresponding to a frequency range extending from 1.2 GHz to 116 GHz). The instrument will be a synthesis radio telescope, with a Main Array constituted of approximately 214 reflector antennas each of 18 meters diameter, operating in a phased or interferometric mode. An additional short-spacing array (SSA) of 19 reflector antennas of 6m aperture will be sensitive to larger angular scales undetected by the main array. The ngVLA will also include continental-scale long baselines (the Long Baseline Array – LBA) by merging the existing Very Long Baseline Array (VLBA) capabilities into ngVLA, with clusters of antennas replacing each VLBA station (10 sites each site containing approximately three 18m antennas).

The ngVLA will have approximately ten times the sensitivity of the JVLA and ALMA, with more than thirty times longer baselines (~9000km), providing milliarcsecond-scale resolution, plus a dense core on km-scales for high surface brightness sensitivity. Such an array bridges the gap between ALMA, the premiere mm/sub-mm array, and the future SKA1, optimized for longer wavelengths. The angular resolution of ngVLA compared to other existing or planned instruments is shown in Figure 1.

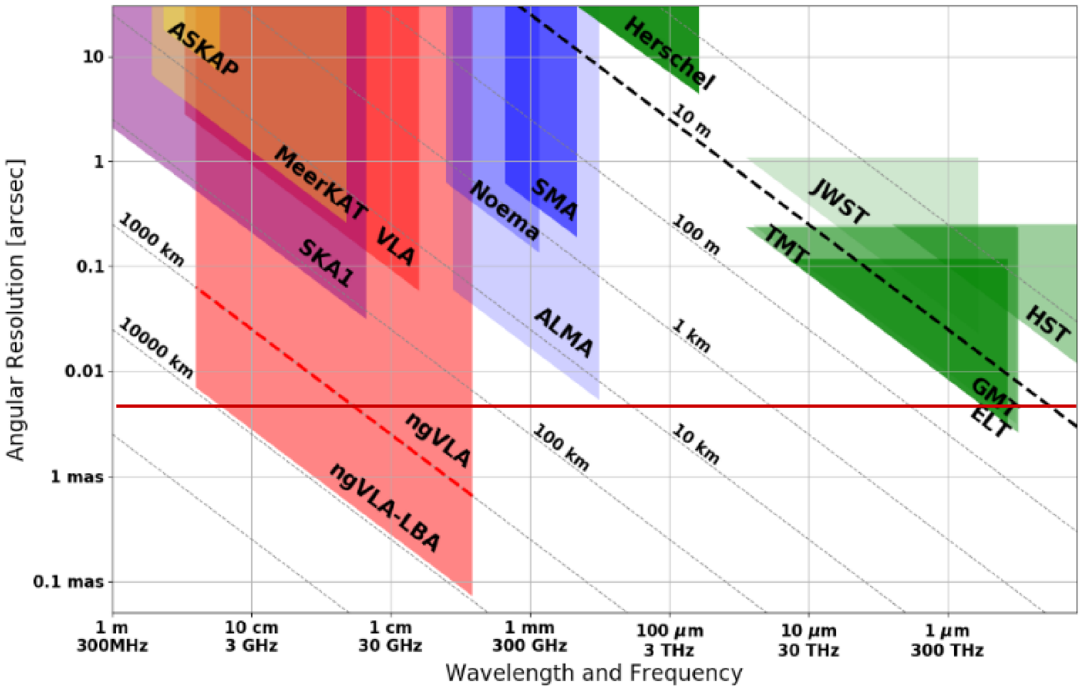


Figure 1: Spatial resolution versus frequency set by the maximum baselines of the ngVLA as compared to that of other existing and planned facilities. The horizontal line indicates the resolution needed to detection objects on 1 astronomical unit scales at a distance of 140 parsec (a typical distance to nearby star-forming regions).

Science

The ngVLA will uniquely explore a broad range of high- priority scientific questions in modern astronomy, physics, chemistry, and biology by simultaneously delivering the capability to: unveil the formation of Solar System analogues on terrestrial scales; probe the initial conditions for planetary systems and life; characterize the assembly, structure, and evolution of galaxies from the first billion years to the present; perform fundamental tests of gravity using pulsars in the Galactic Center; and understand the formation and evolution of stellar and supermassive black holes in the era of multi-messenger astronomy. In delivering transformational new science in each of these areas, the ngVLA will be highly complementary to other National Science Foundation (NSF) astronomy investments.

The ngVLA Science Advisory Council (SAC), a group of leading scientists with a wide range of interests and expertise appointed by NRAO, in collaboration with the broader international astronomical community, has recently defined over 80 compelling science cases requiring observations between 1.2 – 116 GHz with sensitivity, angular resolution, and mapping capabilities far beyond those provided by the Jansky VLA, VLBA, ALMA, and SKA1. These science cases were used to inform a set of key science goals (KSGs) for the ngVLA, which in turn formed the basis of the current ngVLA science requirements. These KSGs include include:

KSG1: Unveiling the Formation of Solar System Analogues on Terrestrial Scales

The ngVLA will measure the planet initial mass function down to a mass of 5 – 10 Earth masses and unveil the formation of planetary systems similar to our own Solar System by probing the presence of planets on orbital radii as small as 0.5 AU at the distance of 140 pc. The ngVLA will reveal circumplanetary disks and sub-structures in the distribution of mm-size dust particles created by close-in planets and measure the orbital motion of these features on monthly timescales. See Figure 2.

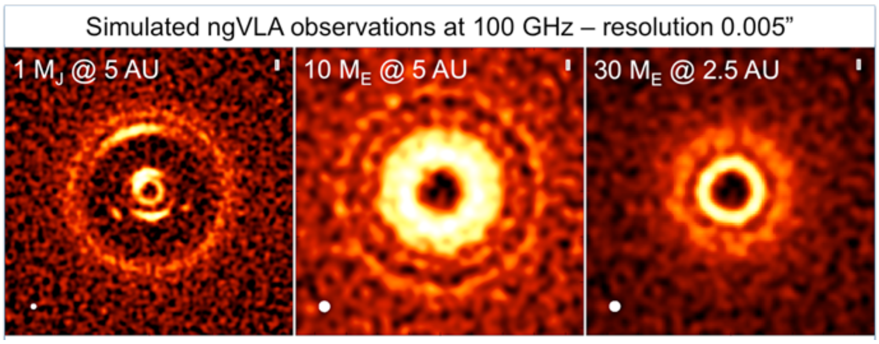


Figure 2: Simulated ngVLA observations of protoplanetary disk continuum emission perturbed by a Jupiter mass planet orbiting at 5 AU (left column), a 10 Earth mass planet orbiting at 5 AU (center column), and a 30 Earth mass planet orbiting at 2.5 AU (right column). The ngVLA's combination of frequency coverage and angular resolution will be able to directly image the formation of Earth-like planets (Ricci, L., Isella, A., Liu, S., Li, H. "Science with a ngVLA: Imaging Planetary Systems in the Act of Forming with the ngVLA" in ASP Monograph Series 7, "Science with a Next-Generation VLA", ed. E. J. Murphy 2018, (ASP, San Francisco, CA)) (2018).

KSG2: Probing the Initial Conditions for Planetary Systems and Life with Astrochemistry

The ngVLA should detect predicted complex prebiotic species that are the basis of our understanding of chemical evolution toward amino acids and other biogenic molecules. It shall also allow us to detect and study chiral molecules, testing ideas on the origins of homochirality in biological systems. The detection of such complex organic molecules will provide the chemical initial conditions of forming solar systems and individual planets. See Figure 3.

KSG3: Charting the Assembly, Structure, and Evolution of Galaxies from the First Billion Years to the Present

The ngVLA will survey cold gas in thousands of galaxies back to early cosmic epochs, while simultaneously enabling routine sub-kiloparsec scale resolution dynamical imaging of their gas reservoirs. In doing so, the ngVLA will afford a unique view into how galaxies accrete, process, and expel their gas through detailed imaging of their extended atomic reservoirs and circum-galactic regions. The ngVLA shall also have enough sensitivity to map the physical and chemical properties of molecular gas over the entire local galaxy population. These studies will reveal the detailed physical conditions for galaxy assembly and evolution throughout the history of the universe.

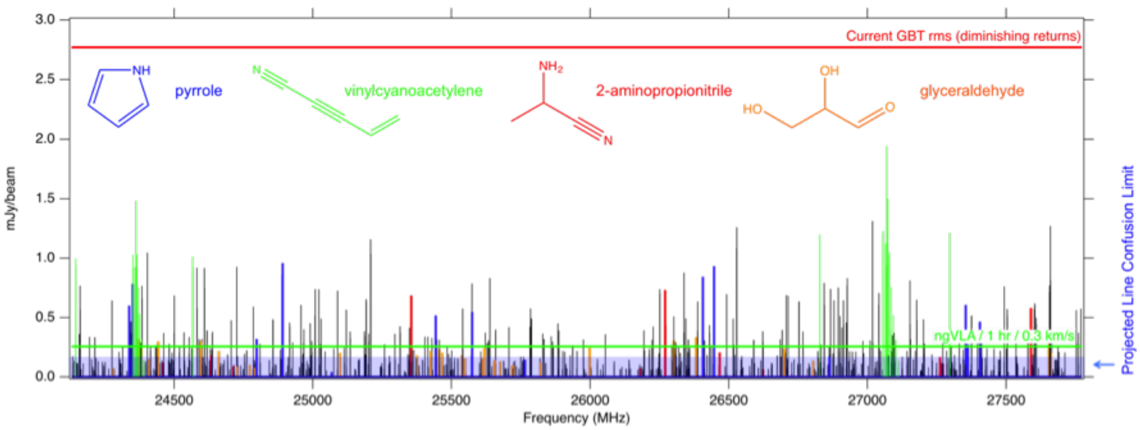


Figure 3: A conservative simulation of a representative set of 30 currently undetected complex interstellar molecules that are likely to be detectable by the ngVLA above the confusion limit of an ngVLA survey in and around 'hot' cores with source sizes typically of ~1" – 4". These lines are not observable with current facilities. A few key molecules are highlighted in color. (Credit B. McGuire).

KSG4: Using Pulsars in the Galactic Center to Make a Fundamental Test of Gravity

Pulsars in the Galactic Center represent clocks moving in the space-time potential of a super-massive black hole and would enable qualitatively new tests of theories of gravity. More generally, they offer the opportunity to constrain the history of star formation, stellar dynamics, stellar evolution, and the magneto-ionic medium in the Galactic Center. The ngVLA can achieve a combination of sensitivity and frequency range that enables it to probe much deeper into the likely Galactic Center pulsar population to address fundamental questions in relativity and stellar evolution.

KSG5: Understanding the Formation and Evolution of Stellar and Supermassive Black Holes in the Era of Multi-Messenger Astronomy

The ngVLA will to survey everything from the remnants of massive stars to the supermassive black holes that lurk in the centers of galaxies, making it the ultimate black hole hunting machine. High-resolution imaging abilities are required to separate low-luminosity black hole systems in our local Universe from background sources, thereby providing critical constraints on the formation and growth of black holes of all sizes and mergers of black hole-black hole binaries. The ngVLA can identify the radio counterparts to transient sources discovered by multi-messenger alerts from gravitational wave, neutrino, and optical observatories. This requires high-resolution, fast-mapping capabilities to make it the preferred instrument to pinpoint transients associated with violent phenomena such as supermassive black hole mergers and blast waves. See Figure 4.

Figure 4: Two tiny, but very dense neutron stars merge and explode as a kilonova. Such a very rare event produces gravitational waves and electromagnetic radiation, as observed on 17 August 2017. The ngVLA will play a pivotal role in characterizing the physics of such events in the era of multi-messenger astronomy. (Artist's impression, Credit: ESO/L. Calçada/M. Kornmesser).

Instrument Definition

The main array, SBA and the signal processing center of ngVLA will be located at the Very Large Array site, on the plains of San Agustin, New Mexico. The array will include stations in other locations throughout the state of New Mexico, west Texas, Arizona, and northern Mexico (the current reference configurations on three physical scales are shown in Figure 5).

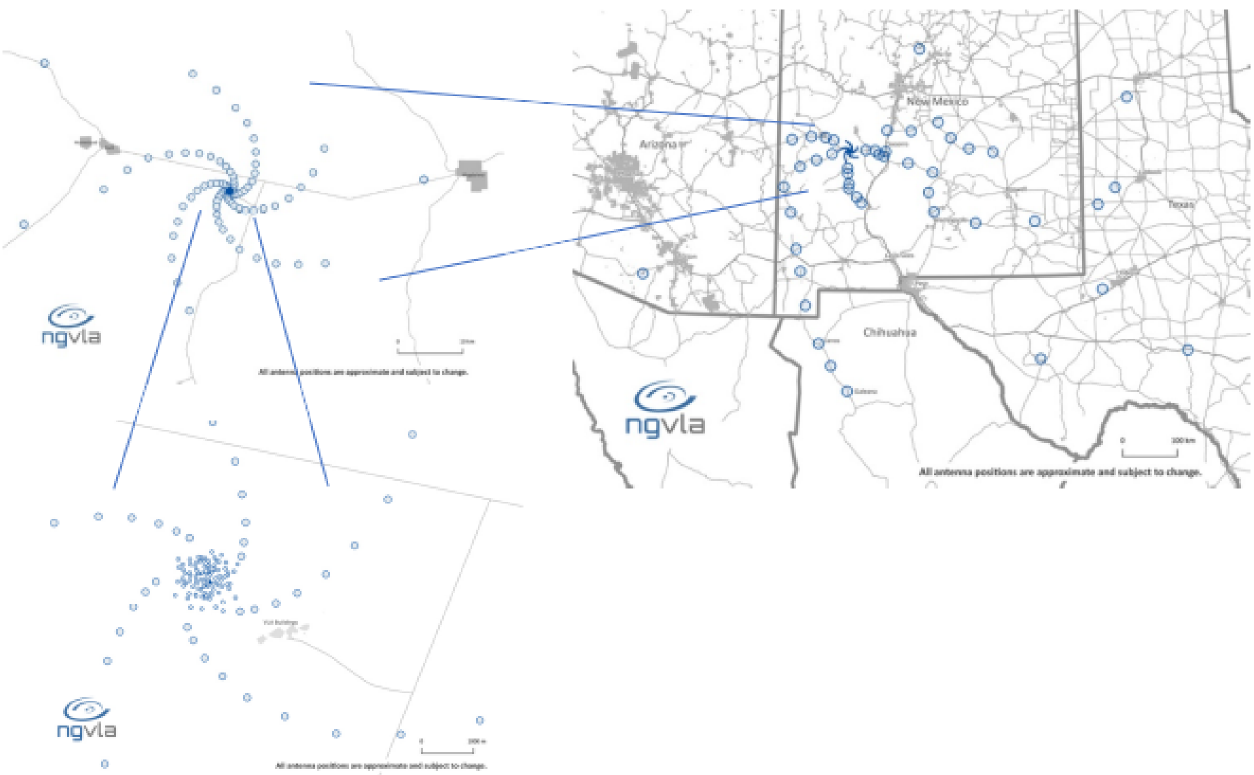


Figure 5: SBA and , Main Array configurations of the ngVLA (March 2019).

The high desert plains of the Southwest U.S., at over 2000m elevation, provide excellent observing conditions for the frequencies under consideration, including excellent phase stability and opacity at 3mm wavelength over a substantial fraction of the year. Engineering operations will be conducted from the VLA site facilities and the Array Operations Center in Socorro, NM. The full ngVLA configuration, including the location of the 10 LBA stations, is shown in Figure 6.

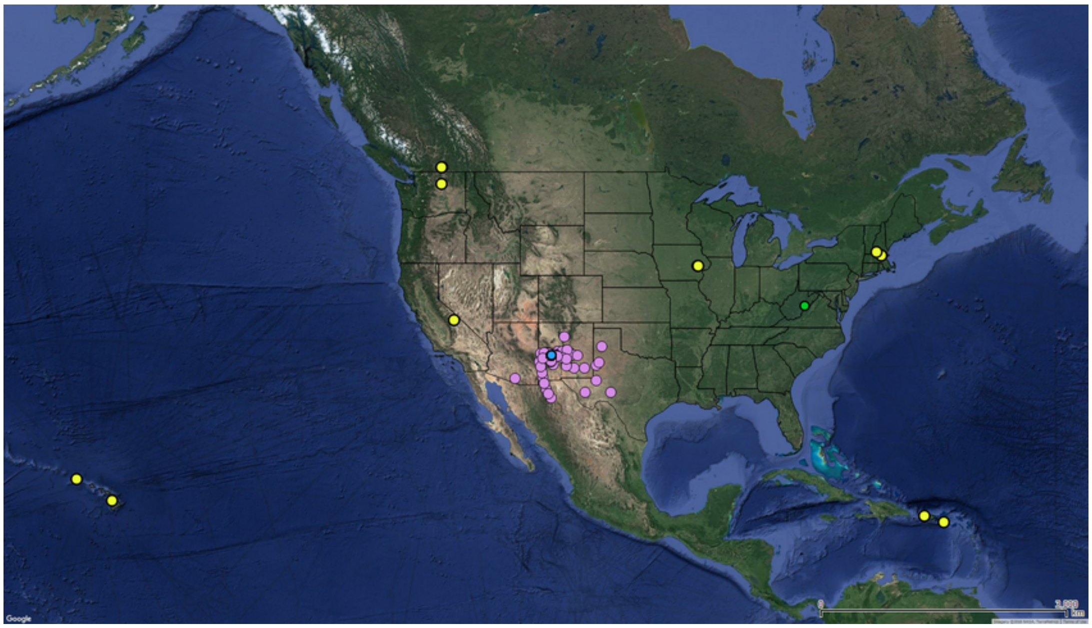


Figure 6: The full ngVLA configuration including the location of the ngVLA LBA stations.

The predicted performance of the array is summarized in Table 1, and a more detailed review of the technical definition of the instrument can be found in Selina et al. (SPIE Astronomical Telescopes & Instrumentation, AS18, 10700-55, 2018). The continuum and line rms values indicated in Table 1 are for point source sensitivity with a naturally weighted beam. Imaging sensitivity will vary depending on the quality of the (sculpted) synthesized beam[1] (defined as the ratio of the power in the main beam attenuation pattern to the power in the entire beam attenuation pattern as a function of the FWHM of the synthesized beam[(1)]) required to support the science use case.

1 The quality of the (sculpted) synthesized beam is defined as the ratio of the power in the main beam attenuation pattern to the power in the entire beam attenuation pattern as a function of the FWHM of the synthesized beam.

Receiver Band	B1	B2	B3	B4	B5	B6	Notes
Center Frequency, f	**2.4 GHz**	**8 GHz**	**16 GHz**	**27 GHz**	**41 GHz**	**93 GHz**	
Band Lower Frequency [GHz]	1.2	3.5	12.3	20.5	30.5	70.0	a
Band Upper Frequency [GHz]	3.5	12.3	20.5	34.0	50.5	116.0	a
Field of View FWHM [arcmin]	24.4	7.3	3.6	2.2	1.4	0.6	b
Aperture Efficiency	0.77	0.76	0.87	0.85	0.81	0.58	b, e
Effective Area, $A_{eff,}$ x 10^3 [m^2]	47.8	47.1	53.8	56.2	50.4	36.0	b, e
System Temp, T_{sys} [K]	25	27	28	35	56	103	a, e
Max Inst. Bandwidth [GHz]	2.3	8.8	8.2	13.5	20.0	20.0	a
Sampler Resolution [Bits]	8	8	8	8	8	4	
Antenna SEFD [Jy]	372.3	419.1	372.1	485.1	809.0	2080.5	a, b
Resolution of Max. Baseline [mas]	2.91	0.87	0.44	0.26	0.17	0.07	c
Continuum rms, 1 hr [μJy/beam]	0.38	0.22	0.20	0.21	0.28	0.73	d, e
Line Width, 10 km/s [kHz]	80.1	266.9	533.7	900.6	1367.6	3102.1	
Line rms, 1 hr, 10 km/s [μJy/beam]	65.0	40.1	25.2	25.2	34.2	58.3	d, e

Table 1: ngVLA Key Performance Metrics

Notes:

(a) 6-band 'baseline' receiver configuration.

(b) Reference design concept of 244 18m aperture antennas. Unblocked aperture with 160μm surface.

(c) Rev. C 2018 Configuration. Resolution in EW axis.

(d) Point source sensitivity using natural weights, dual pol, and all baselines.

(e) Averaged over the band. Assumes 1mm Precipitable Water Vapor for Band 6, 6mm PWV for others; 45 deg elev. on sky for all.

Examples of front-end concepts currently being explored for ngVLA are shown in Figure 7. The ngVLA will provide continuous frequency coverage from 1.2 – 50.5 GHz and 70 – 116 GHz in multiple bands. Receivers will be cryogenically-cooled with the receiver cryostat(s) designed to integrate multiple receiver bands to the maximum extent possible. Bands 1 and 2 employ wideband feed horns and LNAs, each covering the L+S band and, C+X bands. Quad-ridged feed horns (QRFH) are used, with coaxial outputs. The four high-frequency bands (12.6 – 116 GHz) employ waveguide-bandwidth (~1.67:1) feeds & LNAs, for optimum noise performance. Axially corrugated feed horns with circular waveguide output ensure even illumination over frequency and minimal loss.

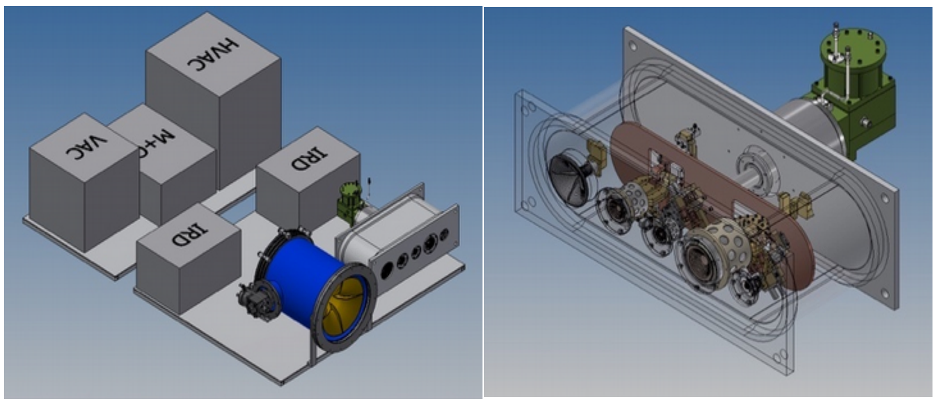


Figure 7: Front end component packaging at the secondary focus of the antenna. Band selection and focus are achieved with a dual-axis translation stage.

A Central Signal Processer (CSP) will ingest the voltage streams recorded and packetized by the antennas, producing low level data products for archiving. The operating modes of the CSP will include:

- Auto-correlation;
- Cross-correlation;
- Beamforming capabilities, for VLBI recording, pulsar search, and timing;
- Pulsar timing engine;
- Pulsar/transient search engine;
- Transient input-stream buffering (to external recorder or processing engine).

