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

Monthly Newsletter of International URSI Commission J – Radio Astronomy

December 2018

Officers

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News Items

Greetings Commission J Members!

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

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

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

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

Submitted by R. Bradley

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

9 -15 March 2019, New Delhi, India

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Cees Bassa, Daniel Estévez, Tammo Jan Dijkema

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

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

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

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

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

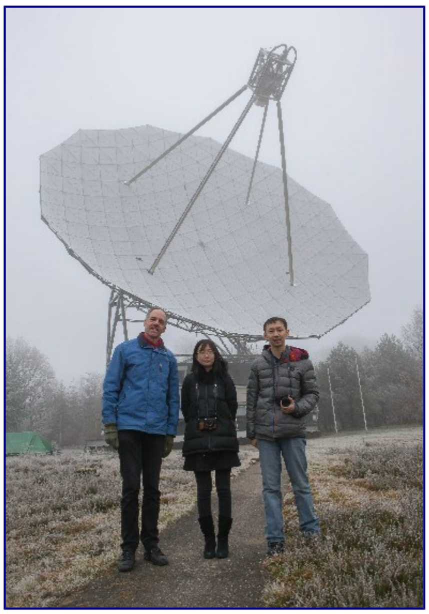
During the trip to the Moon in the days after the 20 May 2018 launch of Longjiang-1 and 2, radio amateurs were able to receive GMSK telemetry from both satellites, as they were still close to the Earth. Due to a malfunction of the thruster control logic required for the spacecraft to make course corrections,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

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

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

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

In the Netherlands, we have been using the Dwingeloo radio telescope, a 25m dish, to receive UHF signals from Longjiang-2. Due to the large sensitivity of the telescope, the GMSK and JT4G digital signals can easily be decoded. The Dwingeloo radio telescope is currently in use by radio amateurs, but has a long history as a radio telescope. It was built in 1956 as the largest radio telescope at that time. The telescope has a long history of discoveries, in particular of the galaxies Dwingeloo 1 and 2. Scientifically obsolete in 1990's, it was taken over by the CAMRAS foundation in 2007. The telescope was declared a national monument, and was fully restored in 2012. The Dwingeloo radio telescope is now maintained and used by volunteers for various purposes, including outreach, radio astronomy, art and amateur radio applications. A few examples of the latter, many of which are led by Jan van Muijlwijk PA3FXB: the telescope has assisted in rescuing several cubesats (BEESAT-3, e-st@r II, Triton-1, INSPIRE-2, UNSW-EC0), and the telescope is one of the largest stations to do Moonbounce experiments. The combination of these two activities make the DSLWP mission fit in very well. Due to the very wide orbit of the satellite and the narrow beam of the 25-meter dish, adjustments were needed to point the dish towards the satellite instead of the Moon. In fact, during the downlink of one the Earth and Moon images, the separation between the two was about 2 degrees.




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

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

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

To arrange taking the pictures, Reinhard Kühn (DK5LA) used his array of yagi antennas to command Longjiang-2 to take an image and transmit it back to Earth. The commands Reinhard sent were generated by MingChuan Wei from the Harbin team that built the Longjiang satellites. The Dwingeloo telescope, as well Robert Mattaliano in North America, Mike Rupprecht in Germany and Imants Tukleris in Latvia were able to receive and decode the packets with image data and upload it to the Harbin telemetry portal

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

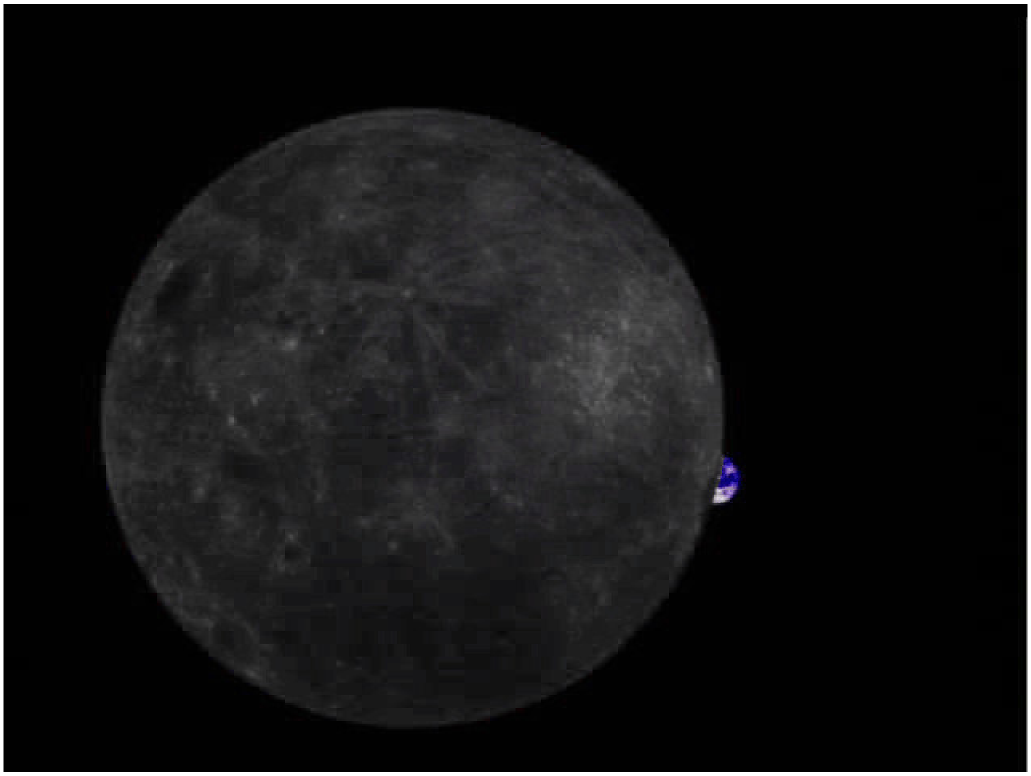
The resulting image, after some slight color corrections, shows the far side of the Moon, with several prominent craters being easily identifiable. The fully illuminated disk of the Earth shows blue oceans, cloud patterns, and some landmasses, which, based on the time the image was taken, are most likely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

