ICRAR

The International Centre for Radio Astronomy Research (ICRAR) is a joint venture between Curtin University and The University of Western Australia with strong support from the West Australian and Australian governments.

We are a multi-skilled institute of astronomers, engineers and data specialists working with industry partners throughout Australia, Europe and the United States to support the build up of the SKA in Australia and expand our understanding of the Universe.

ICRAR's vibrant, supportive and innovative research culture fosters excellence in our key areas of research, which are galaxy formation and evolution, the Epoch of Reionisation, the transient radio Universe, data intensive astronomy and advanced antenna engineering. Since our launch in 2009, ICRAR's researchers have published over 1,000 refereed journal articles.

STUDY OPPORTUNITIES

At ICRAR, we pride ourselves on the opportunities available to our students across astronomy, engineering and data intensive research. When you study at ICRAR you have the experience and support of two universities behind you, as well as the wealth of knowledge provided by more than 100 researchers that make up our centre.

HIGH SCHOOL

Our work experience program gives high school students a taste of the day-to-day life of our astronomers and engineers.

UNDERGRADUATE

Both the Curtin University and University of Western Australia nodes of ICRAR offer undergraduate studies in astronomy and astrophysics.

There are opportunities throughout both degrees to work with ICRAR researchers and start shaping your career. Our Curtin University node also offers specialised training in radio astronomy engineering through links with the ICRAR engineering lab.

POSTGRADUATE

ICRAR has a thriving Masters and PhD program, with over 50 PhD students currently studying with our researchers. We consistently have projects on offer in astronomy, astrophysics, radio astronomy engineering and data intensive astronomy.

For further information on any of the study opportunities at ICRAR, visit www.icrar.org/study or email us at education@icrar.org

ICRAR International Centre for Radio Astronomy Research

THE SQUARE KILOMETRE ARRAY (SKA)

The SKA Project is an international effort to build the world's largest radio telescope, with a square kilometre (one million square metres) of collecting area.

The most capable radio telescope ever built, the SKA will expand our understanding of the Universe and drive technological development worldwide.

Co-located in Australia and South Africa, the SKA will be an unparalleled feat of human scientific endeavour, employing the skills of large numbers of engineers, scientists and technicians around the world.

When complete, the SKA will conduct transformational science, monitoring the sky in unprecedented detail and mapping it hundreds of times faster than any current facility.

Main: The GLEAM view of the centre of the Milky Way, in radio colour, observed by the MWA. Each dot is a galaxy, with around 300,000 radio galaxies observed as part of the survey. Credit: Natasha Hurley-Walker (ICRAR-Curtin) and the GLEAM Team.

Right: Part of the AAVS Test Platform comprising of "Christmas Tree" antennas at the Murchison Radio-astronomy Observatory in outback Western Australia.

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The Government of Western Australia

The University of Western Australia

Left: Artist's impression of the future antennas making up SKA-low in Western Australia. Credit: SKA Organisation

ENGINEERING

ICRAR's world-class engineering team are playing a leading role in the end-to-end design, construction, data processing and science capabilities of the Square Kilometre Array (SKA) radio telescope.

The group is made up of a mix of PhD-level research engineers and professionals from industry, all adept at getting systems on the ground.

Our engineering team is supporting the next generation of radio telescopes such as the Murchison Widefield Array (MWA), the Australian SKA Pathfinder (ASKAP) and the SKA, through:

- Antenna design;
- Radio-frequency engineering;
- Electromagnetic Compatibility;
- High-performance computing;
- Digital systems; and
- Software engineering.

ICRAR also boasts a world-class radio astronomy engineering laboratory at our Curtin University node. This $3 million facility allows engineers to build and test components before they are deployed at the Murchison Radio-astronomy Observatory, acting as an interface between ideas and the real world.

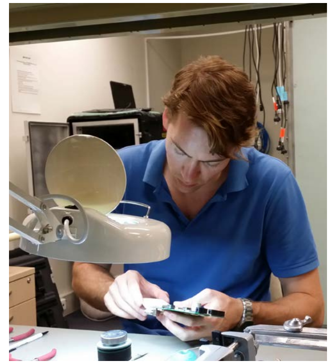
After the successful commissioning of the MWA, ICRAR was awarded a lead role in the SKA Aperture Array Design and Construction Consortium, and will play a key role in much of the low-frequency engineering work for the SKA.