CSP development is ongoing at NRAO and with our ngVLA partners. The ngVLA will be operated as a proposal-driven, PI-pointed instrument, and the fundamental data products provided to researchers will be science-ready data products (i.e., images and cubes) generated using calibration and imaging pipelines created and maintained by the observatory. Both the pipeline products along with the “raw” visibilities and calibration tables will be archived, opening the door to future re-processing and archival science projects.

Additional science options (including a commensal low-frequency array) are being proposed by partner U.S, institutions. An ancillary aperture array observing at frequencies below 150 MHz at ngVLA antenna stations, utilizing the common infrastructure deployed for the ngVLA, is also under consideration (the ngLOBO project).

Broader Impacts

The NRAO closely considers the broader impacts of facility development and operations, including opportunities for student training, increased participation of underrepresented groups, tangible benefits to the wider U.S. research community (e.g., data archive access and the commercialization of new technologies), and impacts to the environment and economy of the communities that host NRAO-run facilities. The project will also engage with experienced individuals and groups within the U.S. university community to (a) advise us on the approach and performance of the project, and (b) to carry out appropriate engineering and software tasks related to specific work packages and deliverables associated with the project. Strong collaboration with the university community has been an important part of the success of all major instrument efforts at NRAO.

The ngVLA antenna project will likely have a direct impact on fostering a revitalized U.S. high-tech manufacturing hub in the southwest, with precision machine fabrication in New Mexico and Texas. The design and fabrication of precision composite, steel and aluminum structures could have long-term benefits to the local economy, enabling high-tech precision manufacturing of other structures such as wind turbines. Such work could have an international impact given the complex supply chains that cross the U.S.-Mexico border. The ngVLA will require fiber optic infrastructure that would extend across the southwest and exceed the information-carrying capacity of the current Los Angeles metropolitan area. The requisite physical infrastructure will renew the telecommunications network of the southwest, and enable rural broadband connections that have been identified as a key utility for high-tech start-ups and job growth.

Future

The ngVLA will be a transformative, multi-disciplinary scientific instrument that will significantly advance our knowledge of the Universe and our place within it. By delivering an order of magnitude improvement in both sensitivity and angular resolution compared to existing and planned radio facilities at frequencies spanning 1.2 – 116 GHz, the ngVLA will open extensive new discovery space through ultra-sensitive imaging of thermal line and continuum emission down to milliarcsecond-scale resolutions, as well as deliver unprecedented broad band continuum polarimetric imaging of non-thermal processes. The ngVLA concept is a large-scale research infrastructure project under development for the NSF Astronomy Division. A successful deployment of the ngVLA will continue and advance U.S. world leadership in radio astronomy, and support NSF’s mission to provide leading-edge instrumentation to the global multi-disciplinary scientific community.

Job Postings – Radio Astronomy and Related Fields

Cavendish Astrophysics - Electromagnetic design and metrology

http://www.jobs.cam.ac.uk/job/20703/ - Antenna design and electromagnetic modelling
http://www.jobs.cam.ac.uk/job/20700/ - Electromagnetic metrology & antenna characterisation

HIRAX Postdoctoral Fellowships in Radio Astronomy and Instrumentation

The Astrophysics and Cosmology Research Unit (ACRU) at the University of KwaZulu-Natal (UKZN) is offering a postdoctoral research position in the area of radio astronomy and instrumentation. For more information, see https://acru.ukzn.ac.za/hirax-postdoc-jan2019/

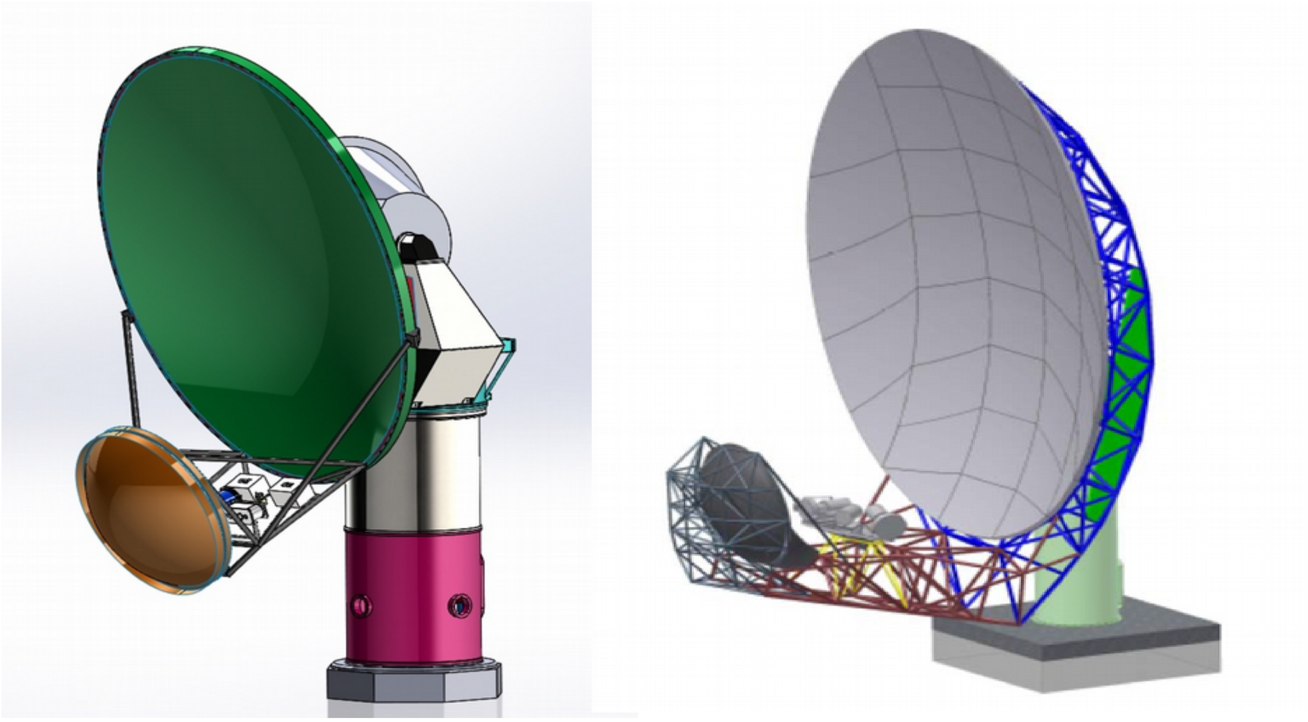
Arizona State University – 3 Positions

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



ngVLA conceptual antenna designs. National Research Council 6-m design (left), General Dynamics 18-m concept (right).

Submitted by A. Beasley

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.

Union Radio-Scientifique Internationale   International Union of Radio Science

Monthly Newsletter of International URSI Commission J – Radio Astronomy

April 2019

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 Pacific Radio Science Conference (AP-RASC) was quite a success! Stefan Wijnholds provides us with a overview of the event in our Activities Spotlight this month. Thank you, Stefan, for the very nice article, complete with photos!

Now that the AP-RASC is behind us, planning activities are now focused on the 2020 URSI General Assembly and Scientific Symposium. The 2020 GASS Commission J program is given below along with the confirmed conveners. We are still in search of conveners so please contact me as soon as possible to volunteer.

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

100 Years URSI

1919 2019

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

Rome, Italy 29 August - 5 September 2020

We are now actively planning for the next URSI General Assembly and Scientific Symposium.

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

Sessions:

New Telescopes on the Frontier
Conveners: Nipanjana Patra
Recent and Future Space Missions
Conveners: Joseph Lazio, Heino Falcke, and Yuri Kovalev
Single Dish Instruments
Very Long Baseline Interferometry
Millimeter/Submillimeter Arrays
Receivers and Radiometers: Design and Calibration
Convener: Jacki Gilmore, Douglas Hayman
Digital Signal Processing: Algorithms and Platforms
Conveners: Grant Hamspon
Big data: Algorithms and Platforms
Conveners: Stefan Wijnholds, Maxim Voronkov
Short-Duration Transients, FRBs, and Pulsars: Observations, Techniques, and Instrumentation
Historical Radio Astronomy
Conveners: Richard Schilizzi
Latest News and Observatory Reports
Conveners: Rich Bradley and Douglas Bock
Power spectrum observations

Shared Sessions

Radio astronomical characterization of the ionosphere and related models (Commissions JG)
Conveners: Claudio Cesaroni (G), Maaijke Mevius (J)
Characterization and Mitigation of Radio Frequency Interference (Commissions JEFGH)
Some aspects of radio science in space weather (Commissions GHJ)
Conveners: Richard Fallows (J), Iwona Stanislawska (G), Baptiste Cecconi, Patricia Doherty, Willem Baan
Spectrum Management (Commissions ECJ)
Conveners: Tasso Tzioumis
Solar, Planetary, and Heliospheric Radio Emissions (Commissions HJ)
Conveners: Pietro Zucca,
The polar Environment and Geospace (Commissions GHJ)
Conveners: Lucilla Alfonsi (G), Nicolas Bergeot (G), Mark Cliverd (H), Stefan Lotz (H)

Meeting and Workshop Announcements

Cerenkov Telescope Array Symposium

"*Science opportunities with CTA*"

Bologna, 6-9 May 2019

Abstract submission deadline has passed!

Dear colleagues,

Registration for the First CTA symposium is now open. Participants can register online at http://www.cta-symposium.com/registration. Your registration will be confirmed by the workshop secretary as soon as the registration fee has been received.
The workshop registration fee is 300 Euros before 20 March, 2019 and 350 Euros after this date. A special rate of 200 (250 after 20 March) euros is available for students.

The theme for the First CTA Symposium is "Science opportunities with CTA" and will take place at the historical Teatro Duse in Bologna 6-9 May 2019 (https://www.cta-symposium.com). The meeting specifically addresses the larger Multi-Wavelength/Multi Messenger communities and aims to set up new channels of communication with those communities. It will feature a combination of invited and contributed talks. The preliminary programme is available on the symposium webpage.

Contributions to the First CTA Symposium in the following areas:

- Cosmic particle acceleration
- Compact objects and relativistic shocks
- Role of cosmic particles in galaxy evolution and star-forming systems
- Gamma rays as cosmic probes
- Fundamental physics
- Multi-wavelength and multi-messenger observations

Or any other topic connected to the scientific possibilities of CTA.

The scientific organising committee (SOC) will consider the submission for inclusion in the preliminary programme and will notify the authors whether their contribution has been selected for an oral/poster presentation by March 15, 2019. We look forward to seeing you in Bologna in May.

With best regards,

Stefan Funk
on behalf of the SOC:

Roger Blandford, Kavli Institute of Particle Astrophysics and Cosmology, Stanford University, USA; Catherine Cesarsky, CEA, France; Andrea Comastri, INAF, Italy; Emma de Oña Wilhelmi, University of Barcelona, Spain; Stefan Funk, University of Erlangen, Germany; Jim Hinton, Max Planck Institute for Nuclear Physics, Germany; Giovanni Pareschi, INAF, Italy; David Reitze, California Institute of Technology, USA; Richard Schilizzi, University of Manchester, UK; Christian Spiering, DESY, Germany; Matthias Steinmetz, IAP, Germany; Wolfgang Wild, CTAO, Italy

Activities Spotlight

An excellent Asia-Pacific Radio Science Conference (AP-RASC)

Stefan J. Wijnholds

From March 9 through March 14, 2019, the Asia-Pacific Radio Science Conference (AP-RASC) was held in the India Habitat Centre in New Delhi, India. The triennial cycle of the AP-RASC complements the triennial cycles of its Atlantic counterpart (the AT-RASC) and the General Assembly and Scientific Symposium (GASS), such that URSI has an annual flagship meeting. With 905 contributions being presented by delegates from 40 countries, it proved to be an interesting meeting. The Commission J program consisted of the following sessions:

Evolution / latest results from the uGMRT, in honour of Govind Swarup
Updates from exiting radio astronomy facilities
RFI mitigation in radio astronomy (with Commission E)
VLBI: current status and future prospects
Radio science for space weather (with Commission H)
Recent scientific results on solar, solar wind and space weather observations
Recent scientific results on Galactic, extra-Galactic star formation and transients
The Early Universe (EoR experiments and related results)
Future radio astronomy facilities (including SKA)
Radio astronomy instrumentation & techniques – I. Receiver systems: analog/digital/optical fibre
Radio astronomy instrumentation & techniques – II. Data processing: Imaging, Big Data

The detailed program (including links to submitted papers and abstracts) can be found at http://www.ursi.org/proceedings/procAP19/programme.html). The Commission J keynote lecture was delivered by Ron Ekers on the topic of “Paths to discovery in radio astronomy – the role of technical innovation and serendipity”.

Young scientists could apply for a Young Scientist Award (YSA) or take part in the Student Paper Competition (SPC). There were three applications for a YSA and two submissions for the SPC from the Commission J community. Unfortunately, none of them was successful.

On Monday, a very interesting general lecture was delivered by Nobel laureate David Wineland on “Optical atomic clocks”. One of the feats highlighted in this lecture was a measurement of the relativistic effect of time dilatation in the Earth’s gravitational field by comparing the frequencies of two atomic clocks placed only 1 feet apart in height above the Earth’s surface!

During the week, several business meetings were scheduled to deal with the organizational matters of URSI. Among them was the well-attended Commission J business meeting on Tuesday. The main topic of this meeting was the program for the GASS. The outcome of this discussion can be found elsewhere in this newsletter.

The conference banquet was held on the premises of the peaceful Sunder Nursery. The banquet was preceded by a cultural function that consisted of a demonstration of various dances from the multitude of cultures found in the different regions of India. Each dance was preceded by a short introduction, which made them accessible despite the large cultural differences between the respective dances and between the people in the audience. After the cultural function, the venue for the next AP-RASC, to be held in 2022, was presented. It will be held at the Darling Harbor Waterfront in Sydney, Australia. The Australians have selected a very nice venue and have an excellent organising committee, so we have something to look forward to!

Ron Ekers' audience with Govind Swarup on the first row.

Photo of the cultural function preceding the banquet

A few South-African delegates having a good time at the banquet.

Job Postings – Radio Astronomy and Related Fields

Radio Astronomy Instrumentation Post-Doc at NASA JPL

Applicants should have a recent PhD in astronomy, physics, or a closely related field. Of particular interest are candidates with expertise in the development and commissioning of instrumentation (both hardware and software) and observations at radio frequencies that would complement the Atacama Large Millimeter/submillimeter Array (ALMA) and current and future NASA missions, particularly far-infrared/sub-millimeter. For more information visit https://jpl.jobs/jobs/2019-10427-Radio-Astronomical-Instrumentation-Postdoctoral-Scholar

Cavendish Astrophysics - Electromagnetic design and metrology

http://www.jobs.cam.ac.uk/job/20703/ - Antenna design and electromagnetic modelling
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Photo from the Field

Ron Ekers delivering the keynote lecture at the AP-RASC
Paths to discovery in radio astronomy
- the role of technical innovation and serendipity -

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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May 2019

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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!

Planning for the 2020 URSI General Assembly and Scientific Symposium is in full swing. The latest version of the Commission J program is given below along with the confirmed conveners. We are still in search of conveners so please contact me as soon as possible to volunteer.

A new technical journal owned and operated by URSI has been announced. The URSI Radio Science Letters (RSL) is an electronic journal – its purpose is to rapidly publish original and previously unpublished scientific research work in all areas of radio science, in the form of short contributions that are rigorously reviewed. For additional information, please see the announcement included in this Newsletter.

The March issue of the Radio Science Bulletin is now available. A synopsis of its content is given below.

Our Spotlight this month is on the Westerbork Synthesis Array. Arnold van Ardenne shares his thoughts on the making of the new book that covers the scientific and instrumental achievements of Westerbork Observatory and a glimpse in the next phase of its life. Thank you, Arnold, for this nice article.

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

100 Years URSI 1919 2019

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We are now actively planning for the next URSI General Assembly and Scientific Symposium.

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A New URSI Journal - URSI Radio Science Letters

URSI Radio Science Letters (RSL) is a new electronic journal owned and operated by URSI. Its purpose is to rapidly publish original and previously unpublished scientific research work in all areas of radio science, in the form of short contributions that are rigorously reviewed. The journal is open access and will be published only in electronic format, one volume per calendar year. Each accepted contribution will be identified by volume number, year of publication, page numbers, and DOI. Each reviewed and accepted paper will be published as soon as full editing is completed. The URSI Board has appointed Prof. Piergiorgio L. E. Uslenghi as the first Editor-in-Chief (EIC) of the RSL.

Contributions to the RSL must be in the form of manuscripts in English, not exceeding four published pages in length. A template and instructions to prospective authors are provided on the journal's Web site. Initial submissions must be in PDF. Final submissions will be accepted in either Word or LaTeX. The PeerTrack manuscript management system of Allen Press is used to handle the submissions and the review and publishing process.

The RSL is intended to be a very rapid publication journal. The EIC will promptly notify the corresponding author of the anonymous reviews and the Associate Editor's comments, and of the consequent disposition of the manuscript. If minor revisions are required, a revised manuscript must be submitted within thirty days of the EIC's recommendation. Any delayed resubmission will be considered as a new submission. Only minor changes are acceptable. If major changes are required, the manuscript will be rejected with or without a suggestion to resubmit a revised version. Plagiarism, as well as duplicate submission and publication, will result in rejection of the submission.

Authors of accepted manuscripts are expected to sign the URSI Publication Agreement as a precondition to publication. Submissions to the RSL will be accepted, shortly. Please send your manuscripts to:

https://www.editorialmanager.com/RSL

An article processing charge of 150 USD per published page or fraction thereof for URSI members (175 USD for URSI nonmembers) is to be paid prior to the posting of an accepted contribution. Any payment delinquency will result in the removal of the contribution from the RSL Website.

Radio Science Bulletin – March 2019 Issue (No. 368) is Available Here

The cover figure for this issue shows the near-zone electromagnetic field power density in the vicinity of a two-layer frequency-selective surface made from unit cells that have U-shaped elements. Frequency-selective surfaces are interesting both because of their physical (electromagnetic scattering) properties and because of their computational modeling properties. They depend on resonant structures to operate, and those very resonances produce fascinating electromagnetic and computational properties. These are explored in Özgür Ergül's Solution Box contribution by Özgür Eriş, Hande İbili, and Özgür Ergül. They considered three such structures, having three different arrangements of U-shaped unit cells. As an example of their results from an electromagnetic scattering standpoint, they showed that two different structures made from layers with identical unit cells but arranged in different orientations had significantly different scattering properties. In particular, one version of the structure had very similar responses to both left-hand and right-hand circularly polarized waves, whereas the other did not. From a computational standpoint, the most challenging frequencies for analysis in terms of number of iterations required for convergence of the solution were not the same as the frequencies at which element resonances occurred. All of this makes for quite interesting reading

Giuseppe Pelosi has brought us a beautiful and intriguing Historical Corner. The article, by Giuseppe Pelosi and Stefano Selleri, traces some introductory steps to the Finite-Element Method. These involved a problem know as the Brachistochrone, which was a deceptively simple shortest-path problem proposed in 1696. There were several other related problems that also played a role. What makes this article so enjoyable to read is not just the history of computational science it tells: it is the accompanying original figures and photos, and the stories of the people involved, all carefully researched and referenced. You will enjoy this.

Tayfun Akgul has brought us his usual wry perspective on a couple of aspects of radio science in his Et Cetera column. It appears that our erstwhile professor is very rapidly gaining a new perspective on one of the hottest new areas of research.

Do you know where the phrase “to show your true colors” came from? Amy Shockley and Randy Haupt explain this and explore the associated ethical implications in their Ethically Speaking column.

In her Women in Radio Science column, Asta Pellinen-Wannberg brings us the story of Tuija Pulkkinen, Professor and Chair of the Department of Climate and Space Sciences and Engineering at the University of Michigan. This is a very intriguing story of a career in space research, with valuable insights into what led to the career and life choices made.

Contributed by Ross Stone

Westerbork Observatory

Arnold van Ardenne

This contribution is not entirely anecdotical and as with earlier contributions, it strikes a serious note and perhaps a message of pride and justice.

In this case, it is about finding a way to celebrate and commemorate at the same time. Let me clarify and expand on this. Around 2014 Ger de Bruyn at the time probably being one of ASTRON's most dedicated and continuous users of the Westerbork Synthesis Array, chaired a small group of selected individuals. This group was keen to "celebrate" the almost 50 years lifetime of the array given its important contribution to science, instrumentation and deep polarimetric synthesis imaging techniques. To start with, around 1996, the book "The Westerbork Observatory, Continuing Adventure in Radio Astronomy", a Kluwer Astrophysics and Space Science Library book still on sale, effectively constituted the 25 years lifetime book using 1971 when the WSRT delivered user science as starting date. Being a good and solid book, it almost exclusively emphasised the earliest and somewhat newer science done with WSRT including an early outlook to the SKA. The thinking of the small Ger-team with newer and older persons connected to the Westerbork-enterprise-at-large went on for some time from 2014 along obvious questions: Should we make a new or updated or e-book, For whom, How many pages and Contributions and Who will contribute etc. etc. Of course, all this with limited reflection at that point on the bill by default assumed to be picked up by ASTRON someway/anyway.

It was remarkable that while some started writing examples of how contributions might look implying that a book was the preferred choice of the historical reflections, others including me took their time contemplating still on the question that it might be of great help if a draft Table of Content could be created. Such book by the way, might also give some reading pleasure and perhaps even some useful background to the younger ones interested and newer in our field.

Then early 2017 misfortune struck when Ger was diagnosed to be incurably ill. Midyear, we were shocked with his passing away and as a result, lead the book-effort to a grinding hold. It was only in January 2018 in planning for the grant opening of a newly born Westerbork array equipped with the wide fielding Apertif focal plane arrays, that a request was bestowed on me to renew the effort. This could not be done given the very short timescales of less than 6 month without the help of all potential contributors and on the short term not without a small team of dedicated co-editors. In this case, Richard Strom in any case interested in the history of radio astronomy and very well informed through his personal engagements with Westerbork and Steve Torschinksky from the Obervatoire de Paris. Steve I knew for many years and was excellent in critical questions required for a good book! He also had previous experience in book editing e.g. for the SKADS-book. Very quickly, the 50 years lifetime festivity now using the full delivery of the telescopes in 1968 as reference date was approaching and even more so because now we wished the book to reflect the role of all involved in this 50 years journey or at least to the extent practically possible.

After many intense weeks and with help of over sixty contributors, the book finally covered scientific and instrumental achievements, technological evolutions and walks an insightful and a sometimes-anecdotical memory lane in 342 pages of advancing radio astronomy. In short, the book shows the broad human endeavour needed to arrive at the next phase of life of the Westerbork Observatory while in the meantime developing LOFAR. This next phase emphasizes wide field astronomy using Focal Plane Arrays at 12 out of the 14 dishes, the other two dishes remaining for VLBI and other purposes.