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

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

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

The first VLBI experiment was performed on 10 June, recording the signal transmitted by Longjiang-2 using the 25m radio telescope in Dwingeloo and a 12m dish in Shahe, Beijing, China. The analysis of this experiment showed that the distance to Longjiang-2 could be measured with a precision of around 50km, and its velocity with a precision of 0.3m/s. This is rather good considering the limitations of the VLBI experiment, which is done on a low-bitrate communications signal, rather than on a signal intended specifically for ranging. The measurements obtained by VLBI were in good agreement with the official orbit determination made by the Chinese Deep Space Network. The second VLBI experiment was performed on 21 October, using ground stations in Dwingeloo, Shahe and Harbin. The data has not been processed yet. These have been the first VLBI observations performed by radio amateurs ever.

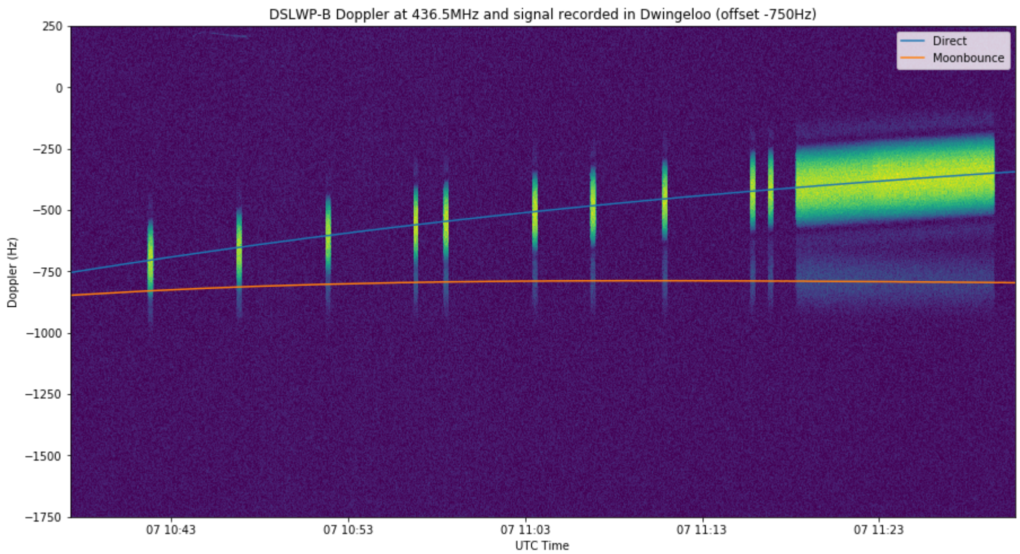


The Earth hiding behind the Moon: One of a series of nine images showing the Moon passing in front of the Earth. MingChuan Wei, Harbin Institute of Technology

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

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

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



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

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

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

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

References:

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

Job Postings – Radio Astronomy and Related Fields

University of Virginia

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

Square Kilometer Array

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

Arizona State University – 3 Positions

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

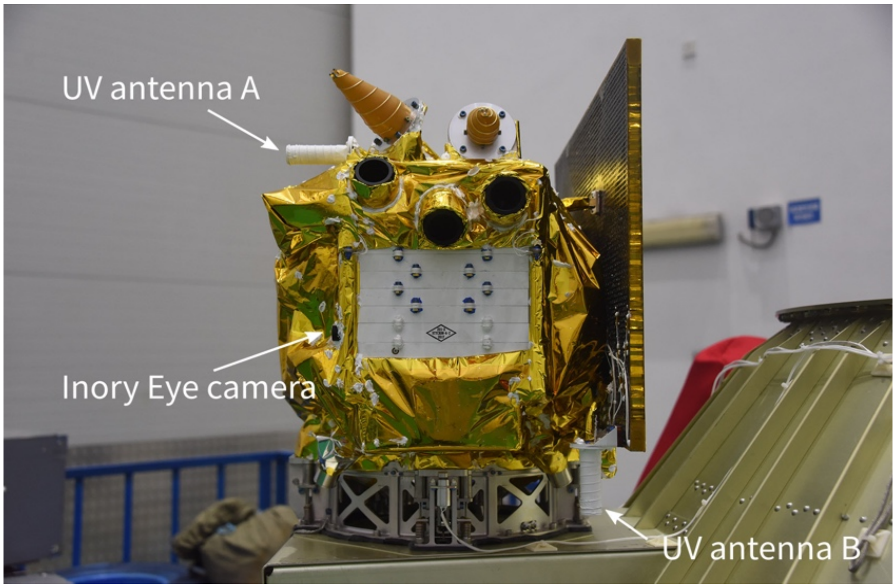
Postdoc in Radio Instrumentation and/or Signal Processing
https://jobregister.aas.org/ad/6f5685cb

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

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

Photo from the Field

Discovering the Sky at Longest Wavelengths Pathfinder (DSLWP)



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

Submitted by Cees Bassa, Daniel Estévez, Tammo Jan Dijkema

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

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