Landmark achievements of ICRAR's engineering program so far include the successful delivery and continued operation of the MWA, the deployment of a verification system for the low-frequency SKA, and development of a new method for detecting fast radio transients.

Projects and engineering challenges like these are equipping us with expertise and experience that will be critical to the effective and efficient construction and operation of the SKA.

Left: Engineering students working in an anechoic chamber at Curtin University, measuring radio frequency interference.

Right: Electrical engineering and computing student, Shane Overington, working in the ICRAR electronic laboratory to diagnose and repair a faulty MWA data transmission printed circuit board.



SCIENCE

Using modern instruments to look beyond the spectrum of visible light, astronomers are now able to see the Universe in its entirety. ICRAR has several key areas of research that relate to the science that will come from observations captured by radio telescopes around the world.

The science at our Curtin University node focuses on three key areas, complementing our engineering and data intensive astronomy work:

ACCRETION PHYSICS

This project builds on ICRAR's recent success and extensive expertise in this field. Combining observations from several telescopes, the accretion physics team will improve our knowledge of the highly energetic processes that surround enigmatic neutron stars and black holes.

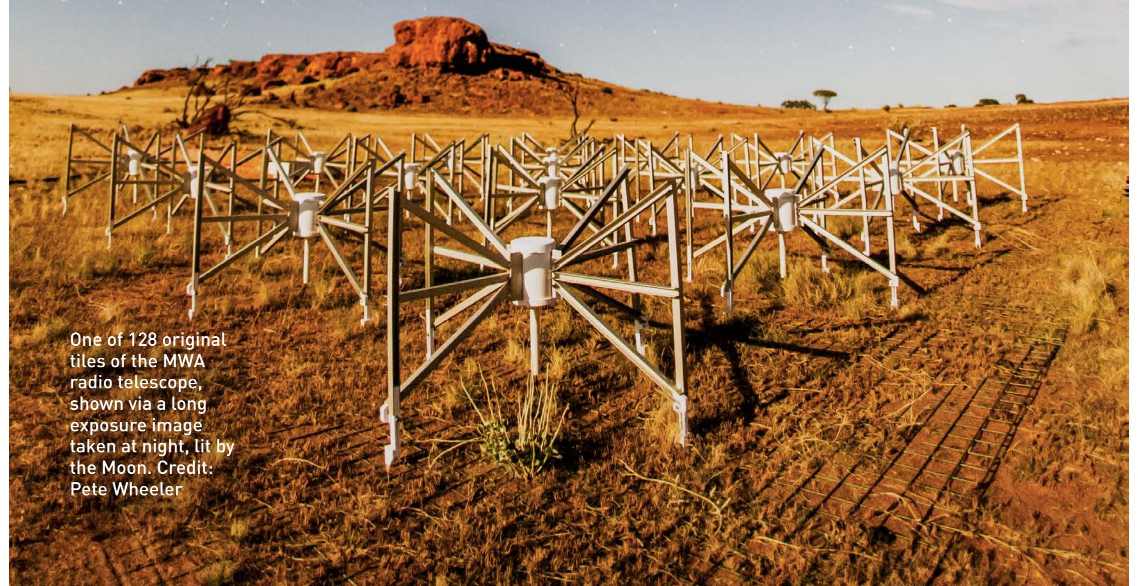
EPOCH OF REIONISATION

The Epoch of Reionisation project explores the first billion years of the Universe, the period when the first stars and galaxies switched on. Through probing the very low energy radio emission from hydrogen gas, we can study the nature of the material between the first galaxies and provide key insights into the growth and structure of the early Universe.

MURCHISON WIDEFIELD ARRAY SCIENCE

This broad project aims to explore the valuable science made possible by the Murchison Widefield Array (MWA) radio telescope, with particular focus on:

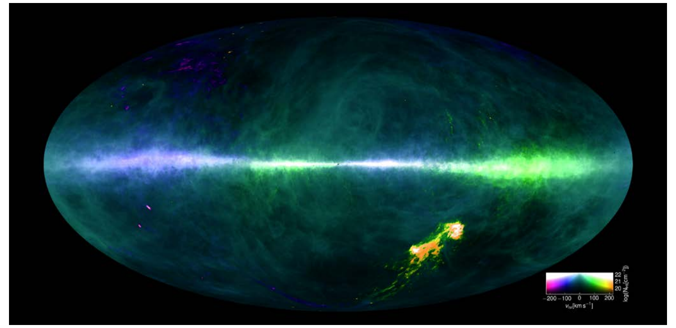
- Characterising enigmatic objects such as pulsars and fast radio transients;
- Our galaxy and beyond. By surveying the entire southern sky, the MWA will make in-depth observations of the Milky Way, as well as more distant galaxies, allowing ICRAR scientists to map the Universe in more detail than ever before.