Apertif as the receiving system part of the new observing system comprises the 37 beam array receivers including all beamforming and processing in the 12 telescopes now ably covering an observing field of 3.5x3.5degrees at the sky. This is over 10 times as much observing space! To deal with all this in full polarimetric imaging and at the same time capable of doing pulsar observations and time varying other phenomena, the “ARTS” Apertif Radio Transient System was build. This FPGA-GPU system produces 468 simultaneous tied array beams within the Apertif field of view and uses deep learning algorithms to sift the candidate transient data. See www.astron.nl for more background.

Obviously, this new phase in life warranted a grand opening at the same time celebration the book to be finished on time! The picture tells it all with a little more explanation:

Carole Jackson, ASTRON DG handing over the book to the Deputy-Kings Commissioner Mr. Cees Bijl (bottom left), ASTRON’s Lodie Voute and Jan Noordam looking for their respective book contribution in print (top left), The Westerbork array equipped with the Apertif frontends (middle), Looking into Apertif array receiver (top right), the ARTS GPU supercomputer (bottom right)

Contributed by Arnold van Ardenne

Photos from the Field

The Westerbork telescope is also a great place to teach students interferometry;

Michiel Brentjes explaining the details at the 2013 European Radio Interferometry School

(from the WSRT 50yrs book)

A.G. (Ger) de Bruyn
13 July 1948 – 9 July 2017
An excellent astronomer, teacher, WSRT user and friend

(from the WSRT 50 yrs book)

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.

Union Radio-Scientifique Internationale — International Union of Radio Science — U.R.S.I.

Monthly Newsletter of International URSI Commission J – Radio Astronomy

June 2019

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 for the 2020 URSI General Assembly and Scientific Symposium continues. For those who have already volunteered to convene a session… thank you! The confirmed conveners are listed on the latest version of the Commission J program given below.

- We have a workshop announcement and a new job posting this month.

- Arnold van Ardenne asked me to pass along the following information with reference to his article on Westerbork ithat appeared in last month's Newsletter:
  Westerbork 50 years book now on-line
  This is to inform that the book can now be downloaded from the ASTRON webpages through:
  https://www.astron.nl/telescopes/history-wsrt
  For any questions, please consult with Arnold van Ardenne (ardenne@astron.nl)

- The Activities Spotlight this month is on holiday but will return next month. I'd like to take this opportunity to thank all of you who have contributed articles in the past. Please consider writing about your research, workshop summary, historical event, educational opportunity, etc. A photo or two for the "Photo from the Field" section is always appreciated. Let's keep our Newsletter interesting and informative!

Submitted by R. Bradley

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

Rome, Italy 29 August - 5 September 2020

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

Sessions:

New Telescopes on the Frontier
Conveners: Nipanjana Patra, Jeff Wagg

Recent and Future Space Missions
Conveners: Joseph Lazio, Heino Falcke, Yuri Kovalev

Single Dish Instruments
Conveners: Alex Kraus

Very Long Baseline Interferometry
Conveners: TBD

Millimeter/Submillimeter Arrays
Conveners: Sheng-Cai Shi

Receivers and Radiometers: Design and Calibration
Convener: Jacki Gilmore, Douglas Hayman

Digital Signal Processing: Algorithms and Platforms
Conveners: Grant Hamspon

Big data: Algorithms and Platforms
Conveners: Stefan Wijnholds, Maxim Voronkov

Short-Duration Transients, FRBs, and Pulsars: Observations, Techniques, and Instrumentation
Conveners: Jason Hessels

Historical Radio Astronomy
Conveners: Richard Schilizzi

Latest News and Observatory Reports
Conveners: Rich Bradley, Douglas Bock

Power spectrum observations
Conveners: TBD

Workshops and Shared Sessions

Workshop: Characterization and Mitigation of Radio Frequency Interference (Commissions JEFGH)
Conveners: Amit K. Mishra (F), David M. Levine (F), Frank Gronwald (E), Richard Bradley (J)

Workshop: Some aspects of radio science in space weather (Commissions GHJ)
Conveners: Iwona Stanislawska (G), Richard Fallows (J), Patricia Doherty (G), Mauro Messerotti (H/J), Baptiste Cecconi (H/J), Vivianne Pierard (H), Janos Lichtenberger (H), Willem Baan (J)

Mutual benefit between radio astronomy and ionospheric science (Commissions JG)
Conveners: Claudio Cesaroni (G), Maaijke Mevius (J)

Spectrum Management (Commissions ECJ)
Conveners: Amir Zaghloul (C), Tasso Tzioumis (J), Jose Borrego (E)

Solar, Planetary, and Heliospheric Radio Emissions (Commissions HJ)
Conveners: Patrick Galopeau (H), G. Mann (H) and H.O. Rucker (H), Pietro Zucca (J)

The polar Environment and Geospace (Commissions GHJ)
Conveners: Lucilla Alfonsi (G), Nicolas Bergeot (G), Mark Cliverd (H), Stefan Lotz (H)

Workshop Announcement

High-Resolution Radio Interferometry in Space: Second International Meeting

Following the spectacular images from the Event Horizon Telescope and the successful Space VLBI missions HALCA and RadioAstron, there is growing interest in the next set of Space VLBI technical concepts, including next-generation constellations and millimeter-wavelength systems. This meeting is a second in a series of international meetings, the first of which was held at Noordwijk in 2018, <URL: https://www.ru.nl/astrophysics/@1164989/future-high-resolution-radio-interferometry-space/ >. The focus of this second meeting is to review black hole and other Space VLBI science cases, and begin to assess the maturity of the relevant technologies and needed technology developments and roadmaps.

Date: 2020 January 27–29 (TBC)
Venue: NRAO, Charlottesville, VA

Job Postings – Radio Astronomy and Related Fields

UC Berkeley Radio Astronomy Lab - seeking a highly motivated individual to conduct research in radio astronomy, designing advanced radio astronomy instrumentation for HERA (the Hydrogen Epoch of Reionization Array) and several other radio telescope arrays, as well as further the Collaboration for Astronomy Signal Processing and Electronics Research (CASPER) by developing open-source software and hardware for the radio-astronomy community.
For more information, please visit the following link: https://aprecruit.berkeley.edu/JPF02148

A New URSI Journal - URSI Radio Science Letters

URSI Radio Science Letters (RSL) is a new electronic journal owned and operated by URSI. Its purpose is to rapidly publish original and previously unpublished scientific research work in all areas of radio science, in the form of short contributions that are rigorously reviewed. The journal is open access and will be published only in electronic format, one volume per calendar year. Each accepted contribution will be identified by volume number, year of publication, page numbers, and DOI. Each reviewed and accepted paper will be published as soon as full editing is completed. The URSI Board has appointed Prof. Piergiorgio L. E. Uslenghi as the first Editor-in-Chief (EIC) of the RSL.

Contributions to the RSL must be in the form of manuscripts in English, not exceeding four published pages in length. A template and instructions to prospective authors are provided on the journal's Web site. Initial submissions must be in PDF. Final submissions will be accepted in either Word or LaTeX. The PeerTrack manuscript management system of Allen Press is used to handle the submissions and the review and publishing process.

The RSL is intended to be a very rapid publication journal. The EIC will promptly notify the corresponding author of the anonymous reviews and the Associate Editor's comments, and of the consequent disposition of the manuscript. If minor revisions are required, a revised manuscript must be submitted within thirty days of the EIC's recommendation. Any delayed resubmission will be considered as a new submission. Only minor changes are acceptable. If major changes are required, the manuscript will be rejected with or without a suggestion to resubmit a revised version. Plagiarism, as well as duplicate submission and publication, will result in rejection of the submission.

Authors of accepted manuscripts are expected to sign the URSI Publication Agreement as a precondition to publication. Submissions to the RSL will be accepted, shortly. Please send your manuscripts to:

https://www.editorialmanager.com/RSL

An article processing charge of 150 USD per published page or fraction thereof for URSI members (175 USD for URSI nonmembers) is to be paid prior to the posting of an accepted contribution. Any payment delinquency will result in the removal of the contribution from the RSL Website.

Photo from the Field

This photo of the Precision Array for Probing the Epoch of Reionization (PAPER) team was taken on May 6, 2010 at the site in Green Bank, WV. Don Backer (left) was the driving force behind PAPER and the Hydrogen Epoch of Reionization Array (HERA), the next generation instrument currently being deployed in South Africa. Don was also an active member of URSI and a zealous advocate for Commission J . Although Don passed away two months after this photo was taken, his passionate ardour in the pursuit of excellence in scientific research continues to inspire us all.

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.

Stimulating and co-ordinating, on an international basis, studies, research, applications, scientific exchange, and communication in the fields of radio science

Monthly Newsletter of International URSI Commission J – Radio Astronomy
July 2019

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 for the 2020 URSI General Assembly and Scientific Symposium continues. At present, the only session lacking conveners is Session J04: "Very Long Baseline Interferometry." Please consider volunteering to organize this interesting session! The confirmed conveners are listed on the latest version of the Commission J program given below.

- The International Astronomical Union (IAU) is also celebrating its centennial this year and so we are exploring the possibility of a joint URSI / IAU session at the 2020 URSI GASS. This is tentatively listed as Session J12.

- As promised, the Activities Spotlight has returned this month with a wonderful article by N. S. Kardashev, Y. Y. Kovalev, P. G. Edwards about the past, present, and future of RadioAstron. Yuri is also one of the conveners of URSI 2020 GASS session J02 "Recent and Future Space Missions." I thank all of the authors for this nice contribution to our Newsletter, with special thanks to Yuri for organizing this article and service to URSI.

- New entries have been added to the Jobs Postings section of the Newsletter this month.

- My apologizes to Willem Baan for missing the announcement of the URSI-sponsored workshop RFI2019: Coexisting with Radio Frequency Interference, which prompted a special mailing last month. I include the announcement in this Newsletter for reference. Although the abstract deadline has passed, late papers may be considered.

Submitted by R. Bradley

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

Rome, Italy 29 August - 5 September 2020

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

Sessions:

J01: New Telescopes on the Frontier
Conveners: Nipanjana Patra, Jeff Wagg

J02: Recent and Future Space Missions
Conveners: Joseph Lazio, Heino Falcke, Yuri Kovalev

J03: Single Dish Instruments
Conveners: Alex Kraus, Anish Roshi

J04: Very Long Baseline Interferometry
Conveners: TBD

J05: Millimeter/Submillimeter Arrays
Conveners: Sheng-Cai Shi, Raymond Blundell

J06: Receivers and Radiometers: Design and Calibration
Convener: Jacki Gilmore, Douglas Hayman

J07: Digital Signal Processing: Algorithms and Platforms
Conveners: Grant Hamspon, Albert-Jan Boonstra

J08: Short-Duration Transients, FRBs, and Pulsars: Observations, Techniques, and Instrumentation
Conveners: Jason Hessels

J09: The Impact of Radio Astronomy on Technology and Society
Conveners: Richard Schilizzi, Leonid Gurvits, Ken Kellermann, Richard Wielebinski

J10: Latest News and Observatory Reports
Conveners: Rich Bradley, Douglas Bock

J11: Big data: Algorithms and Platforms
Conveners: Stefan Wijnholds, Maxim Voronkov

J12: Technologies for the SKA, ngVLA, and ALMA2030 (Joint URSI/IAU Session)
Conveners: Anthony Beasley, Carole Jackson

Workshops and Shared Sessions

Workshop: Characterization and Mitigation of Radio Frequency Interference (Commissions JEFGH)
Conveners: Amit K. Mishra (F), David M. Levine (F), Frank Gronwald (E), Richard Bradley (J)

Workshop: Some aspects of radio science in space weather (Commissions GHJ)
Conveners: Iwona Stanislawska (G), Richard Fallows (J), Patricia Doherty (G), Mauro Messerotti (H/J), Baptiste Cecconi (H/J), Vivianne Pierard (H), Janos Lichtenberger (H), Willem Baan (J)

Mutual benefit between radio astronomy and ionospheric science (Commissions JG)
Conveners: Claudio Cesaroni (G), Maaijke Mevius (J)

Spectrum Management (Commissions ECJ)
Conveners: Amir Zaghloul (C), Tasso Tzioumis (J), Jose Borrego (E)

Solar, Planetary, and Heliospheric Radio Emissions (Commissions HJ)
Conveners: Patrick Galopeau (H), G. Mann (H) and H.O. Rucker (H), Pietro Zucca (J)

The polar Environment and Geospace (Commissions GHJ)
Conveners: Lucilla Alfonsi (G), Nicolas Bergeot (G), Mark Cliverd (H), Stefan Lotz (H)

Workshop Announcements

RFI2019: Coexisting with Radio Frequency Interference

Dear URSI Colleagues:

The URSI-sponsored workshop RFI2019: Coexisting with Radio Frequency Interference will be held in Toulouse, France from 23 - 26 September, 2019. This meeting will bring together researchers from Remote Sensing, Space Physics, Ionospheric Research and Radio Astronomy in order to discuss RFI issues and methods to combat the RFI in our data. The website for RFI2019 is simply http://rfi2019.org and the author registration deadline is August 15, 2019. Late papers may be acceptable.

Kind regards,
Willem Baan
Paolo di Matthaeis

High-Resolution Radio Interferometry in Space: Second International Meeting

Following the spectacular images from the Event Horizon Telescope and the successful Space VLBI missions HALCA and RadioAstron, there is growing interest in the next set of Space VLBI technical concepts, including next-generation constellations and millimeter-wavelength systems. This meeting is a second in a series of international meetings, the first of which was held at Noordwijk in 2018, <URL: https://www.ru.nl/astrophysics/@1164989/future-high-resolution-radio-interferometry-space/ >. The focus of this second meeting is to review black hole and other Space VLBI science cases, and begin to assess the maturity of the relevant technologies and needed technology developments and roadmaps.

Date: 2020 January 27–29 (TBC)
Venue: NRAO, Charlottesville, VA

Activities Spotlight

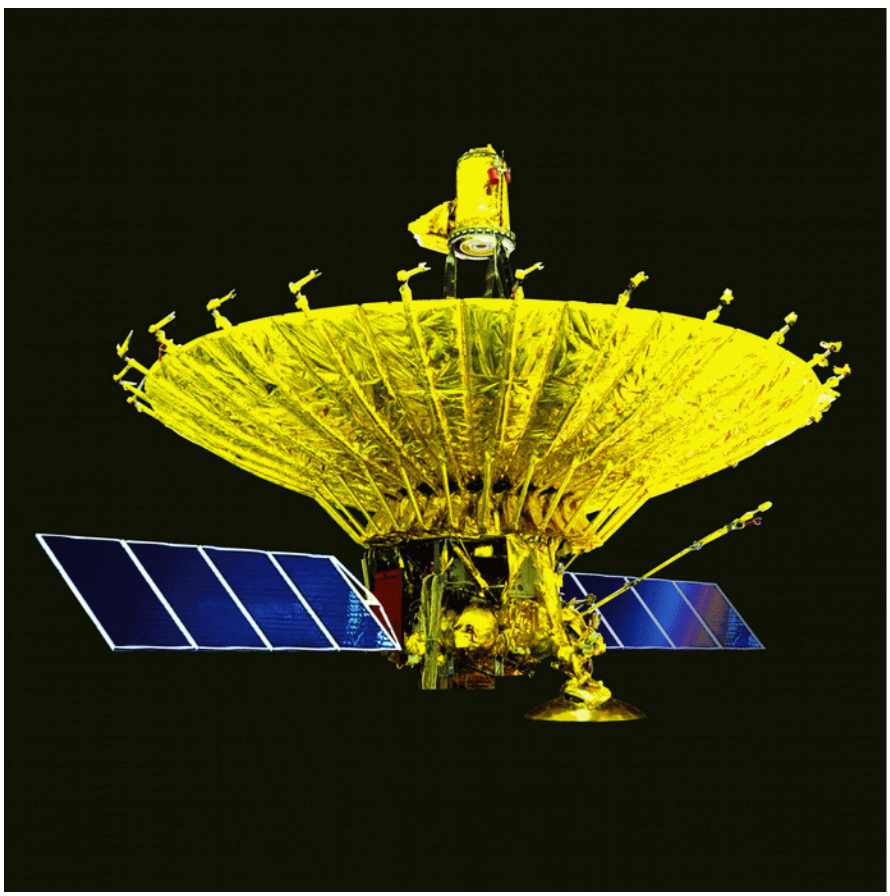
International Space VLBI project RadioAstron

N. S. Kardashev[1], Y. Y. Kovalev[1], P. G. Edwards[2]

[1]Astro Space Center of Lebedev Physical Institute, Moscow

[2]CSIRO Astronomy and Space Science, PO Box 76, Epping, NSW 1710, Australia

For seven and a half years, instead of the planned three, the radio telescope on the Russian Spektr-R spacecraft successfully operated in space following its launch in 2011. Together with the largest terrestrial radio telescopes in many countries of the world, the RadioAstron mission allowed us to study distant and bright objects in the Universe — quasars, pulsars, celestial masers. In early 2019, observing was suspended due to technical problems, and in May spacecraft operations were ended, although the processing of the collected data is still ongoing. The article briefly discusses how the mission started, how the observing phase went, and the results achieved by the largest Russian astrophysical experiment of the 21st century.

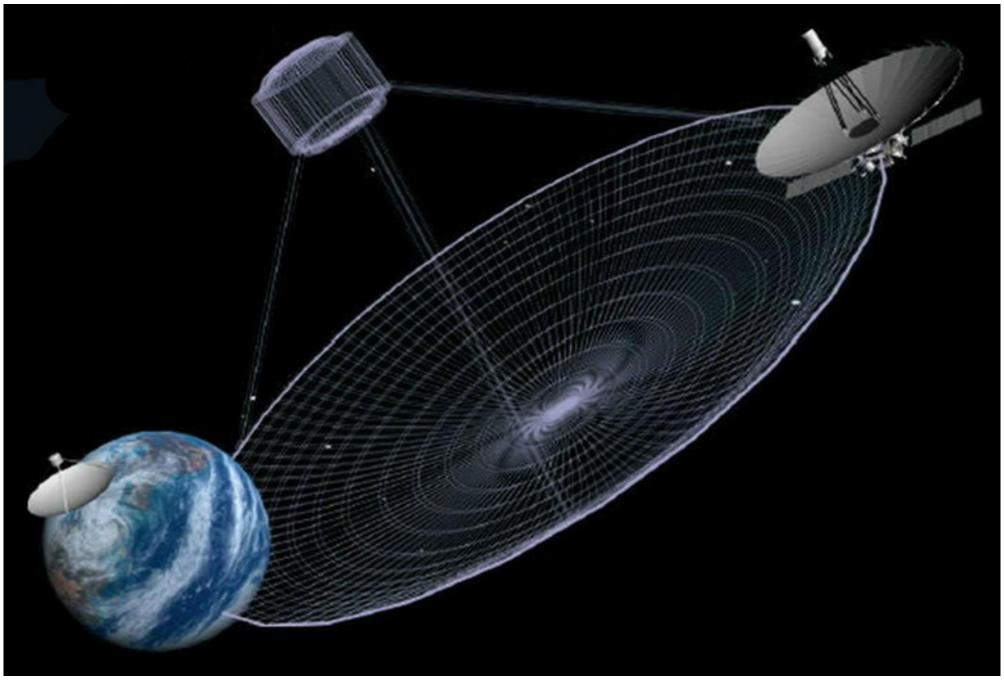


The 10-m Space Radio Telescope. Copyright: A. Zakharov, IKI design.

How did it all start?

Thirty-four years after the beginning of radio astronomy, Soviet scientists Nikolai Kardashev, Gennady Sholomitsky and Leonid Matveenko proposed how to significantly increase the resolution of radio telescopes, that is, the ability to distinguish the smallest details during an observation. The idea was to use several parabolic antennas simultaneously, placed at great distances from each other. The technique was called Very Long Baseline Interferometry (VLBI). The essence of the idea was the ability to receive a radio signal from one source at several antennas, separated by large distances, at the same time, which was equivalent to the signal being received by one antenna with a diameter equal to the distance between the receiving antennas.

VLBI allows the study very remote and very compact celestial objects, if they are strong sources of radio waves. The greater the distance between the antennas, the better the angular resolution of the system. Realizing the prospects that such technology offered, scientists from different countries quickly agreed to collaborate and make use of all the large radio telescopes in the world to observe the most interesting astronomical objects. The only limitation was not the borders between countries, but the diameter of the Earth, on which the antennas are located. The logical solution to this problem, providing an even greater increase in the resolution of telescopes, was to place at least one antenna into orbit.



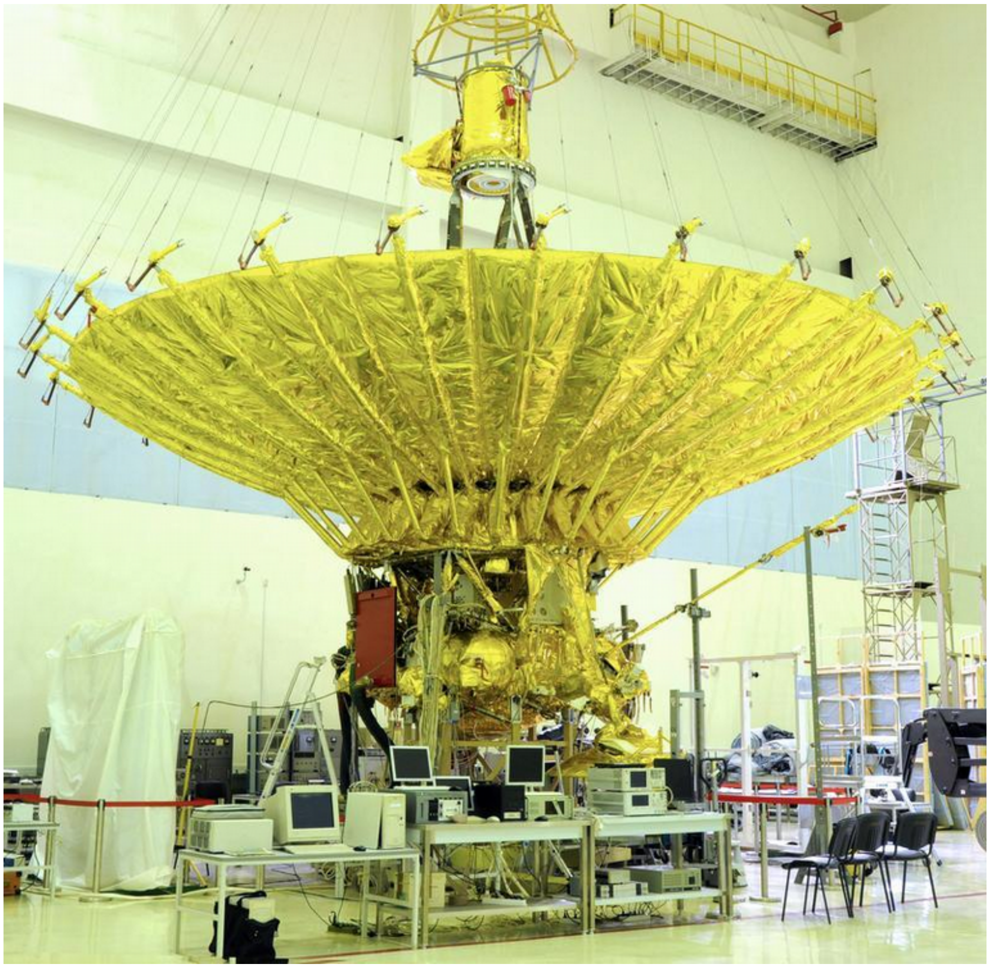
Schematic view of the Space Very Long Baseline Interferometer. Copyright: Roscosmos

The first experiment with a space radio antenna in the Soviet Union was conducted at the near-Earth long-term orbital station Salyut-6. Cosmonauts Vladimir Lyakhov and Valery Rumin launched a 10-meter radio telescope in 1979. The space radio telescope was tested and the effectiveness of the technology was confirmed.

