Union Radio-Scientifique Internationale — International Union of Radio Science

Monthly Newsletter of International URSI Commission J – Radio Astronomy

October 2018

Officers

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

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News Items

Greetings Commission J Members!

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

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

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

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

Submitted by R. Bradley

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

9 -15 March 2019, New Delhi, India

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

JOS: Any Other Aspect of Radio Astronomy

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

Rome, Italy

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

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

Sessions:

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

Workshops:

Space Weather (Commissions GHJ)

Meeting and Workshop Announcements

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

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

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

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

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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

Experience with Student-Constructed Telescopes for Radio Astronomy

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

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

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

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

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

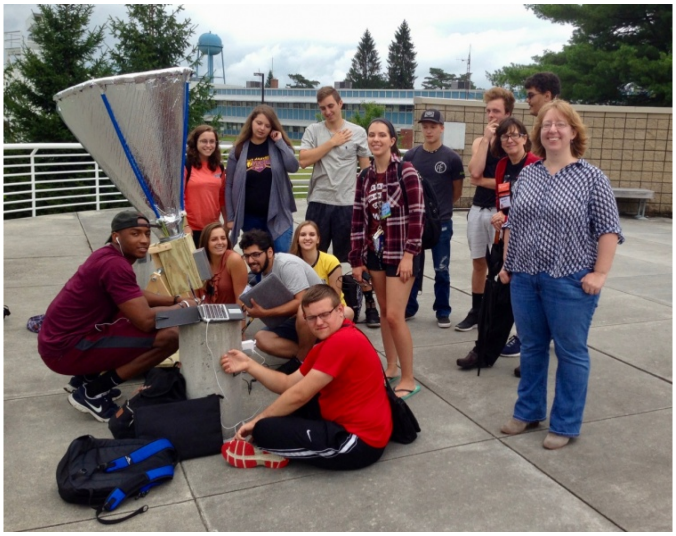

Figure 1: West Virginia University students, and several co-authors, with their student-built radio telescope, named Alexander, in operation at the Green Bank Observatory (GBO) in West Virginia. The horn-shaped telescope was constructed from bubble wrap, and other commercially available parts and electronics.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

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

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

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

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

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

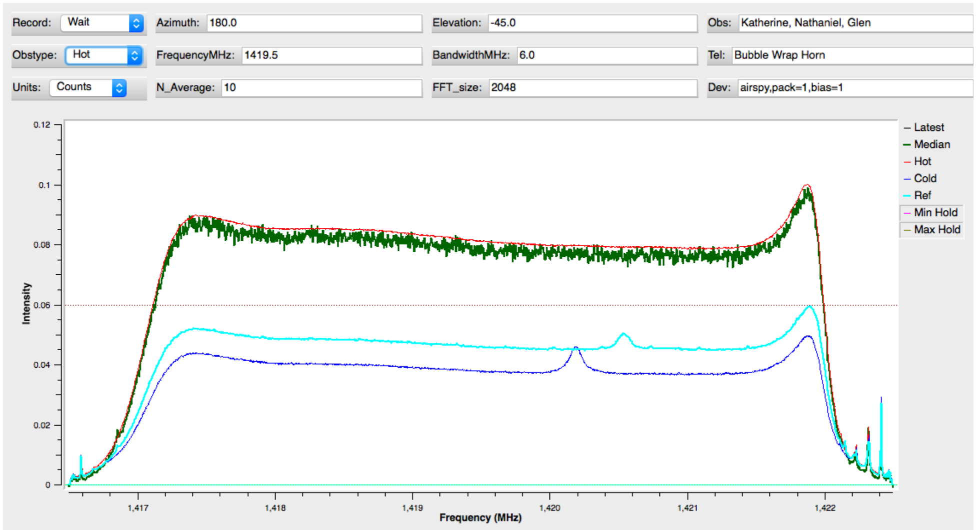

Figure 2: Plot of Raw Intensity (counts) versus Frequency in MHz for spectra selected using the RA_Integrate block. The RA_Integrate block is used to confirm proper operation of the telescope. The observer inputs the direction the telescope is pointing and frequency setup information. The plots show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

