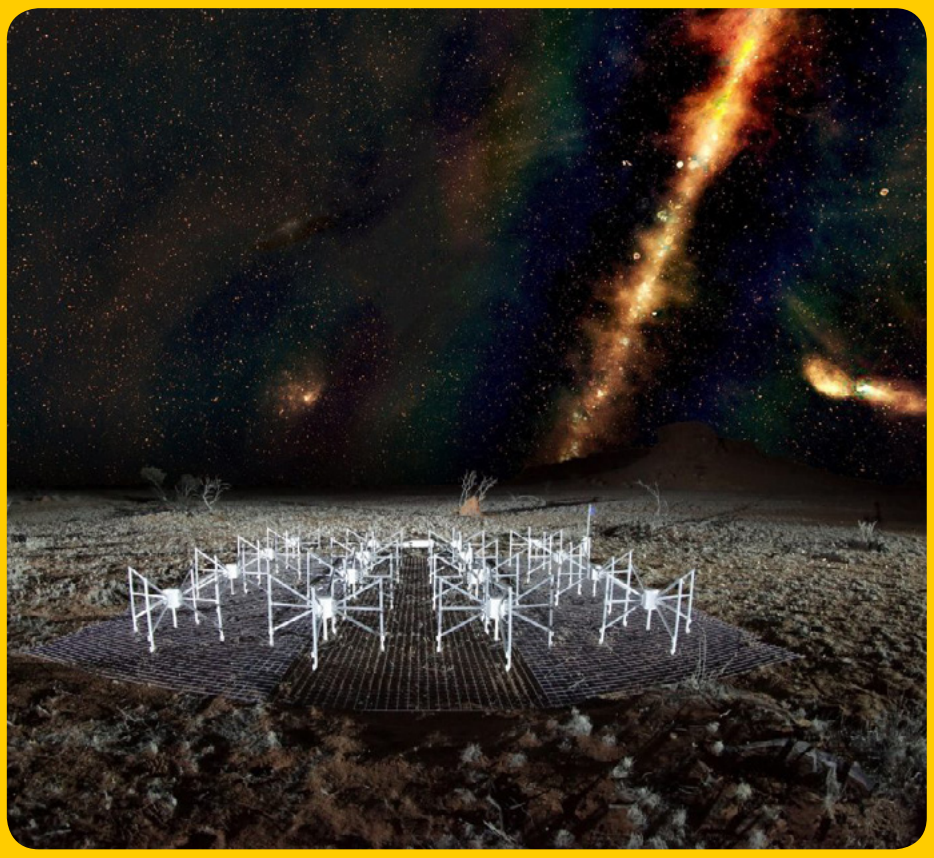
PAWSEY supercomputing centre

PARTNER INSTITUTIONS

ICRAR International Centre for Radio Astronomy Research | Curtin University | The University of Western Australia



PROJECT LEADER
DR NATASHA HURLEY-WALKER
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SYSTEM
GALAXY

TIME ALLOCATED
276,000 HOURS

AREA OF SCIENCE
RADIOASTRONOMY

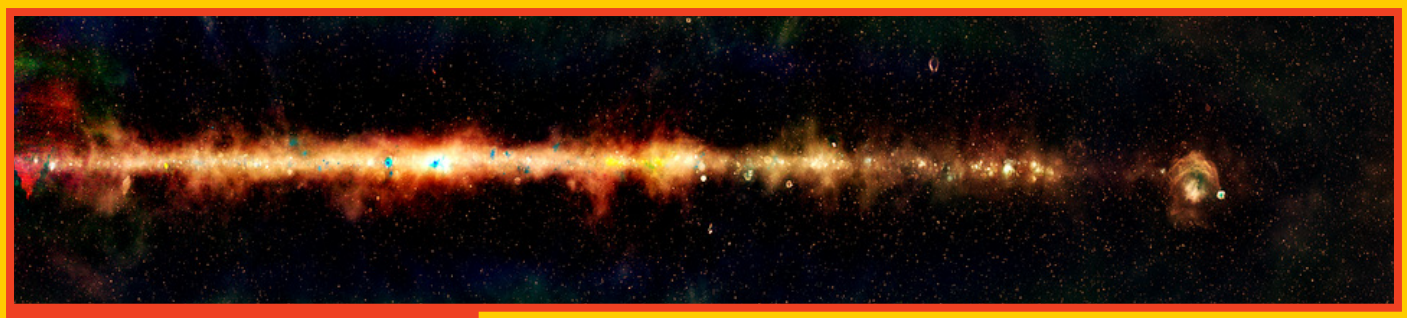
APPLICATIONS USED
WSCLEAN, AEGEAN, SWARP, BASH, PYTHON, ASTROPY, NUMPY, AND SCIPY MODULES.