Soviet postage stamp in honor of the flight of Salyut-6 with the 10-m space radio telescope in 1979.

The Soviet Union started the development of the RadioAstron space radio telescope project in the early 1980s, but events related to the collapse of the USSR prevented production and launch.

For a decade the project languished but, in the 2000s, scientists and engineers of the Astro Space Center (ASC) of the Lebedev Physical Institute of the Russian Academy of Sciences, conducted a significant revision of the mission, incorporating a number of advances in science and technology. As a result, the Lavochkin Association and ASC were able to re-invent the space observatory. Technical difficulties included the development and launch of a space radio telescope with a folding antenna with a diameter of 10 m, which needed to be deployed with surface deviations of not more than 1 mm. The system for the automatic opening of the antenna and the satellite bus were created in the Lavochkin Association. The spacecraft was named Spektr-R (Spectrum-R, with the R for Radio).



The unfolded Spektr-R antenna in the assembly complex of Lavochkin Association. Copyright: Lavochkin.

Radio interferometry with very long baselines requires highly accurate determination of the time of data sampling on different antennas. Only when the recordings of signals received by different antennas coincide in time can they be correlated, or combined, into one common signal (effectively "focusing" the combined signals). To do this, each radio telescope participating in the VLBI network is equipped with a hydrogen maser frequency standard — an ultra-precise atomic clock. For ground-based telescopes there are no major problems with this requirement, but to ensure the operation of the radio telescope in orbit, the satellite also needed an atomic clock that was sufficiently accurate, of small mass and size, and ready for the harsh conditions of space. A compact hydrogen frequency standard was specially developed for RadioAstron by the Nizhny Novgorod company Vremya-Ch.

The accumulation and correlation of scientific data was performed at the ASC Lebedev in Moscow. Later, the Max Planck Institute (Germany) and the Joint Institute for VLBI in Europe (the Netherlands) also took part in the correlation of the RadioAstron project information.

Beginning of work

The launch of the Spektr-R spacecraft with a 10-meter space radio telescope on board took place in July 2011 from the Baikonur cosmodrome. The Zenit-2 rocket and the Fregat upper stage brought the satellite into a regular orbit. Five days later the 27 petals of the radio telescope successfully opened like an umbrella.

The orbit for the space radio telescope was chosen to be highly elongated. The highly elliptical orbit varied from about 1,000 km from the Earth's surface at the closest point to 350,000 km at the farthest. Such an orbit allows observations at different distances from ground-based observatories, i.e., changes the length of the baseline, which determines the angular resolution of the ground-space interferometer. The maximum baseline length of the RadioAstron interferometer was almost 27 Earth diameters.

Folded Spektr-R Space Radio Telescope in the assembly complex of Lavochkin Association. Copyright: Lavochkin.

The orbital period of the Spektr-R satellite was about 9 days. The project required two ground tracking stations to receive scientific data in real time. In the eastern hemisphere, communication was maintained by the 22-meter radio telescope of the Pushchino Radio-astrophysical Observatory near Moscow. From 2013, communication and data reception in the western hemisphere was provided through the 43-meter radio telescope of the Green Bank Observatory in West Virginia.

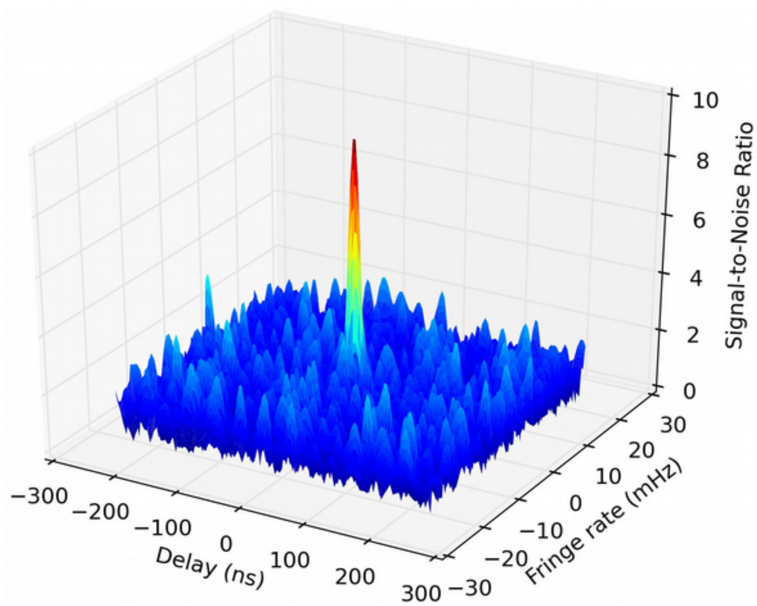
The Pushchino RT-22 RadioAstron tracking station. Copyright: ASC Lebedev.

For the first three months after launch, engineers and scientists analyzed the performance of the satellite bus and scientific systems, carried out tests switching devices, and checked for discrepancies between the calculated and actual characteristics. In September 2011, the telescope saw its "first light" with successful observations of the radio emission of supernova Cassiopeia A. After confirming that the receivers were functioning at all four bands — covering wavelengths of 92 cm, 18 cm, 6 cm and 1.3 cm — the observatory switched to tests in the interferometer mode.

In November 2011, a series of ground-space experiments with radio telescopes from Russia, Ukraine, Europe and the United States confirmed that the telescope was capable of operating in interferometric mode. The RadioAstron project officially started. See for details Kardashev et al. (2013).

Science program

The first two years of RadioAstron's work were carried out according to an early scientific program. It included observations of the nuclei of active galaxies, pulsars, and celestial masers, together with the largest radio observatories in the world. Experience was gained in the operation and performance of the radio telescope in space, the prediction and measurement of the spacecraft's orbit, and the processing and correlation of data.



RadioAstron interferometric signal from the quasar 3C273.
Kovalev et al. (2016)

The capabilities of the radio telescope on the Spektr-R were assessed in several ways:

1. dependence of the quality of observations on the distance between the Earth and the spacecraft, i.e. from the baseline length of the interferometer. First, observations were made on shorter baselines, then the distance was increased, increasing the complexity;

2. reception of signals in different wavelength bands - radio waves of different wavelengths interact in different ways with the interstellar medium and also yield different angular resolutions (the shorter the wavelength, the higher the resolution of the telescope);

3. coherence time - the length of time over which the received signal could be integrated without significant loss due to phase variations;

4. interaction with numerous scientific institutes and ground radio observatories all over the world.

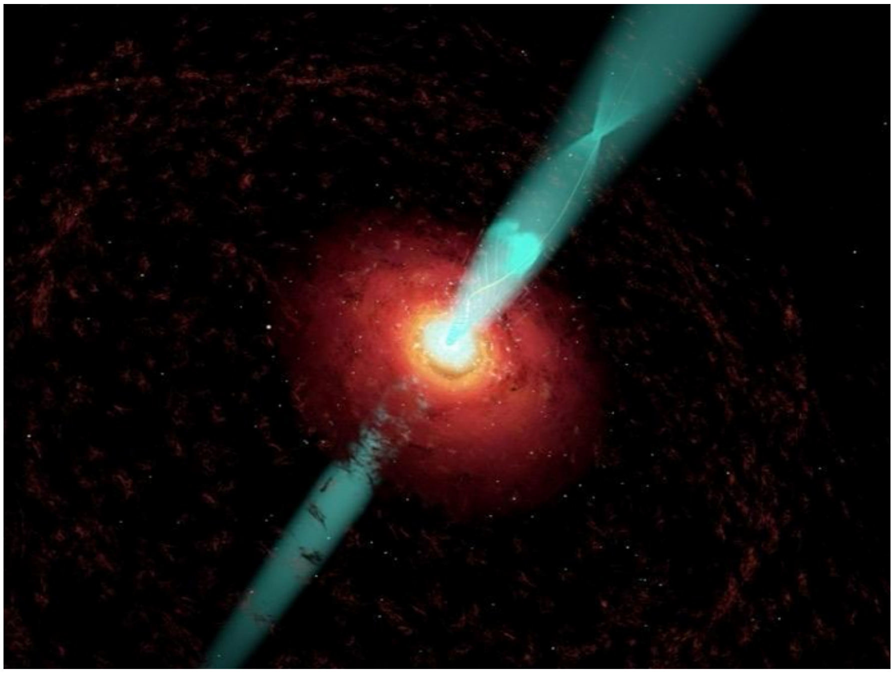
The results confirmed the new opportunities that opened up to radio astronomers around the world. The angular resolution of the ground-space interferometer was ten times higher than radio interferometers could achieve on Earth. Subsequent observations have allowed this figure to be increased even further.

In 2013, the first open call for proposals was announced for the RadioAstron project. Any scientist, from anywhere in the world, could propose scientific observations by providing a justification for their scientific significance. This event marked the end of the early scientific program and marked the beginning of the Key Scientific Program. In the first year, we received 13 applications from various research teams. More than 200 scientists from 19 countries of the world indicated their interest in working on the project.

Based on the capabilities of RadioAstron, scientists chose the most promising areas of research:

- mapping of the central regions of active galaxies (quasars);
- mapping of relativistic jets from the nuclei of active galaxies;
- measurement of the brightness temperature of the nuclei of active galaxies;
- observations of pulsars;
- study of the properties of the interstellar plasma of our Galaxy with the help of radiation from pulsars and quasars, as well as in the direction of the center of the Galaxy;
- mapping and studying the structure of celestial masers in our Galaxy;
- observation of mega-masers in the disks of neighboring galaxies;
- verification of the equivalence principle of the General Theory of Relativity through the measurement of gravitational redshift.

Thanks to the extended lifetime of the Spektr-R, observations were made until the beginning of 2019.



Active galactic nucleus: artistic conception. Copyright: Cosmovision.

RadioAstron results in brief

RadioAstron managed to achieve outstanding scientific results including:

- observe astrophysical objects with record angular resolution;
- clarify the hypotheses about the structure of active galactic nuclei, the formation, magnetic field, internal structure and mechanism of radiation of relativistic jets and celestial masers;
- discover new properties of the interstellar medium and astrophysical objects that were not previously observed;
- master new observational methods based on new knowledge of radio wave propagation in the interstellar medium.

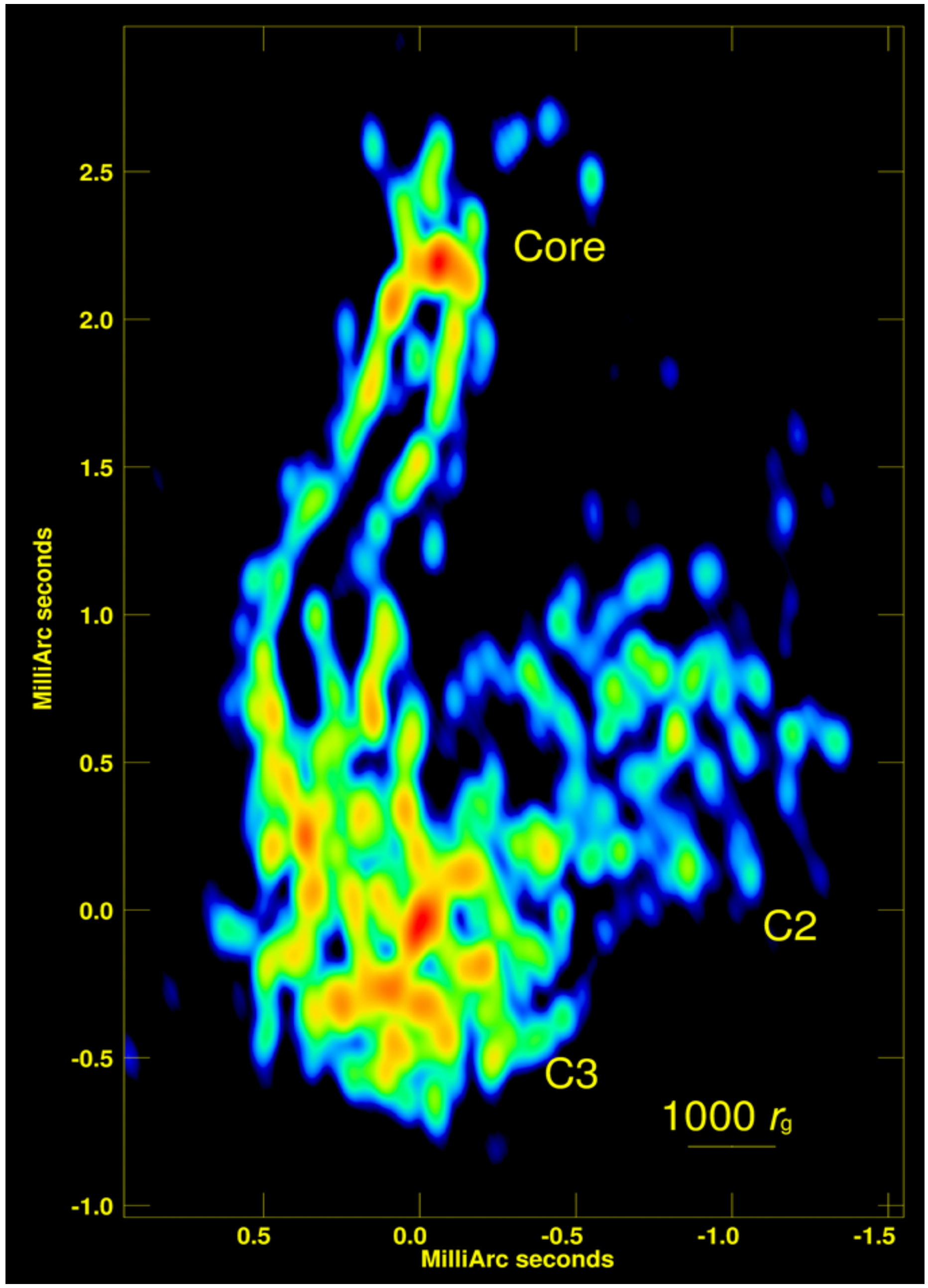
Overall, RadioAstron has allowed scientists to better understand the structure and properties of compact radio sources both in the Milky Way galaxy and in distant active galaxies and quasars.

Among the most important discoveries are:

<u>The measurement of extreme brightness of quasar cores.</u>

The brightness temperature, a measure of the radiation intensity of quasars, was found to be anomalously high: several dozen times higher than previously observed, and than theoretically permissible. There were no convincing explanations for how quasars can maintain such extreme brightness temperatures.

To explain the RadioAstron result, several new hypotheses have been proposed, among which the emission of radio waves from relativistic protons (rather than electrons, as is the case elsewhere) looks most convincing. However, the mechanism for accelerating protons to near-light speed are not yet clear.



3C84 jet at 1.3 cm with RadioAstron. Giovannini et al. (2018)

<u>The Blandford-Payne mechanism of jet formation is found to work in galaxies</u>

Observing the formation of a relativistic jet from the core of the nearby active galaxy Perseus A from a distance of 230 million light years has shown a connection between the appearance of a jet and an accretion disk around a central supermassive black hole.

The image was obtained with an unprecedented angular resolution, which made it possible to measure the width of the base of the jet and explore the details of the structure up to 12 light-days.

It turned out that the jet is formed with a wide base, which confirms the Blandford-Payne hypothesis of the "launching" of a jet from an accretion disk around a black hole, and not from closer to the hole itself.

The structure of the magnetic field of the nuclei of active galaxies is determined.

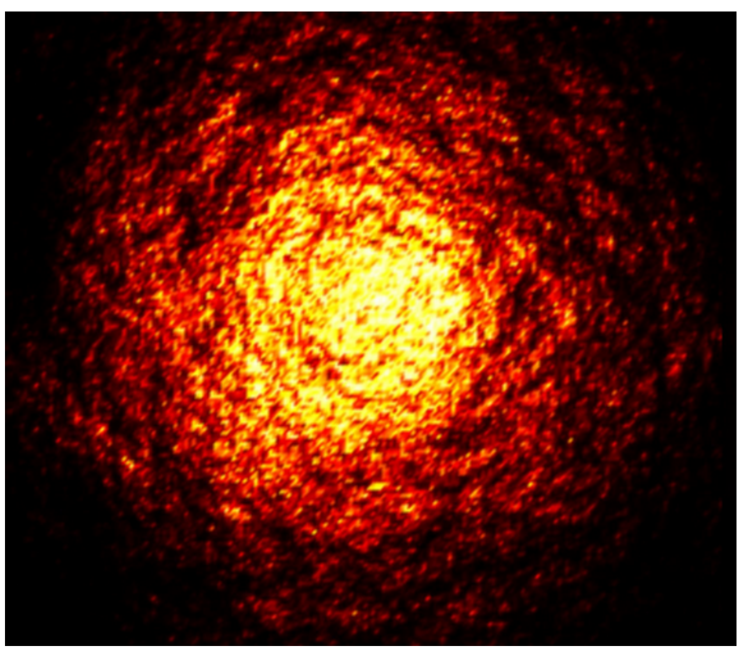
The magnetic field plays a key role in the formation of jets in active galaxies. Therefore, it is important to study the structure of the magnetic field at the base of the jets. This is done by measuring the direction of the electric vector of linear polarization and the Faraday Rotation. Polarization mapping in the RadioAstron project at a wavelength of 1.3 cm with extreme angular resolution made it possible to determine that the magnetic field has a toroidal shape. It works like a magnetic spring, expelling the plasma at relativistic speeds.

The effect of extreme plasma stratification in quasar jets has been found.

The properties of relativistic plasma in quasar jets were practically completely unexplored due to insufficiently high resolution of ground-based interferometers. With RadioAstron, scientists were able to see a brightening at the edges of jets in active galaxies. This meant that hot plasma flows faster in the center and slower at the edges of the jets due to friction with the interstellar medium. Moreover, the difference in the plasma speed in these jet regions was unexpectedly great.

Discovered scattering effect of radio waves in interstellar medium

The study of pulsars revealed a new effect of radio wave scattering in interstellar plasma clouds. The effect, called the "scattering substructure," distorts the high-resolution images. However, it makes it possible to determine the structure and density of interstellar matter in the space between the Earth and pulsars. In the future, this effect will be taken into account when studying the core of the Milky Way galaxy with other tools and in the observations of other distant objects, which will improve the quality of images. This turned out to be an important contribution of RadioAstron to the task of searching for the shadow of a black hole in the center of our Galaxy.



An illustration of the discovered sub-scattering effect. Johnson et al. (2016). It is found to affect quasars, Sgr A (the center of our Galaxy), and pulsars.*

Observation of compact celestial masers

In the field of star formation, Cepheus A, located at a distance of about 2 thousand light years from Earth, was the first to reveal compact sources of water vapour masers, comparable in size to the Sun. Previously, interferometers were unable to determine the size of objects at such distances, and new data will allow a better understanding of the origin of these objects. It is assumed that the observed celestial masers are associated with turbulent eddies in the gas flow from the emerging massive star.

Testing the General Theory of Relativity

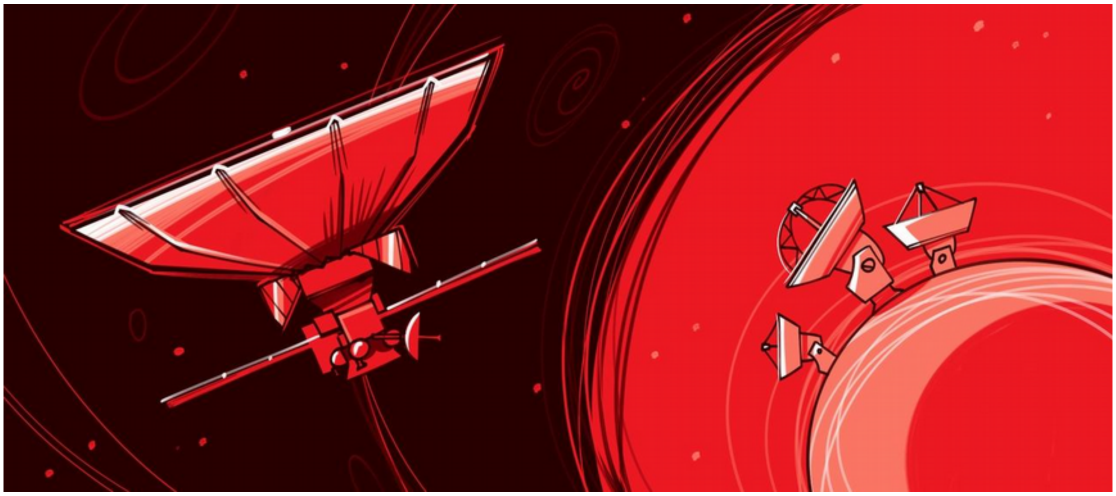
The hydrogen maser frequency standard onboard Spektr-R allowed dozens of experiments to measure the effect of the gravitational time dilation and thus test the Einstein equivalence principle and general relativity theory. Data analysis is ongoing, but preliminary results, from processing of only part of the data, indicate that an accuracy at the level of Gravity Probe A (0.01%), a similar experiment conducted by the USA in 1976, has already been achieved. Further processing has the potential to increase the accuracy of the test by about a factor of 10.

Suspension of observing

In January 2019, the command radio system on the Spektr-R spacecraft stopped operating. After several months of attempts to reestablish communications, in May, the Roscosmos State Commission decided to end the observing phase of the mission. Processing all the data accumulated by the RadioAstron project will require several more years and new discoveries can be expected.

The future of Millimetron

The team of the Astro Space Center of the Lebedev Physical Institute together with the engineers of the Lavochkin Association and the Reshetnev Information Satellite Systems, are developing a new project Spektr-M (Millimetron) under the auspices of Roscosmos. The Spektr-M spacecraft will carry a millimeter-wave telescope to a distance of 1.5 million km from Earth, which will provide baselines of unprecedented length and will give astrophysicists of the world unique opportunities to study objects throughout the Universe at millimeter and sub-millimeter wavelengths.



