

COMMISSION B4

RADIO ASTRONOMY

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COMMISSION B4 WORKING GROUPS

Div. B / Commission B4 WG

**Historical Radio Astronomy
(HRA Joint WG with Commission C3
and an Inter-Union WG with URSI)**

Div. B / Commission B4 WG

Global VLBI Alliance (established 2020)

TRIENNIAL REPORT 2021-2024

1. Background

IAU Commission B4: Radio Astronomy (CB4), commenced in 2015. CB4 is the evolution of IAU Commission 40, as originally established in 1948. This is the Commission's third triennial report in its current form. In the last triennium period, CB4 has again successfully supported the expanding International Radio Astronomy community. CB4 currently has 562 members, more than 40 members than in the previous triennium.

The primary purpose of this Commission is to promote the unique aspects of radio astronomy within multi-wavelength and multi-messenger astronomy. With the development of increasingly international and billion-dollar scale instruments, it is ever more important to ensure a long-term, thriving and international network of discourse for radio astronomy research priorities, technologies and facilities.

2. Highlights and Developments 2021-2024

Commission B4 has supported an exciting triennium period with the maturation of a number of significant radio astronomy facilities, as summarised later.

CB4 was pleased to support its two related Working Groups, namely the intercommission WG (B4-C3) on Historical Radio Astronomy (six-year mandate) and the "Global VLBI Alliance", approved for the period 2021-2024.

Together the commission and its Working Groups continued to develop a fruitful interaction with URSI. For the first time there was joint URSI-IAU session at the URSI General Assembly (GASS) in August 2021. Members of this Commission convened a session entitled URSI J-IAU "Next generation radio astronomy, science & technologies".

A number of CB4 members attended the postponed IAU GA (2022), where the Commission co-sponsored the symposium IAUS 373 “Resolving the rise and fall of star formation in galaxies” (<https://iausymp373.web.illinois.edu>).

Globally, a number of significant projects have been delivered in the last triennium: National and international endeavours have led to the realisation of major new telescopes, upgraded observatories, and new/enlarged research groups. Communicating news of these developments and exploring synergies with other branches of physics and engineering is fundamental to the activities of CB4.

A number of major new and upgraded radio facilities have been completed, as well as many significant legacy surveys in this period. These are briefly reported here.

- The Karoo Array Telescope (MeerKAT) commenced full science operations in July 2018. Among several notable results was a spectacular new image of the Galactic centre showing an unprecedented wealth of detail. MeerKAT has also shown to be an exceptional pulsar research facility. Besides completing many large survey projects, MeerKAT issues annual calls for Open Time PI-led projects - the latest (4th) call was issued in May 2023.

- The East Asia VLBI Network (EAVN) entered a performance testing phase in 2010. The facility links 19 telescopes and significantly expands global VLBI capabilities.

- The Australian SKA Pathfinder (ASKAP) telescope completed further releases of the Rapid ASKAP Continuum Survey, RACS-low (centred on 888 MHz) and RACS-mid (centred on 1368 MHz) at 25 arcsec to 0.2 mJy beam⁻¹.

- The LOw Frequency ARray (LOFAR) has published its second data release of the LOFAR Two Metre Sky Survey (LoTSS) covering 27% of the northern sky at 120–168 MHz, 0.07 mJy beam⁻¹ sensitivity and 6'' resolution. As well as LoTSS, there are a number of other major surveys using LOFAR underway: all are described on the webpage lofar-surveys.org/surveys.html.

- The VLA All-Sky Survey (VLASS) continues to progress (science.nrao.edu/vlass), aiming to observe three epochs over the 75% of the sky visible to the VLA in order to provide deep, high angular resolution images (2.5 arcsec to 120 μ Jy rms) at 2 – 4 GHz as well as additional multiple epochs for time domain studies. Observations up to epoch 3.1 have been completed at this time.

- The Murchison Widefield Array has been expanded with a doubling of its number of stations. The Galactic and Extragalactic All-SKY MWA survey “GLEAM” has been augmented by the “GLEAM-X” survey providing deeper sensitivity (to 1 mJ beam⁻¹) across the same wide low frequency band 72-231 MHz (www.mwatelescope.org/science/galactic-science/gleam-x).

- The Five-hundred-meter Aperture Spherical Telescope (FAST) officially opened and is working through its technical commissioning towards full science operations. During this time, 10% of its observing time has been made available to international astronomers.

- ALMA celebrated its 10 year anniversary in 2021 and continues to provide exquisite data at millimetre wavelengths, exploring gas, dust and magnetic fields throughout the Universe. During this triennium, the concept of ‘ALMA-2’ has been developed with three key scientific goals for the coming decade.

- The Square Kilometre Array telescope achieved significant milestones, most notably the commencement of the build at both sites in South Africa and Australia (skao.int)

- The next-generation Very Large Array (ngVLA) project, designed to bridge SKA and the Atacama Large Millimetre/submillimetre Array in frequency space, continued its design and development activity, alongside the ongoing development of its science goals.

3. Broader Commission activities

Commission B4 has two Working Groups. The Working Group on Historical Radio Astronomy has been active for the full term of the triennium. After the 2020 creation of the new Working Group for the “Global VLBI Alliance”, its workplan started to be developed.

Together the commission and its Working Groups continued to develop a close and fruitful interaction with URSI.

- Members of CB4 were the convenors of a special session at the URSI General Assembly (GASS, August 2021) URSI J-IAU entitled “Next generation radio astronomy, science & technologies’. This session brought together URSI and IAU Commission B4 (Radio Astronomy) to explore the emerging technologies that will impact these major instruments and drive astronomy in the 2030s and beyond. The session was wide-ranging, looking to major trends in photonics, computing and multi-messenger physics, but also the raw reality of increasing number of billion-dollar telescopes.

- The WG HRA organised the session on “The Impact of Radio Astronomy on Technology and Society”. Talks covered a broad range of topics and include The Story of Wifi; VLBI, Navigation, and Geodesy; Cold-War Diplomacy at the Jodrell Bank Observatory; Radio Interferometry and Medical Imaging; Deep Space Navigation; and The Parkes Dish and the First Moonwalk.

4. The next Triennium - future plans

The coming triennium will undoubtedly deliver exciting science from major new and enhanced radio facilities. We expect to see even more agile, user-accessible networks of telescopes and data products in the coming period. In particular, efforts are looking to expand a wide range of ‘VLBI’ capability ready for the era of the ngVLA and SKA. This is key focus of the Global VLBI Alliance Working Group. Long baseline astronomy at very low wavelengths (≤ 80 MHz) will be probed by LOFAR using its pan-European baselines, new algorithms and significant computing capacity. These facilities, and the increasingly dynamic arraying of telescopes in new configurations will ensure that radio data continues to provide exquisite and new insights into our Universe.

The CB4 committee is keen to continue investigating what level of information is most useful to members, particularly with the evolution of hybrid meetings. The Commission’s web page will continue to be upgraded to provide members will a clear view of the Commission’s purpose and mission.

Carole Jackson
President of the Commission