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

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

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

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

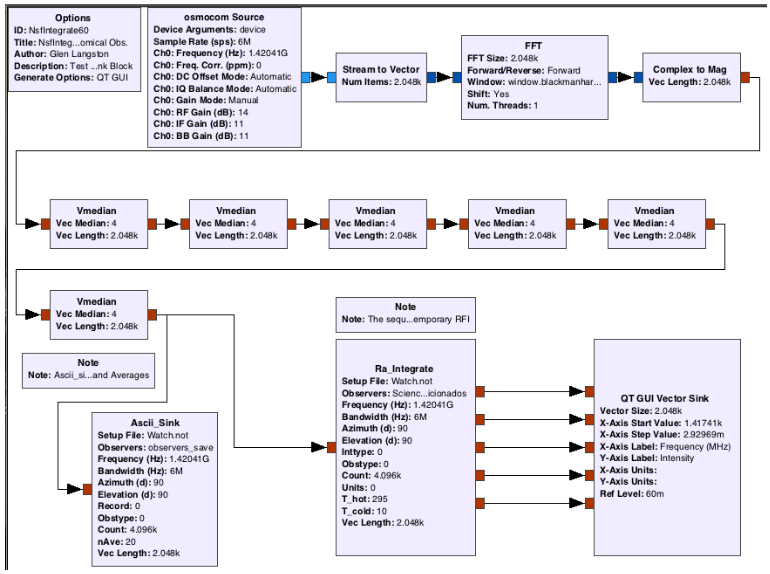

Figure 3: GRC visual program for Radio Telescope Observations. The data flow is simple, from the OSMOSDR source, on the top left, through a block to create a complex vector and a Fourier Transform. The data rate is reduced via a sequence of 6 Vector Median blocks, each that take 4 input vectors and produce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

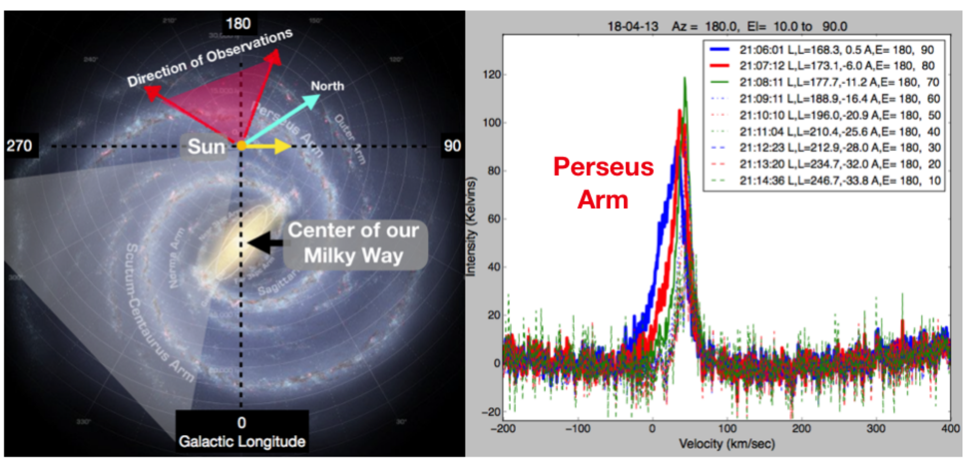

Figure 4: Overview of our place in the Milky Way Galaxy (Left) and 10 Minutes of Observations of the Perseus Arm. The sketch at left shows our Sun (and us) far from the center of the Milky Way. The image was drawn as if we are way above our galaxy. Our galaxy is a disk and the coordinate of the center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

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

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Photo from the Field

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

Photo courtesy of G. Langston

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