Artists concept of Miilimetron. Copyright: M. Kalutskaya.

RadioAstron in numbers

1. 7.5 years of scientific work in orbit.
2. 26.7 Earth diameters (350,000 km) — the maximum baseline of the interferometer.
3. 8 microseconds of arc — maximum resolution — when observing water vapor mega-masers in the accretion disk of the galaxy M106.
4. 1 second in 3 million years (10^{-14} s/s): the stability of the hydrogen maser frequency standard produced by Vremya-Ch (Nizhny Novgorod).
5. 10 m — the diameter of the satellite Spektr-R — a record for space radio telescopes with a filled aperture.
6. Up to 25 radio telescopes on Earth participating in simultaneous observations.
7. A total of 58 radio telescopes participated in the observations of RadioAstron from Russia, Europe, the USA, Africa, Australia, the People's Republic of China, South Korea, and Japan.
8. 3 correlators: ASC LPI (Russia), Max Planck Institute for Radio Astronomy (Germany), the Joint Institute for VLBI in Europe (Netherlands).
9. 2 stations for tracking and collecting scientific information: the 22-meter antenna of the Pushchino radio astronomy observatory (Russia) and the 43-meter antenna of the Green Bank Observatory (USA).
10. 128 Mbps — data transfer rate from the spacecraft in orbit, up to 350,000 km from the Earth

11. 4 petabytes — the amount of accumulated data.
12. 92 cm, 18 cm, 6.2 cm, 1.2-1.7 cm wavelength of observations.
13. over 250 celestial radio sources studied.
14. Over 4000 observation sessions.
15. 240 scientists from 23 countries of the world took part in the observations.

Acknowledgements. The RadioAstron project is led by the Astro Space Center of the Lebedev Physical Institute of the Russian Academy of Sciences and the Lavochkin Scientific and Production Association under a contract with the State Space Corporation ROSCOSMOS, in collaboration with partner organizations in Russia and other countries.

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Job Postings – Radio Astronomy and Related Fields

Science Manager - Arecibo Observatory

The Science Manager will have overall management responsibility over the onsite science team at Arecibo. This position is responsible for administratively managing staff work, making assignments, evaluating performance and providing guidance and direction. The candidate will work directly with the scientists in developing performance plans and metrics aligned with short- and long-term objectives of the facility. Responsible for managing team budget, hiring and reporting requirements. For further information see https://jobs.ucf.edu/en-us/job/497580/science-manager-arecibo-observatory

Observatory Scientist or Senior Observatory Scientist at Arecibo (Radio Astronomy, Interferomtery)

The Arecibo Observatory (AO), part of the University of Central Florida (UCF), is seeking a talented observatory scientist or senior observatory scientist in Interferometry Radioastronomy in Puerto Rico. The Arecibo Observatory (AO) is famous for its outstanding research in radio astronomy, solar-system studies, and space and atmospheric sciences, is home to the world's second largest radio/radar telescope. AO invites applicants to apply for the observatory scientist positions in observational radio astronomy, preferably with Very Long Baseline Interferometry (VLBI) experience. The selected applicants will be expected to participate in enabling Arecibo's user community to obtain the best possible scientific results from the telescope, and pursue their own cutting-edge research programs. Development of novel observational techniques as well as the commissioning of new observing equipment are of importance. Overall, these positions are expected to be 75% service and 25% independent research. The selected candidate will be encouraged to apply for grant funding.

For further details see https://jobs.ucf.edu/en-us/job/497173/observatory-scientist-or-senior-observatory-scientist-interferometry-radioastronomy .

UC Berkeley Radio Astronomy Lab - seeking a highly motivated individual to conduct research in radio astronomy, designing advanced radio astronomy instrumentation for HERA (the Hydrogen Epoch of Reionization Array) and several other radio telescope arrays, as well as further the Collaboration for Astronomy Signal Processing and Electronics Research (CASPER) by developing open-source software and hardware for the radio-astronomy community.

For more information, please visit the following link: https://aprecruit.berkeley.edu/JPF02148

Union Radio-Scientifique Internationale — International Union of Radio Science

Monthly Newsletter of International URSI Commission J – Radio Astronomy

August 2019

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!

- Planning for the 2020 URSI General Assembly and Scientific Symposium continues. For those who volunteered to serve as conveners – thank you! We are still searching for conveners – we would like at least three per session. The latest version of the Commission J program is included in the Newsletter. I should also mention that, in addition to the oral sessions, there will be at least one combined poster session.

- The International Astronomical Union (IAU) is also celebrating its centennial this year - we have confirmed joint session J-IAU: “Technologies for the SKA, ngVLA, and ALMA2030” at the 2020 URSI GASS. Special thank you to Carole Jackson and Tony Beasley for leading the effort to make this unique session possible.

- The Activities Spotlight this month is an interesting article about the Microfabrication Laboratories and the Far Infrared and Terahertz Laboratory at the University of Virginia that has served the radio astronomy community for nearly 50 years. I thank lab directors Arthur Lichtenberger and Robert Weikle for your contribution to the URSI-J Newsletter.

- Looking for a past issue of the J Newsletter? The Newsletters and other URSI Commission J documents are archived at http://www.ursi.org/commission.php?id=J#tab-section4 .

Submitted by R. Bradley

100 Years URSI

1919 2019

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

Rome, Italy 29 August - 5 September 2020

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

Sessions:

J01: New Telescopes on the Frontier
Conveners: Nipanjana Patra, Jeff Wagg

J02: Recent and Future Space Missions
Conveners: Joseph Lazio, Heino Falcke, Yuri Kovalev

J03: Single Dish Instruments
Conveners: Alex Kraus, Anish Roshi, Jin Chengjin

J04: Very Long Baseline Interferometry
Conveners: Francisco Colomer, Taehyun Jung, Chris Jacobs

J05: Millimeter/Submillimeter Arrays
Conveners: Sheng-Cai Shi, Raymond Blundell

J06: Antennas, Receivers and Radiometers: Simulation, Design and Calibration
Convener: Jacki Gilmore, Douglas Hayman, Pietro Bolii, David Davidson

J07: Digital Signal Processing: Algorithms and Platforms
Conveners: Grant Hamspon, Albert-Jan Boonstra

J08: Short-Duration Transients, FRBs, and Pulsars: Observations, Techniques, and Instrumentation
Conveners: Jason Hessels

J09: The Impact of Radio Astronomy on Technology and Society
Conveners: Richard Schilizzi, Leonid Gurvits, Ken Kellermann, Richard Wielebinski

J10: Latest News and Observatory Reports
Conveners: Rich Bradley, Douglas Bock

J11: Big data: Algorithms and Platforms
Conveners: Stefan Wijnholds, Maxim Voronkov

Workshops and Shared Sessions

Workshop: Characterization and Mitigation of Radio Frequency Interference (Commissions JEFGH)
Conveners: Amit K. Mishra (F), David M. Levine (F), Frank Gronwald (E), Richard Bradley (J)

Workshop: Some aspects of radio science in space weather (Commissions GHJ)
Conveners: Iwona Stanislawska (G), Richard Fallows (J), Patricia Doherty (G), Mauro Messerotti (H/J), Baptiste Cecconi (H/J), Vivianne Pierard (H), Janos Lichtenberger (H), Willem Baan (J)

J-ITU: Technologies for the SKA, ngVLA, and ALMA2030 (Joint URSI/IAU Session)
Conveners: Anthony Beasley, Carole Jackson, Gabriele Giovannini, Melissa Soriano

Mutual benefit between radio astronomy and ionospheric science (Commissions JG)
Conveners: Claudio Cesaroni (G), Maaijke Mevius (J)

Spectrum Management (Commissions ECJ)
Conveners: Amir Zaghloul (C), Tasso Tzioumis (J), Jose Borrego (E)

Solar, Planetary, and Heliospheric Radio Emissions (Commissions HJ)
Conveners: Patrick Galopeau (H), G. Mann (H) and H.O. Rucker (H), Pietro Zucca (J)

The polar Environment and Geospace (Commissions GHJ)
Conveners: Lucilla Alfonsi (G), Nicolas Bergeot (G), Mark Cliverd (H), Stefan Lotz (H)

Workshop Announcements

RFI2019: Coexisting with Radio Frequency Interference

Dear URSI Colleagues:

The URSI-sponsored workshop RFI2019: Coexisting with Radio Frequency Interference will be held in Toulouse, France from 23 - 26 September, 2019. This meeting will bring together researchers from Remote Sensing, Space Physics, Ionospheric Research and Radio Astronomy in order to discuss RFI issues and methods to combat the RFI in our data. The website for RFI2019 is simply http://rfi2019.org and the author registration deadline is August 15, 2019. Late papers may be acceptable.

Kind regards,
Willem Baan
Paolo di Matthaeis

High-Resolution Radio Interferometry in Space: Second International Meeting

Following the spectacular images from the Event Horizon Telescope and the successful Space VLBI missions HALCA and RadioAstron, there is growing interest in the next set of Space VLBI technical concepts, including next-generation constellations and millimeter-wavelength systems. This meeting is a second in a series of international meetings, the first of which was held at Noordwijk in 2018, <URL: https://www.ru.nl/astrophysics/@1164989/future-high-resolution-radio-interferometry-space/ >. The focus of this second meeting is to review black hole and other Space VLBI science cases, and begin to assess the maturity of the relevant technologies and needed technology developments and roadmaps.

Date: 2020 January 27–29 (TBC)
Venue: NRAO, Charlottesville, VA

Activities Spotlight

Charlottesville Virginia USA Has Emerged as a World Hub for THz Materials, Devices, and Circuits

The University of Virginia Microfabrication Laboratories (UVML) and the Far Infrared and Terahertz Laboratory (FIRTL) has a long-standing internationally recognized program of excellence in THz materials, devices, circuits, and metrology, with its original roots focused on realizing detectors and sources for radio astronomy. This effort began in 1970 (under the previous facility name, Semiconductor Device Laboratory) with the pioneering work of Professor Robert Mattauch, in a historic collaboration with NRAO, to develop semiconductor Schottky barrier diodes and later, with Professor Lichtenberger, to research and develop superconducting detectors for submillimeter-wave astronomy. The Schottky detector effort at UVA (Mattauch, Crowe and Weikle) and the spin off high tech company Virginia Diodes (founded by Tom Crowe and Bill Bishop) has and continues to have significant impact on radio astronomy, plasma diagnostics and scaled radar range systems. These include the original mapping of the ozone hole, and component development for a number of major facilities, including the Very Large Array, Kitt Peak 12 meter Telescope, Submillimeter Wave Astronomy Satellite, Microwave Instrument for the Rosetta Orbiter, US Advanced Microwave Sounding Unit, ODIN, ALMA, IceCube Cubesat, the US Defense Meteorological Satellite Program and a number of forecasting satellites in the US Defense Metrological Satellite Program.

The UVML maintains a sophisticated thin film fabrication processes for GaAs, superconducting and photodiode devices and circuits and is well positioned for the investigation and development of new materials and chip architectures. The UVML was the first group to develop, in collaboration with Tony Kerr at NRAO, tunerless SIS mixers with low output capacitance and inductance, the first single chip balanced SIS mixer, the first superconducting 180° IF Hybrid, the “SOI” mixer architecture for superconducting circuits with ultra-thin Si chips and Au beam leads (**Fig. 1**) and the first group to develop inductively coupled plasma (ICP) grown AlN tunnel barriers that have led to the highest quality Nb/Al-AlN/Nb and Nb/Al-AlN/NbTiN SIS devices. The UVML, in collaboration with the NRC Herzberg Institute of Astrophysics (NRC-HIA), the NRAO, the University of Arizona, and the Institut de Radioastronomie Millimétrique (IRAM) has demonstrated SIS mixers that exceed the design specifications of the largest land-based radio

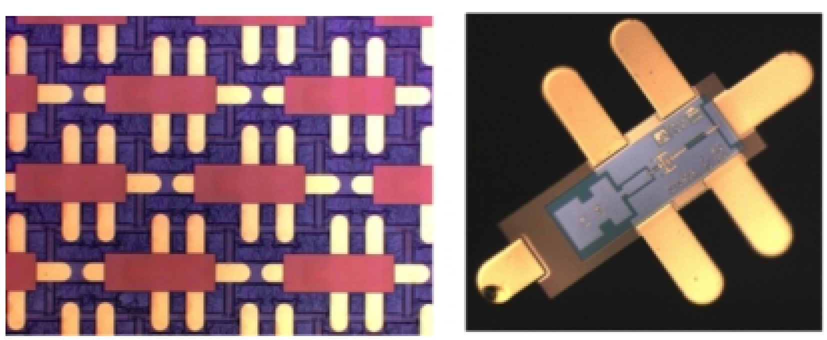

Figure 1: (Left) SIS mixer chips with 3um thick Si substrate and Au beamleads still mounted face down to its carrier wafer, and (Right) one chip dismounted.

astronomical facility in the world (Atacama Large Millimeter Array (ALMA) for bands 3, 6, 7 & 8 respectively, and is the SIS foundry for all Band3 and Band6 SIS mixer circuits. Our SOI architecture and AlN barrier technologies are currently being exploited for more sensitive and wider bandwidth receivers.

Our superconducting detector technology (**Fig. 2**) played an important role in the recent first-ever imaging of a black hole approximately 55 million light-years from Earth by an international team of astronomers and engineers. This achievement captivated the world, as previously the evidence for black holes had been obtained indirectly, for example by measuring their gravitational effect on the path of other celestial bodies and more recently by detection of gravity waves from the collision of black holes using the Laser Interferometer Gravitational-Wave Observatory (LIGO) in 2015. **However, very excitingly for the astronomical community, a black hole has now been imaged using superconducting detectors at radio astronomy observatories around the world in a remarkable and common-culture captivating discovery.** The Event Horizon global network of eight observatories relied on ultra low-noise SIS detectors, most of which were developed over several decades by engineers and scientists at NRAO and UVA, operating at 230 GHz, about 100 times higher frequency than Wi-Fi. The largest and most sensitive millimeter radio telescope facility in the world, the Atacama Large Millimeter/submillimeter Array (ALMA) in Chile, utilized 132 of detectors, while the Arizona Submillimeter Telescope, the UMass Large Millimeter Telescope in Mexico and the South Pole Telescope also each made use of two of the NRAO-UVA detectors.

Figure 2: Picture of an NRAO-UVA Band6 ALMA receiver

This mapping of the gas ring swirling around and violently captured by the black hole also provided further confirmation of Einstein’s theories on relativity and enabled astronomers to measure its mass (6.5 billion times heavier than our own sun!). This feat is remarkable on many levels. The black hole was chosen for imaging because it had the clearest sight-lines from earth, yet it is 55 million light years, or three hundred quintillion miles away. The imaged gas emission ring surrounding the black hole's event horizon is only on order of the size of a single large star. And as if the task couldn't get more challenging, the electromagnetic signal that transverses the heavens is attenuated and distorted by gas clouds and ionized particles along its 55-million-year journey. While it took an international cast of scientists and engineers working together to accomplish this feat, this discovery could not have been accomplished without the heart of the telescope- the Superconducting Insulating Superconducting (SIS) detectors that first greeted each photon after its long journey through the heavens.

The UVML and FIRTL are the state's flagship university nano-micro fabrication and measurement facilities spearheading multidisciplinary research and educational activities that span high-speed THz and infrared (IR) systems, high performance photodiodes for RF photonics and communications, biotechnology and nanotechnology. As a result, we are developing state-of-the-art electronic, photonic and superconducting devices, circuits and micromachined components that are transcending the limits of conventional electronics, impacting a variety of technologies, including emerging 5G networks, radar sensors for autonomous vehicles, wireless Internet of Things platforms, quantum computing, and future-generations of communication systems. With $10 million in recent investment from the University of Virginia's Strategic Investment Fund for critical equipment, and more than $15 million from UVA and the School of Engineering for a cleanroom renovation and expansion (which includes Multifunctional Materials Integration and Nano-Bio initiatives) that is currently underway, the UVML is well positioned for the future.

Shaping ground-breaking technology and catalyzing innovation at a systems level is only possible with the collaboration and support of cross-sector entities that include, government organizations, businesses and other research agencies. For nearly 50 years, UVA and the NRAO have joined together to establish world-renowned low-noise detectors which have first detected many of the known interstellar molecules. In addition to our UVA group, there is an unprecedented, internationally recognized level of high frequency expertise in the Charlottesville region. This includes the UVA THz-FIR group (Lichtenberger, Weikle, Barker, Cyberey, Campbell, Beling, Bowers), the National Radio Astronomy Observatory (Tony Kerr, S.-K. Pan, Marion Pospieszalski - headquartered in Charlottesville), Virginia Diodes Inc (a UVA spin off company - Tom Crowe, Jeffrey Hesler, ~ 100 employees and internationally recognized as the source for commercial THz components and systems with sales to over fifty countries), National Ground Intelligence Center (NGIC, focused on THz scaled radar systems), and Dominion MicroProbes Inc (DMPI, a UVA spin-off company - Lichtenberger, Barker and Weikle for THz wafer measurements).

Submitted by Arthur Lichtenberger (director of the UVA Microfabrication Laboratories) and Robert Weikle (director of the UVA Far Infrared and THz Laboratory)- both professors of electrical and computer engineering at the University of Virginia School of Engineering.

Job Postings – Radio Astronomy and Related Fields

Science Manager - Arecibo Observatory

The Science Manager will have overall management responsibility over the onsite science team at Arecibo. This position is responsible for administratively managing staff work, making assignments, evaluating performance and providing guidance and direction. The candidate will work directly with the scientists in developing performance plans and metrics aligned with short- and long-term objectives of the facility. Responsible for managing team budget, hiring and reporting requirements. For further information see https://jobs.ucf.edu/en-us/job/497580/science-manager-arecibo-observatory

Observatory Scientist or Senior Observatory Scientist at Arecibo (Radio Astronomy, Interferomtery)

The Arecibo Observatory (AO), part of the University of Central Florida (UCF), is seeking a talented observatory scientist or senior observatory scientist in Interferometry Radioastronomy in Puerto Rico. The Arecibo Observatory (AO) is famous for its outstanding research in radio astronomy, solar-system studies, and space and atmospheric sciences, is home to the world's second largest radio/radar telescope. AO invites applicants to apply for the observatory scientist positions in observational radio astronomy, preferably with Very Long Baseline Interferometry (VLBI) experience. The selected applicants will be expected to participate in enabling Arecibo's user community to obtain the best possible scientific results from the telescope, and pursue their own cutting-edge research programs. Development of novel observational techniques as well as the commissioning of new observing equipment are of importance. Overall, these positions are expected to be 75% service and 25% independent research. The selected candidate will be encouraged to apply for grant funding.
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For more information, please visit the following link: https://aprecruit.berkeley.edu/JPF02148

July 31, 1919 - July 31, 2019

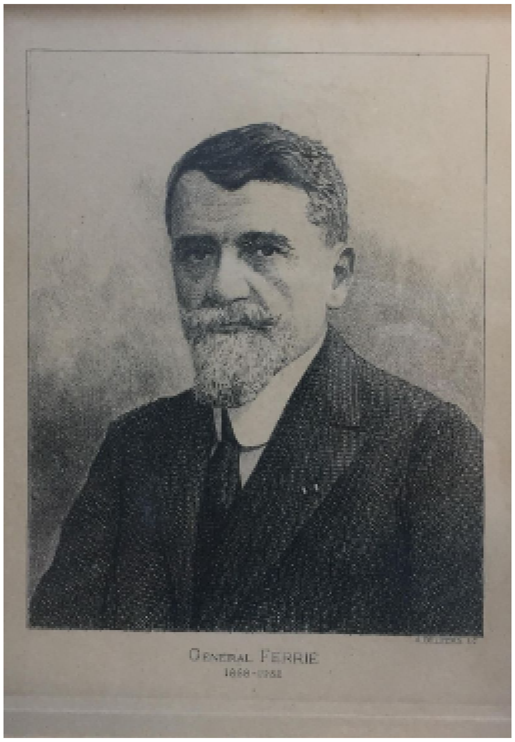
Celebrating 100 Years of URSI !

Exactly 100 years ago, URSI was founded in Brussels under the name 'Union international de radiotélégraphie scientifique' during the 'Conseil international de Recherches'.

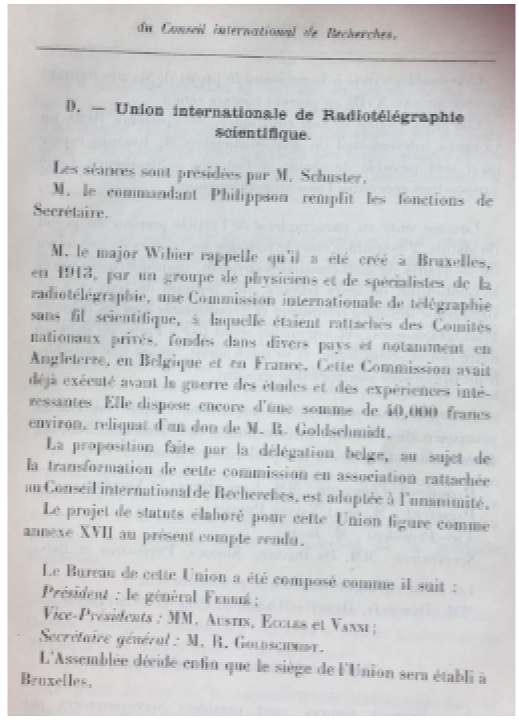
URSI's 100th Birthday will be celebrated at several occasions the next three years.

We will keep you updated with our latest activities by mailings and through our Social Media platforms !

The Founding Fathers of URSI



General Ferrié, first President of URSI



du Conseil international de Recherches.

D. — Union internationale de Radiotélégraphie scientifique.

Les séances sont présidées par M. Schuster.

M. le commandant Philippson remplit les fonctions de Secrétaire.

M. le major Wibier rappelle qu'il a été créé à Bruxelles, en 1913, par un groupe de physiciens et de spécialistes de la radiotélégraphie, une Commission internationale de télégraphie sans fil scientifique, à laquelle étaient rattachés des Comités nationaux privés, fondés dans divers pays et notamment en Angleterre, en Belgique et en France. Cette Commission avait déjà exécuté avant la guerre des études et des expériences intéressantes. Elle dispose encore d'une somme de 40,000 francs environ, reliquat d'un don de M. R. Goldschmidt.

La proposition faite par la délégation belge, au sujet de la transformation de cette commission en association rattachée au Conseil international de Recherches, est adoptée à l'unanimité.

Le projet de statuts élaboré pour cette Union figure comme annexe XVII au présent compte rendu.