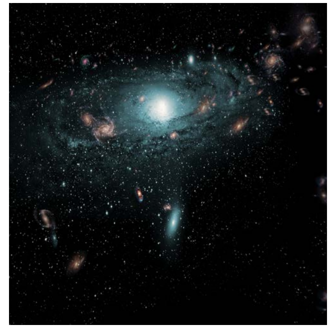


One of 128 original tiles of the MWA radio telescope, shown via a long exposure image taken at night, lit by the Moon. Credit: Pete Wheeler

SCIENCE

Collaboration between ICRAR's Engineering, Data Intensive Astronomy and Science teams is strong, and the science conducted at both nodes is both complementary and collaborative in nature.





Left: A detailed map of the Milky Way created from data gathered by two of the world's largest fully steerable radio telescopes in Germany and Australia. Credit: Benjamin Winkel and the HI4PI collaboration.

Right: An artist's impression of the galaxies found in the 'Zone of Avoidance' behind the Milky Way.

The science at our University of Western Australia node focuses on three key areas:

COMPUTATIONAL THEORY AND MODELLING

This project helps refine existing ideas about the Universe that make predictions for large galaxy populations. Using large-scale simulations, these refined models will guide future surveys and aid the interpretation of their results.

Making use of the extensive supercomputing power in Western Australia, the models developed by ICRAR create accurate predictions of many astrophysical processes including galaxy formation, galactic gas accretion and cosmic structure.

GAS AND FEEDBACK WITH RADIO SURVEYS

This project will discover more about the origin and evolution of galaxies through the new generation of radio telescopes, including ASKAP and the MWA.

Through the WALLABY and DINGO surveys being conducted by the Australian SKA Pathfinder, and the GLEAM survey of 300,000 galaxies observed by the MWA, ICRAR researchers are mapping the radio sky in unprecedented detail to better understand how galaxies have changed over 4 billion years of cosmic time.

MULTIWAVELENGTH AND SPECTROSCOPIC SURVEYS

This project focuses on the evolution of mass, energy and structure in the Universe and is tackling one of the enduring mysteries of the Universe, the nature of dark matter.

At ICRAR we lead the GAMA and WAVES spectroscopic surveys, both making use of many next-generation telescopes across multiple wavelengths of light.

DATA INTENSIVE ASTRONOMY

When the SKA comes online in the next decade, the computational portion of the telescope will need to process up to one billion gigabytes of data every single day, requiring supercomputers that are faster, larger and more energy efficient than anything available today.

The low frequency part of the SKA alone is set to have more than a quarter of a million antennas facing the sky, collectively producing terabytes of data every second.

With so many antennas creating such sensitive observations, there has to be a point where the data is calibrated, processed and archived—the 'brain' of the SKA.

This brain is called the Science Data Processor (SDP) and it will filter out interference and turn the data into a form that can be accessed by astronomers around the world.

This hugely important step —which makes incredible discoveries from the SKA possible—is one that ICRAR'S Data Intensive Astronomy (DIA) team is working on with a suite of prestigious institutions and industry partners.

Our DIA team is well placed to succeed in this endeavour, comprising researchers from astronomy and industry who have led the development of data and operations systems for large-scale astronomical infrastructure in Europe and South America.

Overcoming challenges such as this for the SKA will undoubtedly lead to innovative solutions and spin-off technologies that have the potential to benefit the day-to-day lives of billions of people.

Through wireless communications, medical imaging, atomic clocks, GPS navigation, spacecraft navigation systems and innumerable spin-off technologies, the world is already reaping the rewards of astronomical endeavour.

WE CAN ONLY BEGIN TO IMAGINE THE LIFE-CHANGING, DOWN TO EARTH INNOVATIONS THE SKA WILL BRING.

The data storage tape library at the Pawsey High Performance Computing Centre in Perth, WA.