Le Bureau de cette Union a été composé comme il suit :

Président : le général Ferrié ;

Vice-Présidents : MM. Austin, Eccles et Vanni ;

Secrétaire général : M. R. Goldschmidt.

L'Assemblée décide enfin que le siège de l'Union sera établi à Bruxelles.

Proceedings of the Assembly of the 'Conseil international de Recherches' held in July 2019

Our mailing address is:
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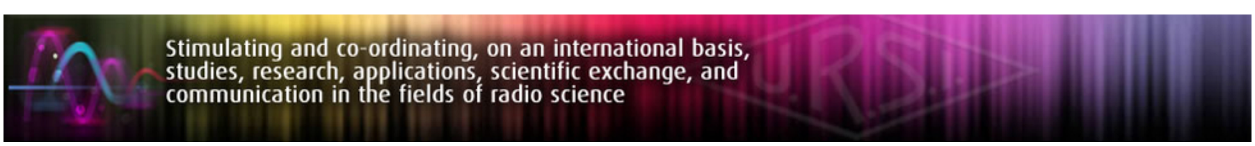
Ghent University /INTEC
Technologiepark-Zwijnaarde 126
B-9052 Gent, BELGIUM

info@ursi.org



Monthly Newsletter of International URSI Commission J – Radio Astronomy

September 2019

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 from the Chair!

- This issue marks the end of the 2nd year for the Commission J Newsletter. This month, we list the Activities Spotlight topics covered over the past two years and encourage you to submit an article in the future. Also, I include a table, compiled by Inge Heleu, of general lectures and tutorials presented at past URSI General Assemblies since 1984. Your help in supplying any missing information would be appreciated.

- Planning for the 2020 URSI General Assembly and Scientific Symposium continues. For those who volunteered to serve as conveners – thank you! The latest version of the Commission J program is included in the Newsletter.

- Many of you are familiar with the HF radio time stations around the world. October 1st marks the centennial of U.S. time station WWV operations. The centennial will be celebrated on the amateur radio bands by a special event station operating from September 28 through October 2. Details may be found at http://wwv100.com/ Recently on radioastronomy-hams@groups.io, we had a very delightful sharing of thoughts and anecdotal stories on the topic of time stations and radio astronomy over the years. The issue of injecting leap seconds in UTC is a hot topic today.

- It is with deep sadness that I report the passing of URSI member Richard Prestage. Richard was active in USNC URSI and was a co-convener of several sessions for the URSI flagship conferences over the years. He will be greatly missed.

- Looking for a past issue of the J Newsletter? The Newsletters and other URSI Commission J documents are archived at http://www.ursi.org/commission.php?id=J#tab-section4 .

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

Rome, Italy 29 August - 5 September 2020

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

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Conveners: Nipanjana Patra, Jeff Wagg, Arnold van Ardenne

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Conveners: Alex Kraus, Anish Roshi, Jin Chengjin

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Conveners: Sheng-Cai Shi, Raymond Blundell

J06: Antennas and Receivers: Simulation, Design and Calibration

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Conveners: Jason Hessels

J09: The Impact of Radio Astronomy on Technology and Society

Conveners: Richard Schilizzi, Leonid Gurvits, Ken Kellermann, Richard Wielebinski

J10: Latest News and Observatory Reports

Conveners: Rich Bradley, Douglas Bock

J11: Big data: Algorithms and Platforms

Conveners: Stefan Wijnholds, Maxim Voronkov

Workshops and Shared Sessions

<u>Workshop</u>: Characterization and Mitigation of Radio Frequency Interference (Commissions JEFGH)

Conveners: Amit K. Mishra (F), David M. Levine (F), Frank Gronwald (E), Richard Bradley (J)

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

Conveners: Patrick Galopeau (H), G. Mann (H) and H.O. Rucker (H), Pietro Zucca (J)

The polar Environment and Geospace (Commissions GHJ)

Conveners: Lucilla Alfonsi (G), Nicolas Bergeot (G), Mark Cliverd (H), Stefan Lotz (H)

Activities Spotlight Articles

2017

October	*Working Group on Historical Radio Astronomy* R. Schilizzi, K. Kellermann and R. Wielebinski
November	*ECR Update* S. J. Wijnholds
December	*The Indirect Influence of Amateur Radio in Radio Astronomy* M. Ewing

2018

January	*Radio Science and Commission J* P. Wilkinson
February	*Radio Astronomy: a continuous demand for breakthrough technology* P. Bolli, N. D'Amico, and R. Nesti
March	*NRAO/AUI Archives* E. Bouton
April	*Low Radio Frequency Astronomy Opportunities from Space* D. Rapetti and J. O. Burns
May	*Human Capital Development Programme - Creating excellence in radio astronomy* V. Rowland and J. Gilmore
June	*2018 URSI Atlantic Radio Science Conference in Perspective* R. Bradley
July	*Ionospheric Measurements Using LOFAR* M. Mevius and R. Fallows
August	*MeerKAT Inaugration* J. Jonas
September	*LOFAR Single Station as the Tool in Student's Education* Leszek Błaszkiewicz and PL612 Team
October	*Experience with Student-Constructed Telescopes for Radio Astronomy* G. I. Langston, S. A. Heatherly, and Kevin Bandura
November	*Measuring Pulsars using Amateur Radio Equipment* H. Faschin
December	*Downlink and amateur radio experiments with the lunar satellite DSLWP-B* C. Bassa, D. Estévez, T. Jan Dijkema

Activities Spotlight Articles (continued)
2019

January *Cryogenic PAF for the Green Bank Telescope*
B. Shillue, K. Warnick, and D. J. Pisano

February *Of Mice and In-Flight Magazines (PRIZM)*
H. C. Chiang

March *The Next Generation Very Large Array (ngVLA)*
A.J. Beasley, E. Murphy, R. Selina, M. McKinnon, & ngVLA Project Team

April *An Excellent Asia-Pacific Radio Science Conference (AP-RASC)*
S. J. Wijnholds

May *Westerbork Observatory*
A. van Ardenne

June On Holiday

July *International Space VLBI project RadioAstron*
N. S. Kardashev1, Y. Y. Kovalev1, P. G. Edwards

August *Charlottesville Virginia USA Has Emerged as a World Hub for THz Materials, Devices, and Circuits*
A. Lichtenberger and R. Weikle

September *Topical Summary*
R. Bradley

First, I want to thank all of the authors for submitting articles to the Activities Spotlight. As you can see, a wide variety of topics were covered over the past two years. Please consider submitting an article for Activities Spotlight in the future. The topic, writing style, and length are totally up to you. I am quite flexible with regard to your busy calendar in scheduling deadlines. The Spotlight articles and Photo from the Field section keeps your Newsletter fresh and interesting each month. Consider this your platform to share thoughts, ideas, historical notes, research activities, updates, etc.

The Newsletters are archived at http://www.ursi.org/commission.php?id=J#tab-section4 .

Year-Commission T- Tutorial GL- General Lecture	Topic	Presenter
2017-AT	Distributing Time and Frequency Data: Requirements and Methods	Judah Levine (USA)
2017-BT	Metasurfaces: Synthesis for perfect refraction and reflection of waves into arbitrary directions	Sergei Tretyakov (Denmark)
2017-CT	Challenges of Millimeter Radio Channel Sounding and Channel Modelling	Sana Salous, Jeanne Quimby (United Kingdom)
2017-DT	The Path towards 100 Gbit/s Wireless Communications	J Leuthold (Switzerland)
2017-ET	EMC Aspects in Smart Grids	William Radasky (USA)
2017-FT	Modeling Rain Medium for Weather Radar and Propagation	Luca Baldini (Italy)
2017-GT	Will we Ever be Able to Model and Forecast the Ionosphere Well Enough to Support the Needs of the Radio Wave Users?	Tim Fuller-Rowel (USA)
2017-HT	Drivers, Detection, and Wider Significance of Precipitation from the Radiation Belts	Craig Rodger (New Zealand)
2017-JT	The Atacama Large Millimeter Array (ALMA)	Ake Nyman (Chile)
2017-KT	International EMF Project to assess health and environmental effects of exposure to static and time varying electric and magnetic fields in the frequency range 0-300 GHz	Tahera Emilie van Deventer (Canada)
2014-GL1	Energy harvesting for Autonomous Wireless Sensors and RFID's	Apostolos Georgiadis (Spain)
2014-GL2	Square Kilometer Array	Phil Diamond (United Kingdom)
2014-GL3	Solar Superstorms - a storm in a tea cup, or a global risk for society and economies?	Paul S Cannon (United Kingdom)
2014-AT	The BeiDou Navigation Satellite System	Chunhao Han (China, CIE)
2014-BT	Controlling Waves with Metasurfaces	S. Maci (Italy)
2014-CT	State of the art mobile radio channel sounding and data analysis	Sana Salous (United Kingdom)
2014-DT	Terahertz Time-Domain Spectroscopy: Principles and recent Developments	Jean-Louis Coutaz (France)
2014-ET	SKA and EMC: The Need for Science and Engineering Dialogue	Howard Reader (South Africa)
2014-FT	Looking at the Earth as a planet: Passive Microwave Remote Sensing of Land Surfaces	Paolo Pampaloni (Italy)
2014-GT	Ionosphere and Plasmasphere Electron Density Profiles	Bodo Reinisch (USA)
2014-HT	Theory and Simulations of Nonlinear Wave-Particle Interactions in the Planetary Radiation Belts	Yoshiharu Omura (Japan)
2014-JT	Enabling Technologies for Modern Radio Astronomy	R.D. Ekers (Australia)
2014-KT	New Horizons in Bioelectromagnetics and Bioimaging	Shoogo Ueno (Japan)
2011-GL1	Recent Advances and Problems in Millimeter Wave Communications	Aldo Paraboni (Italy)
2011-GL2	The Radio Physics of Meteors: High Resolution Radar Methods Offering New Insights	Asta Pellinen-Wannberg (Sweden)
2011-GL3	Position, Navigation and Time via Global Positioning Systems	Per K. Enge (USA)
2011-PL	Lightning-induced Effects in the Ionosphere and the Radiation Belts	Umran S. Inan and Hamit Serbest (Turkey)
2011-AT	Single Electron Tunneling (SET)	Stephen Giblin (United Kingdom)
2011-BT	Passive and Active Metamaterial Constructs and Their Impact on Electrically Small Radiating and Scattering Systems	Richard W. Ziolkowski (USA)
2011-CT	Six-port Wave Correlator Theory and Practical Application to RF Network Analysis	Yoshiyuki Yakabe (Japan)
2011-DT	RFID Technology and Applications	Manos M. Tentzeris (USA)
2011-ET	EMC Measurements in the Time-Domain	Peter Russer (Germany)
2011-FT	Remote Sensing SAR Systems and Applications: Present and Future	Alberto Moreira (Germany)
2011-GT	Sprites and Energetic Radiation Above Thunderstorms	Martin Füllekrug (United Kingdom)
2011-HT	Major developments in our understanding of electric antennas in space plasmas	H. Gordon James (Canada)
2011-JT	Exploring the Epoch of Reionization with Low-Frequency Radio Telescopes	Aaron Parsons (USA)
2011-KT	??????????	Joachim Schüz (France)
2008-GL1	Microwave Imaging in Medicine: Promises and Future Challenges	Susan C. Hagness (USA)
2008-GL2	Pulsars, General Relativity and Gravitational Waves	Jim Cordes (USA)
2008-GL3	Wireless Communications: 2020	William Webb (United Kingdom)
2008-AT	From Nanoscience to Nanometrology and its Impact on Electrical Metrology	J.T.Janssen (United Kingdom)

Year-Commission T- Tutorial GL- General Lecture	Topic	Presenter
2008-BT	Negative-Refractive-Index Transmission-Line Metamaterials: Fundamentals and Applications	George Eleftheriades (Canada)
2008-CT	Cooperative Communications	M.Z. Win (USA)
2008-DT	Silicon nanophotonics	Michal Lipson (USA)
2008-ET	An Introduction to Reverberation Chambers	John Ladbury (USA)
2008-FT	Ground Penetrating Radar into real world	Motoyuki Sato (Japan)
2008-GT	Ionospheric Data Assimilation: Techniques and Performance	Brian Wilson (USA)
2008-HT	Wave Acceleration and Loss Processes in the Magnetosphere of Earth and Planets	R.M. Thorne (USA)
2008-JT	Phased Arrays in Radio Astronomy	Arnold van Ardenne (Netherlands)
2008-KT	Epidemiological Studies of the Association Between Handheld Cellular Telephone Use and Cancer Risk	D. Krewski (Canada)
2005-GL1	Metamaterials and plasmonic Phenomena	Nader Engheta (USA)
2005-GL2	Solar Power Satellite (SPS) for Sustainable Clean Energy Humanosphere	Hiroshi Matsumoto (Japan)
2005-GL3	Impacts of Extreme Solar Disturbances on the Earth's Near-Space Environment	Sunanda Basu (USA)
2005-AT	The role of plasmon-polaritons in the optical properties of thin metal films and nanostuctures	Christopher C. Davis (USA)
2005-BT	Advances in Computational Models for the Design of Planar and Compact Antennas	Juan R. Mosig and Anja K. Skrivervik (Switzerland)
2005-CT first part	Ultrawideband communications	R. Kohno (Japan)
2005-CT second part	Signal Processing for Analog Smart Antennas	Takashi Ohira (Japan)
2005-DT	Nanoelectronics	Paolo Lugli (Germany)
2005-ET	High power sources and intentional EMI: From the generation of HPEM to their use and consequences	Dave V. Giri (USA)
2005-FT	Spaceborne radar mapping of boreal forests	C. Schmullius (Germany)
2005-GT	Coherent Radar imaging	Ronald Woodman (Peru)
2005-HT	Tracking energetic phenomena in the solar corona and interplanetary space using radio observations	Jean-Louis Bougeret (France)
2005-JT	Low-Frequency Imaging	A. Pramesh Rao (India)
2005-KT	Assessment of health effects associated with EMF by WHO, IARC, and ICNIRP	P. Vecchia (Italy)
2002-GL1	Probing the Origin and Evolution of the Universe with the Cosmic Microwave background Radiation	John Carlstrom (USA)
2002-GL2	Health Effects of Electromagnetic Fields	Michael Repacholi (Switzerland)
2002-GL3	Synthesizing Optical Frequencies with a Femtosecond Laser	Theodor Haensch (Germany)
2002-AT	Cold Atom Clocks	Christophe Salomon (France)
2002-BT	Inverse Scattering and its Applications to Sub-Surface Sensing and Medical Imaging	Peter van den Berg (The Netherlands)
2002-CT	Spatial Channel Models for Mobile Communications	A. Molisch (USA)
2002-DT	Ultra-High Capacity Optical Fibre Communication	Satoki Kawanishi (Japan)
2002-ET	Electromagnetic Effects: Do We Know Everything?	Michel Ianoz (Switzerland)
2002-FT	Recent Development of Data Processing in Polarimetric and Interferometric SAR	Eric Pottier (France)
2002-GT	Ionospheric Irregularities	Jean-Pierre St.-Maurice (Canada)
2002-HT	Forced and/or Self-Organised Criticality in Space Plasma Processes	Tom Chang (USA)
2002-JT	Radio Astronomy on the Move Toward Microarcsecond Accuracy from Geodesy to Cosmology	Leonid Gurvits (The Netherlands) and James Campbell (Germany)
2002-KT	Magnetite Based Magneto Receptors	Joseph Kirschvink (USA)
1999-GL1	Engineering Issues in Space Weather	L.J. Lanzerotti, D.J. Thompson and C.G. Maclennan (USA)
1999-GL2	Space-to-Ground Interferometry for Radio Astronomy	
1999-GL3	Future Generations of Mobile Communications, the Scientific aspect	J. Bach Andersen (Denmark)
1999-AT	Electromagnetic Metrology Issues in Wireless Communications	Quirino Balzano (USA)
1999-BT	Electromagnetic System Design Using Genetic Algorithms	Eric Michielssen (USA)

Year-Commission T- Tutorial GL- General Lecture	Topic	Presenter
1999-CT	Intelligent Antennas for Future Wireless Cummunications	
1999-DT	High-Impedence Electromagnetic Surfaces	
1999-ET	ELF Sferics and Lightning Effects on the Middle and Upper Atmosphere	
1999-FT	Remote Characterization of Geophysical Phenomena Using EM Waves	D.T. Gjessing (Norway)
1999-GT	Radar Systems for Ionosheric Research	J. Roettger (Germany)
1999-HT	Wave Distribution Functions in Magnetospheric Physics	
1999-JT	Radio Stars : The High Sensitivity Frontier	
1999-KT	An Assessment of the Bioeffects Induced by Power-Line Frequency Electromagnetic Fields	Russel J. Reiter (USA)
1996-GL1	From Coherence to Confusion: a Conservative SAR View	R.K. Raney (USA)
1996-GL2	Non-Linear Physics and Chaos	W. Lauterborn (Germany)
1996-GL3	Lightwave Communications	M. Joindot (France)
1996-AT	Counting of Single Flux and Single Charge Quanta for Metrology	J. Niemeyer (Germany)
1996-BT	High Frequency Methods in Electromagnetics	R. Tiberio (Italy)
1996-CT	Communications by Means of Low Earth Orbiting Satellites	R.L. Pickholtz (USA)
1996-DT	optoelectronics Integration	H. Burkhard (Germany)
1996-ET	Topology-based Modelling of Very Large EM Systems	J.P. Parmentier and P. Degauque (France)
1996-FT	Impact of Numerical Methods on Propagation Modelling	K.H. Craig (United Kingdom)
1996-GT	The EquatorialIonosphere and Radio Communications	B.M. Reddy (India)
1996-HT	Radio Emission from Instabilities in Space Plasmas : Marginal Stability, Stochastic Growth and Fine Structures	D.B. Melrose (USA)
1996-JT	Cosmic Masers - a Useful Tool in Radio Astronmy	J.M. Moran (USA)
1996-KT	Personal Communication Services - Technology and Health Concerns - Is there a common solution?	M.A. Stuchly (Canada)
1993-GL1	Time and Frequency in Communications and Navigation Systems	J. McSteele (United Kingdom)
1993-GL2	New Development and Prospect of HDTV Satellite Broadcasting	T. Nishizawa (Japan)
1993-GL3	Radio and Radar Exploration from Space-craft : Highlights of Magellan at Venus	G. Pettengill (USA)
1993-AT	State of the art communication techniques : from radio-waves to optical fibres	S. Shimada (Japan)
1993-BT	Modern Concepts in Analysis, Synthesis and Measurements of Antennas	Yahya Rahmat-Samii (USA)
1993-CT	Overview of Mobile and Personal Communication	A. Viterbi (USA)
1993-DT	Optical Solitons : Physics and Applications for communications	A. Barthelemy (France)
1993-ET	Telecommunication at the Cross Road	D. Parlow (USA)
1993-FT	Results from Spaceborne Radars (ER-1, JER-1, Almaz)	E. Attema (Netherlands)
1993-GT	Ionospheric Modelling	D. Anderson (USA)
1993-HT	40 Years of Whistler Research	R.A. Helliwell (USA)
1993-JT	Charm of Radio Astronomy and its protection	M. Morimoto (Japan)
1993-KT	Electromagnetics in Biology and Medicine	W.R. Adey (USA)
1990-GL1	Electromagnetic Fields and the Essence of Living Systems	
1990-GL2	Scientific and Technological Research fro Manned Space Platforms	
1990-GL3	Revealing the Invisible Universe	
1990-AT	Electromagnetic Quantities; Units and Standards in a Changing SI	B. Kibble (United Kingdom)
1990-BT	Solution Techniques in Electromagnetic Field Problems	Staffan Ström (Sweden)
1990-CT	Non-Linear Networks and Chaos	L. Chua (USA)
1990-DT	New Bio-Information from Ultraweak Photon Emissopn in Life and Biological Activities	H. Inaba (Japan)

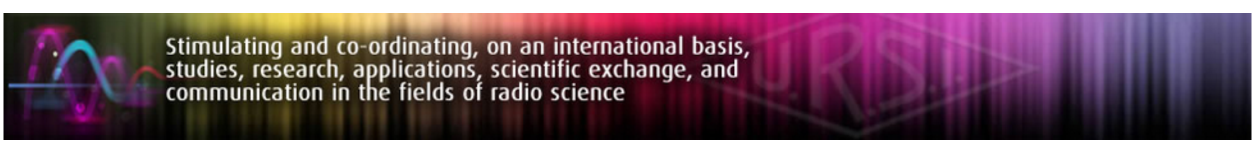
Year-Commission T- Tutorial GL- General Lecture	Topic	Presenter
1990-ET	What is the Scientific Approach to EMC Control and Vulnerability	C. Baum (USA)
1990-FT	Global Climate Change	G.R. North (USA)
1990-GT	The Ionosphere from Space	Pierre Bauer (France)
1990-HT	Simulation Technology for Plasma Wave Research	J.W. Eastwood (United Kingdom)
1990-JT	Polarization	V. Radhakrishnan (India)
1987-GL1	New Communication Networks	
1987-GL2	Digital Optical Techniques in Computing and Switching	
1987-GL3	The Encounters with Comet Halley, March 1986	
1987-AT	Laser Measurements 1968-1987 and Beyond	
1987-BT	Waves and Spectra: A Modern Perspective	L.B. Felsen (USA)
1987-CT	Queuing and Coding in Multi-User Communications : Ideas, Techniques, Theory	S. Csibi (Hungary)
1987-DT	Coherent Optical Fibre Communications	
1987-ET	Recent Research on Lightning	
1987-FT	Present and Future Research on Wave Propagation	
1987-GT	Aspects of Ionospheric Physics Relevant to Radio Propagation	
1987-HT	Present and Future Trends in Research in Waves in Plasmas	
1987-JT	Radio Astronomy - New Horizons	
1984-GL1	Very-Long Baseline Interferometry	R.T. Schilizzi
1984-GL2	Twenty years of Satellite Communication	J.V. Evans
1984-GL3	Solitons in Biology	A. Scott
1984-Open Symposium 1	Interaction of Electromagnetic Fields with Biological Systems	S. W. Rosenthal
1984-Open Symposium 2	Active Experiments in Space Plasmas	R.L. Dowden, J. Fejer, P. Stubbe
1984-Open Symposium 3	Radio Techniques in Planetary Exploration	K. Runcorn and W.J.G. Beynon
1984-Open Symposium 4	Data, Signal and Image Processing	J.L. Lacome, D. Jones, K. Tsuruda and R.H. Frater
1984-AT1	Frequency Standards	C. Audouin (France)
1984-AT2	Automatic Network Analyzers and Six-Port Systems	C.A. Hoer (USA)
1984-JT	Quasi-Optical Techniques at mm and sub-mm Wavelengths	P.F. Goldsmith

Workshop Announcements

High-Resolution Radio Interferometry in Space: Second International Meeting

Following the spectacular images from the Event Horizon Telescope and the successful Space VLBI missions HALCA and RadioAstron, there is growing interest in the next set of Space VLBI technical concepts, including next-generation constellations and millimeter-wavelength systems. This meeting is a second in a series of international meetings, the first of which was held at Noordwijk in 2018, <URL: https://www.ru.nl/astrophysics/@1164989/future-high-resolution-radio-interferometry-space/ >. The focus of this second meeting is to review black hole and other Space VLBI science cases, and begin to assess the maturity of the relevant technologies and needed technology developments and roadmaps.

Date: 2020 January 27–29 (TBC), Venue: NRAO, Charlottesville, VA



Union Radio-Scientifique Internationale — International Union of Radio Science — U.R.S.I.

Monthly Newsletter of International URSI Commission J – Radio Astronomy
October 2019

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 from the Chair!

- **PAPER SUBMISSION FOR THE 2020 URSI GASS IS NOW OPEN!!** Please consider presenting your work at the Scientific Symposium – the Commission J program is listed in the Newsletter. URSI GASS details may be found at https://www.ursi2020.org/

- The Chair of Commission A, Yasuhiro Koyama, brought to my attention the current situation within the ITU-R regarding a possible redefinition of Coordinated Universal Time (UTC). The Activities Spotlight this month is on this interesting but rather contentious topic. In 2015, the ITU-R decided to continue further discussions until 2023 by cooperating with other relevant organizations, including URSI. An official statement from URSI is planned. In preparation for this statement, I'd like to open this topic for discussion within our Newsletter.

- Consider highlighting your research in the Activities Spotlight section of our Newsletter. The topic, writing style, and length are totally up to you. I am quite flexible with regard to your busy calendar in scheduling deadlines. The Spotlight articles and Photo from the Field section keeps your Newsletter fresh and interesting each month. Consider this your platform to share thoughts, ideas, historical notes, research activities, updates, etc.

- Looking for a past issue of the "J" Newsletter? The Newsletters and other URSI Commission J documents are archived at http://www.ursi.org/commission.php?id=J#tab-section4 .

Submitted by R. Bradley

100 Years URSI
1919 U.R.S.I. 2019

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

Rome, Italy 29 August - 5 September 2020

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

Sessions:

J01: New Telescopes on the Frontier
Conveners: Nipanjana Patra, Jeff Wagg, Arnold van Ardenne

J02: Recent and Future Space Missions
Conveners: Joseph Lazio, Heino Falcke, Yuri Kovalev

J03: Single Dish Instruments
Conveners: Alex Kraus, Anish Roshi, Jin Chengjin

J04: Very Long Baseline Interferometry
Conveners: Francisco Colomer, Taehyun Jung, Chris Jacobs

J05: Millimeter/Submillimeter Arrays
Conveners: Sheng-Cai Shi, Raymond Blundell

J06: Antennas and Receivers: Simulation, Design and Calibration
Convener: Jacki Gilmore, Douglas Hayman, Pietro Bolii, David Davidson

J07: Digital Signal Processing: Algorithms and Platforms
Conveners: Grant Hampson, Albert-Jan Boonstra

J08: Short-Duration Transients, FRBs, and Pulsars: Observations, Techniques, and Instrumentation
Conveners: Jason Hessels

J09: The Impact of Radio Astronomy on Technology and Society
Conveners: Richard Schilizzi, Leonid Gurvits, Ken Kellermann, Richard Wielebinski

J10: Latest News and Observatory Reports
Conveners: Rich Bradley, Douglas Bock

J11: Big data: Algorithms and Platforms
Conveners: Stefan Wijnholds, Maxim Voronkov

Workshops and Shared Sessions

<u>Workshop</u>: Characterization and Mitigation of Radio Frequency Interference (Commissions JEFGH)
Conveners: Amit K. Mishra (F), David M. Levine (F), Frank Gronwald (E), Richard Bradley (J)

<u>Workshop</u>: Some aspects of radio science in space weather (Commissions GHJ)
Conveners: Iwona Stanislawska (G), Richard Fallows (J), Patricia Doherty (G), Mauro Messerotti (H/J), Baptiste Cecconi (H/J), Vivianne Pierard (H), Janos Lichtenberger (H), Willem Baan (J)

J-ITU: Next Generation Radio Astronomy Science and Technologies (Joint URSI/IAU Session)
Conveners: Anthony Beasley, Carole Jackson, Gabriele Giovannini, Melissa Soriano

Mutual benefit between radio astronomy and ionospheric science (Commissions JG)
Conveners: Claudio Cesaroni (G), Maaijke Mevius (J)

Spectrum Management (Commissions ECJ)
Conveners: Amir Zaghloul (C), Tasso Tzioumis (J), Jose Borrego (E)

Solar, Planetary, and Heliospheric Radio Emissions (Commissions HJ)
Conveners: Patrick Galopeau (H), G. Mann (H) and H.O. Rucker (H), Pietro Zucca (J)

The polar Environment and Geospace (Commissions GHJ)
Conveners: Lucilla Alfonsi (G), Nicolas Bergeot (G), Mark Cliverd (H), Stefan Lotz (H)

Activities Spotlight – Leap Seconds

The International Telecommunication Union – Radio Communications Sector (ITU-R) is pondering the current practice of adding Leap Seconds to UTC (its rate defined by International Atomic Time) to force congruence with UT1 to within 0.9 sec. Should this practice continue? What are the advantages and disadvantages of allowing them to drift apart? The ITU-R asked for input from various organizations, including URSI, on this rather contentious topic. Some background information is available in this 2016 article in Nature Physics: https://www.nature.com/articles/nphys3975 . Details of the ITU-R position may be found on pp. 357-359 of the Provisional Final Acts, World Radiocommunication Conference (WRC-15), reproduced at the end of this article for your reference. The complete document may be found at https://www.itu.int/dms_pub/itu-r/opb/act/R-ACT-WRC.11-2015-PDF-E.pdf

Last month, I posed the question to radioastronomy-hams@groups.io for an initial response. It generated some interesting comments and anecdotal stories highlighting both sides of the debate. As URSI begins drafting a response to the ITU-R request, input from Commission J is of utmost importance. Our Newsletter may be used to as forum for this discussion. To share your comments, suggestions, and stories with our readers please send them to me at rbradley@nrao.edu – they will appear in upcoming issues of the Newsletter. I'm looking forward to hearing from you.

Submitted by R. Bradley

[pp. 357-359 of the Provisional Final Acts, World Radiocommunication Conference (WRC-15)]

RESOLUTION COM5/1 (WRC-15)

Definition of time scale and dissemination of time signals via radiocommunication systems

The World Radiocommunication Conference (Geneva, 2015),

considering

a) that the ITU Radiocommunication Sector (ITU-R) is responsible for defining the standard frequency and time signal service and the standard frequency and time signal-satellite service for the dissemination of time signals via radiocommunication;

b) that the International Bureau of Weights and Measures (BIPM) is responsible for establishing and maintaining the second of the International System of Units (SI) and its dissemination through the reference time scale;

c) that the definition of reference time scale and dissemination of time signals via radiocommunication systems are important for applications and equipment that require a time traceable to the reference time,

considering further

a) that ITU-R is an organization member of the Consultative Committee for Time and Frequency (CCTF) and participates in the General Conference on Weights and Measures (CGPM) as an observer;

b) that BIPM is a Sector Member of ITU-R and participates in the relevant activities of ITU-R,

noting

a) that the international reference time scale is the legal basis for time-keeping for many countries, and de facto is the time-scale used in the majority of countries;

b) that disseminated time signals are used not only in telecommunications but also in many industries and practically all areas of human activities;

c) that time signals are disseminated by both wired communications covered by Recommendations of the ITU Telecommunication Standardization Sector (ITU-T) and by systems of different radiocommunication services (space and terrestrial), including the standard frequency and time signal service for which ITU-R is responsible,

recognizing

a) that No. 26.1 states that: “Attention should be given to the extension of this service to those areas of the world not adequately served”;

b) that No. 26.6 states that: “In selecting the technical characteristics of standard frequency and time signal transmissions, administrations shall be guided by the relevant ITU-R Recommendations”;

c) that the current definition of the international reference time scale UTC resulted from work completed in 1970 by the International Radio Consultative Committee (CCIR) of ITU, in full cooperation with CGPM;

d) that the ITU World Administrative Radio Conference 1979 (WARC-79) included UTC in the Radio Regulations, and since then UTC, as “strongly endorsed” in Resolution 5 of CGPM (1975), has been used as the main time scale for telecommunication networks (wired and wireless) and for other time-related applications and equipment,

resolves to invite the ITU Radiocommunication Sector

1) to strengthen the cooperation between ITU-R and BIPM, the International Committee for Weights and Measures (CIPM), CGPM, as well as other relevant organizations, and to carry out a dialogue concerning the expertise of each organization;

2) to further and more widely study in cooperation with the relevant international organizations, concerned industries and user groups, through the participation of the membership, the various aspects of current and potential future reference time scales, including their impacts and applications;

3) to provide advice on the content and structure of time signals to be disseminated by radiocommunication systems, using the combined expertise of the relevant organizations;

4) to prepare one or more reports containing the results of studies that should include one or more proposals to determine the reference time scale and address other issues mentioned in 1, 2 and 3 above,

resolves

that until WRC-23, UTC as described in Recommendation ITU-R TF.460-6 shall continue to apply, and for most practical purposes associated with the Radio Regulations, UTC is equivalent to mean solar time at the prime meridian (0° longitude), formerly expressed in GMT,

instructs the Director of the Radiocommunication Bureau

1) to invite the relevant international organizations such as the International Maritime Organization (IMO), the International Civil Aviation Organization (ICAO), CGPM, CIPM, BIPM, the International Earth Rotation and Reference Systems Service (IERS), the International Union of Geodesy and Geophysics (IUGG), the International Union of Radio Science (URSI), the International Organization for Standardization (ISO), the World Meteorological Organization (WMO) and the International Astronomical Union (IAU) to participate in the work mentioned in *resolves to invite the ITU Radiocommunication Sector*;

2) to report on the progress of this resolution to WRC-23,

invites the Director of the Telecommunication Development Bureau

to assist the participation of developing countries in meetings, within approved budgetary resources,

invites administrations

to participate in the studies by submitting contributions to ITU-R,

instructs the Secretary-General

to bring this resolution to the attention of IMO, ICAO, CGPM, CIPM, BIPM, IERS, IUGG, URSI, ISO, WMO and IAU.

Workshop Announcements

High-Resolution Radio Interferometry in Space: Second International Meeting

Following the spectacular images from the Event Horizon Telescope and the successful Space VLBI missions HALCA and RadioAstron, there is growing interest in the next set of Space VLBI technical concepts, including next-generation constellations and millimeter-wavelength systems. This meeting is a second in a series of international meetings, the first of which was held at Noordwijk in 2018, <URL: https://www.ru.nl/astrophysics/@1164989/future-high-resolution-radio-interferometry-space/ >. The focus of this second meeting is to review black hole and other Space VLBI science cases, and begin to assess the maturity of the relevant technologies and needed technology developments and roadmaps.

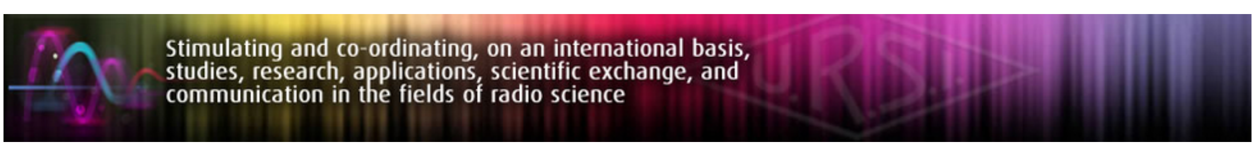
Date: 2020 January 27–29 (TBC), Venue: NRAO, Charlottesville, VA

Job Postings – Radio Astronomy and Related Fields

ASSISTANT PROFESSOR IN SPACE PHYSICS
School of Earth and Space Exploration
School of Mathematical and Statistical Sciences
Arizona State University

The School of Earth and Space Exploration (SESE) and the School of Mathematical and Statistical Sciences (SoMSS) at Arizona State University invite applications for a joint appointment as tenure-track Assistant Professor with expertise in space physics to begin August 2020. We encourage applications from a diverse range of candidates who approach space physics from varied perspectives, including theory, analysis, observation, and/or instrument development. Examples of research and teaching areas of interest include solar processes, space plasma physics, ionospheric dynamics, space weather and its impact on technological systems, or the general heliophysical environment and its response to solar events, as well as data analysis, computation, or engineering methods used to enable the study of space physics.

An essential characteristic of the academic environment at ASU is integration of research and teaching across traditional disciplinary boundaries. We seek someone who would be excited to catalyze research and educational collaborations with other faculty and groups. Existing areas of research emphasis at ASU that may present opportunities for collaboration include star-planet connections in exoplanetary systems, stellar models, planetary atmospheres and magnetism, ionospheric data modeling, resilient computing and microwave communications systems, and small satellite and instrument development. For more information, see http://apply.interfolio.com/68689



Monthly Newsletter of International URSI Commission J – Radio Astronomy

November 2019

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 from the Chair!

- **PAPER SUBMISSION FOR THE 2020 URSI GASS IS NOW OPEN!!** Present your work at the Scientific Symposium! Our Commission J program is listed in the Newsletter. URSI GASS details may be found at https://www.ursi2020.org/

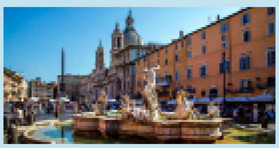
- There was an important email this month from URSI Secretary-General Peter Van Daele regarding a recent phishing attempt. The email is reproduced in the Newsletter to keep you informed.

- The Conference / Workshop section has been updated with new information.

- We need articles for the Activities Spotlight section of our Newsletter! The topic, writing style, and length are totally up to you. I am quite flexible with regard to your busy calendar in scheduling deadlines. The Spotlight articles and Photo from the Field section keeps your Newsletter fresh and interesting each month. Consider this your platform to share thoughts, ideas, historical notes, research activities, updates, etc. Commission J wants to hear from you!

- Looking for a past issue of the "J" Newsletter? The Newsletters and other URSI Commission J documents are archived at http://www.ursi.org/commission.php?id=J#tab-section4 .

Submitted by R. Bradley



The XXXIII General Assembly and Scientific Symposium (GASS) of the International Union of Radio Science (URSI) will be held at Sapienza University Campus.

The GASS of URSI are held at intervals of three years to review current research trends, present new discoveries and make plans for the future research and special projects in all areas of radio science.

We are looking forward to welcoming you in the eternal city for this unmissable appointment.

TOPICS

Commission A: Electromagnetic Metrology, Electromagnetic measurements and Standards

Commission B: Fields and Waves

Commission C: Radio-communication Systems and Signal Processing

Commission D : Electronics and Photonics

Commission E : Electromagnetic Noise and Interference

Commission F : Wave Propagation and Remote Sensing

Commission G : Ionospheric Radio and Propagation

Commission H : Waves in Plasmas

Commission J : Radio Astronomy

Commission K : Electromagnetics in Biology and Medicine

SUBMIT YOUR PAPER

SUBMIT YOUR ABSTRACT HERE!

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

Rome, Italy 29 August - 5 September 2020

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Workshop: Some aspects of radio science in space weather (Commissions GHJ)

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J-ITU: Next Generation Radio Astronomy Science and Technologies (Joint URSI/IAU Session)

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Spectrum Management (Commissions ECJ)

Conveners: Amir Zaghloul (C), Tasso Tzioumis (J), Jose Borrego (E)

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

Conveners: Patrick Galopeau (H), G. Mann (H) and H.O. Rucker (H), Pietro Zucca (J)

The polar Environment and Geospace (Commissions GHJ)

Conveners: Lucilla Alfonsi (G), Nicolas Bergeot (G), Mark Cliverd (H), Stefan Lotz (H)

Beware of Phishing !

Dear URSI Colleagues,

Some of you may recently have been the victim of phishing mails being sent to other URSI people asking for financial support.

We have to be vigilant. Please know that URSI members will never be asked for their personal details nor for financial support to one of the URSI Officials or events.

Although some of these mails can be very convincing, please know they are fake.

Please excuse us for this inconvenience. Unfortunately our IT-people cannot prevent such mails being sent.

With best regards,

Peter Van Daele

Prof. dr. Ir. Peter Van Daele
Secretary General
URSI – International Union of Radio Science
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Technologiepark-Zwijnaarde 126, B-9052 Ghent, Belgium
T: +32 9 264 33 20
W: www.ursi.org

Workshop / Meeting Announcements

EVENT OVERVIEW

Multiple space missions have demonstrated the potential for extremely high angular resolution observations, achieving interferometric baselines longer than the diameter of the Earth. New scientific results at millimeter wavelengths, from ALMA and the Event Horizon Telescope (EHT), suggest the possibility for obtaining even higher angular resolutions. This second meeting in The Future of High-Resolution Radio Interferometry in Space series will focus on mission concepts and supporting technology developments to enable the highest angular resolution observations at centimeter and shorter wavelengths (30+ GHz observing frequencies). The meeting will highlight recent scientific advances and developments in the motivations for future space-based very long baseline interferometry and the resulting technical requirements and challenges, building upon the foundation provided by the first meeting in the series: The Future of High-Resolution Radio Interferometry in Space.

Of particular interest are contributions in areas such as

- Science at extremely high angular resolutions (e.g., population studies of black holes, jets and accretion studies at all scales, GR testing and black hole physics);
- Apertures --- size and performance for space apertures;
- Receiver and detector technology status and performance;
- Data volume and transport;
- Clocks and synchronization;
- Orbital dynamics and u-v plane coverage;
- Orbit determination;
- Data processing (in-space vs. ground) for correlation and analysis;
- VLBI simulations for science cases;
- Optimization for mission concepts; and
- Concepts (particularly one large aperture vs. many small apertures in space).

There is also interest in exploring the opportunities made available by recent innovations for very long baseline interferometry and in space missions. Significant time will be made available for discussions, including on synergies with other upcoming facilities.

CONFERENCE DATES AND DEADLINES

Registration and Abstract Submission Opens	Oct 12, 2019
Travel Visa Letter Request Deadline	Nov 20, 2019 (on going, please submit your requests as soon as possible)
Abstract Submission Deadline (Oral)	Nov 22, 2019
Final Program Announced	Dec 13, 2019
Hotel Reservation Deadline	Jan 8, 2020
Registration Deadline	Jan 8, 2020
Abstract Submission Deadline (Poster)	Jan 8, 2020
Conference Begins	Jan 28, 2020

REGISTRATION AND ABSTRACT SUBMISSIONS ARE OPEN

For more information, go to https://go.nrao.edu/SpaceVLBI2020

The ALMA2030 Vision: Design considerations for the Next ALMA Correlator

A meeting to discuss considerations for the design of the next ALMA correlator will be held in Charlottesville, Virginia February 11-13, 2020

The purpose of this meeting is to bring together experts on the ALMA system and modern digital correlator design in order to (1) discuss ALMA design requirements for the next generation ALMA correlator that enables the ALMA2030 vision; (2) share pros and cons of recent and currently under design correlator architectures; and (3) identify challenges for implementing and deploying a new ALMA correlator. Ultimately we hope this meeting encourages and informs the submission of viable designs for the next ALMA correlator in the near future.

Registration and abstract submission opens November 12, 2019: http://go.nrao.edu/NextALMACorrelator

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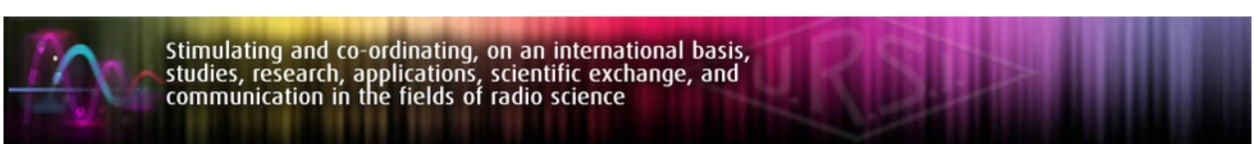
Job Postings – Radio Astronomy and Related Fields

ASSISTANT PROFESSOR IN SPACE PHYSICS
School of Earth and Space Exploration
School of Mathematical and Statistical Sciences
Arizona State University

The School of Earth and Space Exploration (SESE) and the School of Mathematical and Statistical Sciences (SoMSS) at Arizona State University invite applications for a joint appointment as tenure-track Assistant Professor with expertise in space physics to begin August 2020. We encourage applications from a diverse range of candidates who approach space physics from varied perspectives, including theory, analysis, observation, and/or instrument development. Examples of research and teaching areas of interest include solar processes, space plasma physics, ionospheric dynamics, space weather and its impact on technological systems, or the general heliophysical environment and its response to solar events, as well as data analysis, computation, or engineering methods used to enable the study of space physics.

An essential characteristic of the academic environment at ASU is integration of research and teaching across traditional disciplinary boundaries. We seek someone who would be excited to catalyze research and educational collaborations with other faculty and groups. Existing areas of research emphasis at ASU that may present opportunities for collaboration include star-planet connections in exoplanetary systems, stellar models, planetary atmospheres and magnetism, ionospheric data modeling, resilient computing and microwave communications systems, and small satellite and instrument development. For more information, see http://apply.interfolio.com/68689



Union Radio-Scientifique Internationale — International Union of Radio Science

U.R.S.I.

Monthly Newsletter of International URSI Commission J – Radio Astronomy

December 2019

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 from the Chair!

- **PAPER SUBMISSION FOR THE 2020 URSI GASS IS NOW OPEN!!** Present your work at the Scientific Symposium! Our Commission J program is listed in the Newsletter. URSI GASS details may be found at https://www.ursi2020.org/

- **Nominations for Commission J Vice-Chair and Early Career Representative (ECR) will open on January 1, 2020.** I will send out an official invitation mailing within a few days that provides additional information and a nomination form. Nominations must be received by me no later than March 1, 2020.

- Our Activities Spotlight this month is about the the 38th World Radiocommunication Conference WRC-19 that recently ran its 4-week course in Sharm El-Sheik (Egypt). Harvey Liszt, NRAO Spectrum Manager and Chair, IUCAF, summarizes the event and its impact on the radio astronomy community. Thank you, Harvey, for this important contribution to our Newsletter.

- There is a change in the Norwegian Committee of URSI Commission J. Associate Prof. Claudia Cicone is replacing Prof. Per Lilje. On behalf of Commission J, I thank Prof. Per Lilje for his service to URSI, and welcome Prof. Claudia Cicone of the University of Oslo's Institute of Theoretical Astrophysics.

- Looking for a past issue of the "J" Newsletter? The Newsletters and other URSI Commission J documents are archived at http://www.ursi.org/commission.php?id=J#tab-section4 .

100 Years URSI

1919 U.R.S.I. 2019

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

Rome, Italy 29 August - 5 September 2020

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

Sessions:

J01: New Telescopes on the Frontier

Conveners: Nipanjana Patra, Jeff Wagg, Arnold van Ardenne, Pietro Bolli

J02: Recent and Future Space Missions

Conveners: Joseph Lazio, Heino Falcke, Yuri Kovalev

J03: Single Dish Instruments

Conveners: Alex Kraus, Anish Roshi, Jin Chengjin

J04: Very Long Baseline Interferometry

Conveners: Francisco Colomer, Taehyun Jung, Chris Jacobs, Tiziana Venturi

J05: Millimeter/Submillimeter Arrays

Conveners: Sheng-Cai Shi, Raymond Blundell

J06: Antennas and Receivers: Simulation, Design and Calibration

Convener: Jacki Gilmore, Douglas Hayman, Pietro Bolli, David Davidson

J07: Digital Signal Processing: Algorithms and Platforms

Conveners: Grant Hampson, Albert-Jan Boonstra

J08: Short-Duration Transients, FRBs, and Pulsars: Observations, Techniques, and Instrumentation

Conveners: Jason Hessels

J09: The Impact of Radio Astronomy on Technology and Society

Conveners: Richard Schilizzi, Leonid Gurvits, Ken Kellermann, Richard Wielebinski

J10: Latest News and Observatory Reports

Conveners: Rich Bradley, Douglas Bock

J11: Big data: Algorithms and Platforms

Conveners: Stefan Wijnholds, Maxim Voronkov, Urvashi Rau

Workshops and Shared Sessions

<u>Workshop</u>: Characterization and Mitigation of Radio Frequency Interference (Commissions JEFGH)

Conveners: Amit K. Mishra (F), David M. Levine (F), Frank Gronwald (E), Richard Bradley (J)

<u>Workshop</u>: Some aspects of radio science in space weather (Commissions GHJ)

Conveners: Iwona Stanislawska (G), Richard Fallows (J), Patricia Doherty (G), Mauro Messerotti (H/J), Baptiste Cecconi (H/J), Vivianne Pierard (H), Janos Lichtenberger (H), Willem Baan (J)

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WRC-19 and WRC-23: What happened?

Harvey Liszt

NRAO Spectrum Manager and Chair, IUCAF

The 38th World Radiocommunication Conference WRC-19 recently ran its 4-week course during the period 10/28/2019 - 11/22/2019 in Sharm El-Sheik (Egypt), with broad implications for radiocommunications and radio astronomy in the coming years. Moreover, the Agenda for WRC-23 was adopted and its details were fixed at the 1st Conference Preparatory Meeting just after.

WRC-19 was attended by 3400 participants from the ITU's 193 member administrations and affiliated Sector Members (like IUCAF). Among them were a handful of astronomers and engineers representing radio astronomy on behalf of IUCAF, CRAF and SKA, in addition to the slightly larger group who participated as national delegates from Australia, China, Japan and the US. It was the culmination of four years of work to update and amend the ITU-R Radio Regulations (RR), an international treaty having the force of law among the administrations that participate in the work and sign and nationally adopt the treaty. On the last day of WRC-19 the Provisional Final Acts were signed, implementing changes to the Radio Regulations in the presence of the Egyptian ruler Abdel Fattah el-Sisi. The final Final Acts will be incorporated into the Radio Regulations and published with final editorial adjustments in 2020.

The Radio Regulations have five weighty volumes whose practical concerns are most probably found in Volume 5 that contains the international table of frequency allocations and the footnotes describing use of the frequency allocations in the table. But even Volume 1 rewards close reading with such gems as the (fundamental) definition of terrestrial radiocommunications in Article *1.7: Any radiocommunication other than space radiocommunication or radio astronomy*. This highlights the special place that the radio astronomy service (RAS) holds as an entity apart from, but required to co-exist with, other uses of the radio spectrum.

The WRC-19 Agenda covered a multitude of sins, here is a survey.

I. Three astronomical maser lines, five Agenda Items -- 1.6, 1.8, 1.13, 1.14 and AI 1.2 (WRC-23)

Radio astronomy has maser lines of paramount importance at 1612 MHz (OH, hydroxyl), 6.67 GHz (CH_3OH, methanol) and 43 GHz (SiO), and the use of all are under extreme pressure.

a) 1612 MHz OH (Agenda Item 1.8)

Since 1978, the spectrum band allocated to radio astronomy at 1610.6 – 1613.8 MHz has successively received withering interference from GPS, GLONASS, and (since 1998) the Iridium satellite phone system known at ITU-R as HIBLEO-2, operating at 1617.775 – 1626.5 MHz in the mobile-satellite service (MSS) and maritime mobile-satellite service (MMSS) under the authority of the US. Interference from Iridium is caused by a combination of inadequate filtering and overdriving of the amplifiers, producing a smooth roll-off and occasional discrete 5^{th}- and 7^{th}-order IM products in the RAS band. This interference increases as the Iridium operating bandwidth widens to include spectrum below 1621.35 MHz but recent spectra taken in Australia, US (VLA and GBT), South Africa (Meerkat), France (Nançay) and Germany (Leeheim) all showed that Iridium habitually illuminates radio observatories with its full allowed operating range down to 1618 MHz, virtually guaranteeing that it wipes out the RAS band. Nevertheless, the Iridium constellation was recently replaced and is now required by the US to operate on a non-interfering basis under international footnote RR. 5.372.

At WRC-19, actions were taken under Agenda Item 1.8 to allow Iridium to operate in the Global Maritime Distress and Safety System (GMDSS), providing safety of life service including in polar regions that are not serviced by an existing GSO GMDSS satellite system. A new primary MMSS (space-Earth) allocation was created at 1621.35 – 1626.5 MHz, additional restrictions were incorporated in the protective footnote 5.372 (including a rare explicit mention of Rec. RA. 769 that contains the most fundamental RAS interference protection thresholds), and a loophole around the requirements in RR. 5.372 was removed from another part of the RR, Resolution 739.

It is now up to the radio astronomy community to organize a response in light of the outcomes at WRC-19 and the strictures most recently placed on Iridium operations by the US, requiring it to operate on a non-interference basis. At the moment the 1612 MHz OH band cannot be usefully observed at singledish telescopes whose standard calibration and pipeline data reduction procedures are disturbed by the presence, in the nearby passband, of Iridium's rapidly varying in-band signals at 1618 – 1626.5 MHz that appear in astronomical spectra with strengths measured in thousands, or hundreds of thousands of Jy as received in low-gain sidelobes far from the main lobe, averaged over periods of hundreds of seconds.

b) The SiO maser band at 42.5 – 43.5 GHz (Agenda Items 1.6 and 1.13)

The spectrum band at 42.5 – 43.5 GHz is allocated to radio astronomy on a primary basis to observe the J=1-0 SiO maser lines. The band is shared with fixed, fixed-satellite (Earth-space) and the mobile (except aeronautical mobile) service (5G!) and the bands immediately above and below have, inter alia, primary fixed- and/or mobile-satellite downlink allocations. If these services begin to operate the radio astronomy band could suffer serious interference, but even if it remains clean, mindful of the present situation with Iridium, observations will have to be conducted in the presence of rapidly time-varying signals 60 – 120 dB above the radio astronomy detection limit in adjacent and nearby spectrum.

Work performed under Agenda Item 1.6 studied the compatibility of non-GSO operations at 37 – 42.5 GHz in bands where GSO operations are now conducted. Radio astronomy was not directly engaged in this issue because the radio astronomy band is strongly protected by footnotes 5.551H and 5.551I limiting interference from GSO and non-GSO fixed-satellite downlinks at 41 – 42.5 GHz although the limit for GSO satellites was wrongly copied into the footnote long ago, cannot be easily corrected now, and is 15 dB too permissive. A strip +/-19° wide about the GSO belt cannot be observed with full sensitivity owing to this error, as opposed to a +/-5° wide strip if it were correct. In any case, V-band non-GSO constellations were so poorly defined that realistic RAS compatibility studies could not be conducted and no aggregation of GSO and non-GSO operations was contemplated.

There was some hope that AI 1.6 would culminate only in further study. This did not turn out to be the case, and AI 1.6 was really a wakeup call to observe the SiO masers as much as possible while the spectrum around 43 GHz is still relatively unmarked. More serious consequences were found for remote sensing, the Earth-exploration Satellite Service (EESS) (passive). Studies found that interference from the existing GSO uses was much higher than was understood ten years ago when last studied, so that no additional interference from non-GSO uses could be tolerated without putting correspondingly stronger limits on GSO uses. The GSO community balked at such an imposition on their operation and limits were set only on new non-GSO use.

As noted, the RAS band is shared internationally with the mobile service and (see below) AI 1.13 identified it for use by 5G. This implies that the band will only be usable inside well-defined radio quiet and coordination zones in administrations that follow the international table. At the moment, the US does not follow the international table in this regard, allocating the 42.5 – 43.5 GHz band exclusively to radio astronomy for non-Federal use. A rulemaking to align the US and international tables seems likely in the near future.

c) The 6.675 GHz Methanol maser (AI 1.14 and 1.2 (WRC-23))

There are no meaningful protections for this line whose use we presently enjoy while the nearby spectrum is relatively unused. This will change. AI 1.14 narrowly missed allocating the surrounding spectrum for High Altitude Platform Systems (HAPS; see below) but the same spectrum is being hungrily eyed by RLAN and 5G. The spectrum at 5.8 – 7.2 GHz is the subject of intense interest now (the frequency band 5.9 – 8.5 GHz is already allocated to the mobile service) and AI 1.2 (WRC-23) will likely identify the methanol line frequency for worldwide harmonized IMT use unless that conflicts with something else that would be equally problematic for RAS.

2. HAPS -- AI 1.14

The idea here is that platforms circulating vertically and orbiting horizontally about a nominal position at 20 km elevation (visible above the horizon for 510 km!) serve as communication hubs. Such systems have been discussed at ITU-R for more than 30 years and none have been deployed. Their current spectrum use is limited to a country footnote identifying spectrum around 48 GHz for use by HAPS in a few administrations (but including Australia that pushed this idea at WRC-12).

Following a big push by Facebook, Alphabet, Airbus, Boeing and other commercial enterprises, spectrum for HAPS use was to be identified within existing fixed service allocations at WRC-19 but final actions taken under AI 1.14 created new allocations at 22 and 24.25-25.25 GHz in ITU-R Region 2 (the Americas). The final band list includes identifications at or near 6.5, 22, 24-28, 30-31, 38 and 48 GHz. HAPS hit the spectrum jackpot: AI 1.14 was every bit as complex as the IMT AI 1.13 and, until the very last moments, was completed without any of the fuss associated with the burgeoning 5G industry.

For radio astronomy, the compatibility studies considered a full build-out of HAPS in which case about 80 platforms would be visible above the horizon. To achieve 2% data loss to RAS, a cone of avoidance of angular radius 3° was imagined around each HAPS such that the total solid angle of all cones of avoidance comprised 2% of the visible sky. In order to make this possible, each HAPS must limit its unwanted emissions into the corresponding RAS band to a level 30 dB below that given in ITU-R Rec. RA. 769, which was a serious concession on the part of the HAPS proponents. The studies somewhat underestimated the data loss because the orbital radius of 5 km and altitude variation from 18 – 26 km of an actual system were ignored, but this was compensated by considering a full buildout of 80 HAPS in every case.

Although the cones of avoidance can be understood as mathematical devices needed only to calculate a limit for the pfd of HAPS unwanted emissions in the direction of a radio astronomy station (the limit 30 dB below RA. 769), a radio telescope would probably need to include the cones of avoidance in its operations, a real nightmare. The unwanted emissions into the nearby RAS band used for compatibility studies are 60 dB below the service levels of the HAPS inband signals after filtering, and the 3°-radius cone of avoidance about each HAPS corresponds to an RAS gain that is 50 or more dB below the peak gain of a typical RAS antenna. Hence the HAPS inband signals would always be present at levels at 60-100 dB above the RAS detection limit.

The rules for HAPS operation put a premium on notification of RAS sites in the Master International Frequency Register (MIFR). HAPS operations are required to protect RAS instruments in service before May 2020, or before the date of notification of the HAPS operation. Unregistered RAS sites will not be protected from HAPS except accidentally or by special arrangement. Distributed systems occupying many discrete sites must be registered as soon as possible to be protected.

3) Spectrum above 275 GHz -- AI. 1.15

Land mobile and fixed-service uses were studied in the frequency range 275 – 450 GHz that is not yet allocated to radio services. Hold your phone against the kiosk and download a movie in 5 seconds (LM use). Use 50 GHz bandwidths for 5G front- and backhaul (FS). Bands in the frequency range 275 – 1000 GHz identified (but not reserved) for passive science use are given in footnote No. 5.565 (WRC-12). For RAS they correspond to the various atmospheric windows

Compatibility studies identified a band segmentation that would allow LM and FS use without regulatory constraints while protecting EESS (passive) use, and this band segmentation was written into a new footnote to the frequency allocation table. Studies identified various measures that LM and FS might take take to achieve compatibility with RAS and the conditions necessary for compatibility with RAS and EESS (passive) were specified in principle by modifying an existing Resolution 731 referring to spectrum use above 71 GHz.

AI 1.15 (WRC-19) was a harbinger of things to come. An item tentatively on the WRC-27 agenda concerns radiolocation in the range 231.5 – 700 GHz, for high precision ranging at distances up to 300m.

4) IMT -- AI 1.13

This was the 5G agenda item, for the purpose of identifying (mostly) and allocating (as appropriate) mobile service spectrum for worldwide harmonized use by 5G at frequencies in portions of the frequency range 24 – 86 GHz. The corresponding AI at WRC-15 concerned spectrum up to 6 GHz, and identified spectrum for IMT up to about 4 GHz, and AI 1.2 (WRC-23) will concern itself with C-, X- and Ku band spectrum.

The frequency ranges identified for harmonized global use by IMT at WRC-19 were 24.25-27.5 GHz, 37-43.5 GHz (with notes indicating that existing FS uses will put pressure to deploy IMT only in very upper portions of the range) and 66-71 GHz In Regions 1 and 3 and Brazil. A new allocation at 31.8 – 33.4 GHz was found to be incompatible with existing FS use but may still be considered in the US where NRAO and T-Mobile argued back and forth over this two years ago. Studies conducted during the WRC cycle by CRAF and presented by CRAF and IUCAF showed that separation distances of, typically, 50 km, were required between 5G and RAS operations. The study results were contingent on assumptions regarding unwanted emissions levels that were not made concrete until the final moments of the WRC.

There was much consternation over this AI, even though the US and Central Europe (CEPT) had already acted to allocate spectrum for mobile use in the same frequency range two years ago, in an effort to influence the outcome at WRC-19. The big news was that mandatory unwanted emission limits for IMT equipment operating at 24.25-25.25 GHz were only specified at levels 10-15 dB above what is needed to protect EESS (passive) operations in the frequency band at 23.6 – 24 GHz (shared with RAS) that has contributed most of the improvement in short and medium-range weather forecasting in the last 30 years. The interference from 5G could roll back these gains, a very bad outcome considering the increasing impact of extreme weather.

5. Miscellaneous

There was a nice outcome in AI 1.9.2 whereby RAS bands at 150.05-153 MHz, and 322-328.6 MHz received protection in Res. 739 from marine applications near the lower RAS band. Including the harmonically-related RAS DI band was something of an innovation. In the process, footnote RR. 5.208A was reworded in a more streamlined form that explicitly cites Rec. RA.769, a relative rarity in the Radio Regs.

AI 1.7 was concerned with finding spectrum for links to/from short-duration missions, ie, CubeSats. The new downlink at 137-138 MHz was a good outcome, being well-separated from the RAS allocation at

150.05-153 MHz, but RAS protection probably did not receive adequate recognition in the outcome for the new Earth-space link at 148 – 149.9 MHz. Studies had indicated the need for significant physical separation distances and a 1.5 MHz frequency separation with RAS bands that were not reflected in the outcome so it will be up to national regulators to figure this out for themselves.

RAS had contributed to studies for AI 1.9.1 (160 MHz maritime AMRD) and 9.1.9 (new primary allocations to the FSS in the frequency band 51.4-52.4 GHz (Earth-to-space)) but did not follow up at the WRC. Considerations for AI 1.6 and 9.1.9 highlighted the fact that some passive service bands in the range 50-54 GHz do not include RAS even though ALMA will observe in Band 1 up to 52 GHz and the ALMA radio quiet zone only grants full protection in spectrum bands that are allocated to RAS on a primary basis. In any case, this spurred an effort during the WRC cycle to register ALMA in the MIFR in the bands above 50 GHz that had not been done before.

It is too arcane a matter to merit a full discussion here, but Japan introduced a proposal to reword Article 4.6 of the RR, whose 2nd sentence in the English language version is sometimes cited by active services to imply (in contradiction to RR 29.8) that RAS does not enjoy the full extent of spectrum protections that are afforded by the primary status of many of its frequency allocations. Japan's specific proposal was openly supported by a handful of administrations, but defeated after adamant opposition and some finger-pointing from the US. However, the proposal from Japan was sufficient to demonstrate an obvious discrepancy with the official (French) version, and a new translation of the French version of RR 4.6 into English will appear in the 2020 edition of the RR. This may resolve the issue to the satisfaction of RAS.

6. WRC-23

In the absence of more specifics the Agenda for WRC-23 does not seem to be as broadly concerning for RAS as were other recent WRCs. For sure there is the IMT AI 1.2 to identify C, X, and Ku band spectrum that will likely identify the 6.67 GHz methanol line frequency for IMT: In the absence of an allocation to RAS there will be little or no opportunity to influence the outcome and in any case the spectrum at 5950 – 8500 MHz is already allocated to the mobile service. Other AI will consider spectrum use by sub-orbital vehicles in FSS bands and inter-satellite links in MSS bands. A particularly noxious Agenda Item will consider "HIBS" (IMT base stations on HAPS) but not at frequencies that directly threaten any nearby RAS allocations. Earth stations in motion (aka ESIMs) are a coming thing, as everything that now transmits from fixed locations on the ground will transmit from fixed locations inside anything that moves above the surface of the Earth. Another AI concerns a possible rearrangement of spectrum allocated to EESS (passive) above 231.5 GHz, in bands mostly shared with RAS.

7. A few concluding words and some references

The current press has been very concerned with the impending launch of thousands or tens of thousands of non-GSO radiocommunication satellites in Low Earth Orbit (LEO) and their effect on the appearance of the night sky with ramifications for wide-field synoptic astronomy that scans the sky every night. No one can really say where the human race will find peace when the night sky is crawling with bright moving points of light all the time. Less noticed but not uniquely affective is, for instance, the impact of the ongoing launch of commercial fleets of dozens of orbiting high-power synthetic aperture C- and X-band radars of the sort that national space agencies used to announce as individual flagship missions. Any of these could burn out a radio astronomy receiver if viewed with too much RAS gain and none are constrained to avoid illuminating RAS sites except under very narrow circumstances.

The asymptotic state of spectrum use is that the sky will generally be bright at all frequencies that do not impair terrestrial radio services and the ground will be noisy at all places and frequencies that do not disrupt space communications or cause things (including drones and ESIM) to drop out of the sky. Partial exceptions will be the small percentage of the spectrum that is devoted to passive services, and the physical radio quiet and coordination zones around radio observatories. Even so, radio astronomy will have to learn how to detect weak cosmic signals amid the increasingly crowded and noisy spectrum environment.

Our ability to use the electromagnetic spectrum for scientific purposes is being eroded at a quickening pace. In the absence of specific policies that establish values and priorities for scientific use on a par with commercial exploitation we cannot expect it to persist indefinitely.

The ITU-R (https://www.itu.int/en/ITU-R/Pages/default.aspx) makes many of its publications freely available, including the Radio Regulations and the ITU-R Reports and Recommendations that are linked under the “publications” menu item on the ITU-R main page.

Contributed by Harvey Liszt

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Registration Deadline	Jan 8, 2020
Abstract Submission Deadline (Poster)	Jan 8, 2020
Conference Begins	Jan 28, 2020

REGISTRATION AND ABSTRACT SUBMISSIONS ARE OPEN

For more information, go to https://go.nrao.edu/SpaceVLBI2020

The ALMA2030 Vision: Design considerations for the Next ALMA Correlator

A meeting to discuss considerations for the design of the next ALMA correlator will be held in Charlottesville, Virginia February 11-13, 2020

The purpose of this meeting is to bring together experts on the ALMA system and modern digital correlator design in order to (1) discuss ALMA design requirements for the next generation ALMA correlator that enables the ALMA2030 vision; (2) share pros and cons of recent and currently under design correlator architectures; and (3) identify challenges for implementing and deploying a new ALMA correlator. Ultimately we hope this meeting encourages and informs the submission of viable designs for the next ALMA correlator in the near future.

Registration and abstract submission opens November 12, 2019: http://go.nrao.edu/NextALMACorrelator

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Job Postings – Radio Astronomy and Related Fields

Traineeships in science operations with massive arrays

The Netherlands Institute for Radio Astronomy (ASTRON) and the Joint Institute for VLBI ERIC (JIVE) announce the availability of a minimum of two grants for their Traineeship in Science Operations with massive arrays. The programme enables astronomers (post doc, PhD or graduate student level) to spend a trimester (12 weeks) at the institute in Dwingeloo in the Netherlands. Under the supervision of Telescope Scientists, you will be exposed to the science operations of massive arrays. You will develop fundamental skills and novel experimental methods on systems using technologies that produce cutting-edge science now and contribute to the development of the SKA. ASTRON & JIVE are committed to increasing their staff diversity, and we are especially interested in applications from all traditionally under-represented groups. The submission deadline is 15 January 2020.

For more information, see http://www.werkenbijastron.nl/en/vacatures/traineeships-in-science-operations-with-massive-arrays-2/

ASSISTANT PROFESSOR IN SPACE PHYSICS

School of Earth and Space Exploration
School of Mathematical and Statistical Sciences
Arizona State University

The School of Earth and Space Exploration (SESE) and the School of Mathematical and Statistical Sciences (SoMSS) at Arizona State University invite applications for a joint appointment as tenure-track Assistant Professor with expertise in space physics to begin August 2020. We encourage applications from a diverse range of candidates who approach space physics from varied perspectives, including theory, analysis, observation, and/or instrument development. Examples of research and teaching areas of interest include solar processes, space plasma physics, ionospheric dynamics, space weather and its impact on technological systems, or the general heliophysical environment and its response to solar events, as well as data analysis, computation, or engineering methods used to enable the study of space physics.

An essential characteristic of the academic environment at ASU is integration of research and teaching across traditional disciplinary boundaries. We seek someone who would be excited to catalyze research and educational collaborations with other faculty and groups. Existing areas of research emphasis at ASU that may present opportunities for collaboration include star-planet connections in exoplanetary systems, stellar models, planetary atmospheres and magnetism, ionospheric data modeling, resilient computing and microwave communications systems, and small satellite and instrument development.

For more information, see http://apply.interfolio.com/68689