A 'radio colour' view of the sky above a 'tile' of the Murchison Widefield Array radio telescope, located in outback Western Australia. The Milky Way is visible as a band across the sky and the dots beyond are some of the 300,000 galaxies observed by the telescope for the GLEAM survey. Red indicates the lowest frequencies, green the middle frequencies and blue the highest frequencies. Credit: Radio image by Natasha Hurley-Walker (ICRAR/Curtin) and the GLEAM Team. MWA tile and landscape by Dr John Goldsmith / Celestial Visions.

GLEAM: A PANORAMIC VIEW OF THE UNIVERSE IN COLOUR

In searching for cosmic events and the evolution of our solar system, radio astronomers have traditionally surveyed only segments of the sky. Recently, however, the GaLactic and Extragalactic All-sky Murchison Widefield Array survey (GLEAM) project has collected and processed enough data to survey the entire Southern sky: in "radio colour." GLEAM'S key researcher is Dr Natasha Hurley-Walker, a radio astronomer at Curtin University and the International Centre for Radio Astronomy Research (ICRAR). Using the Murchison Widefield Array (MWA) telescope, and the world-class facilities at Pawsey Supercomputing Centre, the GLEAM survey has produced the first multi-coloured panoramic view of the universe. Dr Hurley-Walker and her team have produced a catalogue of over 300,000 radio galaxies from the extensive sky survey which provides a valuable scientific resource for astronomers.

2016



A Molleweide projection in Galactic co-ordinates of the GLEAM survey, showing how it covers the entire southern sky. Red indicates the lowest frequencies, green the middle frequencies and blue the highest frequencies. Credit: Natasha Hurley-Walker (ICRAR/Curtin) and the GLEAM Team.

MWA SCIENCE PRE-PROCESSING

THE CHALLENGE

In the outback of Western Australia (WA) sits the Murchison Radio-astronomy Observatory (MRO). It is a radio-quiet zone where over 4,000 spider-like antennas make up the MWA radio telescope in 128 "tile" formations spread across ten square kilometres of land. The MWA, a precursor telescope for the Square Kilometre Array (SKA), collects low-frequency radio signals from the night sky. Signals are then correlated by researchers and sent through a fibre optic link to the Pawsey Supercomputing Centre. The sheer number of the collective MWA antennas, and the correlations between them, compared to previous radio telescopes, means that vast amounts of astronomy data are generated. Data for the GLEAM survey was sent to the Pawsey Supercomputing Centre at the rate of about one Blue-Ray disc per minute, requiring immense data storage and processing.

"Most past radio surveys were performed with dish-based interferometers with a low number of antennas, small fields-of-view, and narrow bandwidths," said Dr Hurley-Walker.

"The MWA is a massive aperture array with no moving parts, a wide bandwidth, and a very large field-of-view. The first step of transforming interferometric data into images is to perform a Fourier Transform which becomes very much more [computationally] expensive as you increase the field-of-view, the bandwidth and number of antennas, so a supercomputer was very necessary to cope with this problem."

THE SOLUTION

By utilising Pawsey Supercomputing infrastructure, the GLEAM research team could store and process over 600 terabytes of radio astronomy data from the MWA telescope as it was piped down from the WA outback.

"We used the supercomputers Raijin (NCI) and Galaxy (Pawsey) to process the GLEAM survey. The way that the GLEAM observations were performed meant that we had around 7, 000 near-identical datasets to process," said Dr Hurley-Walker.

"This was perfectly suited for parallel supercomputing since each data set could be processed at the same time, subject to disk space limitations. Of course, we had to do this a few times, because each time we learned something new about the data! So all in all, we used a few million CPU hours to fully process the survey."

OUTCOME

Using the state-of-the-art facilities at Pawsey Supercomputing Centre, Dr Hurley-Walker and her team of researchers were able to process over 35,000 images of the night sky. With each MWA telescope capturing around one-tenth of the sky, Dr Hurley-Walker painstakingly combined the images to create a complete panoramic view of the southern sky in radio colour: a world-first.

"We created the images and performed source-finding to derive a catalogue of over 300, 000 radio galaxies, each with 20 brightness measurements across the low-frequency band of the MWA," said Dr Hurley-Walker.

"The images and the catalogue are helping astronomers learn more about the environments around supermassive black holes, find colliding clusters of galaxies, and understand the cosmic ray electron budget of the Milky Way. The survey is also a perfect way of calibrating the low-frequency component of the Square Kilometre Array, due to be built on the same site as the MWA in coming years."

The GLEAM data set will soon be published in a series of papers of which the radio-astronomy community will be able to publicly access.

"It would not have been possible without the Pawsey Supercomputing Centre," said Dr Hurley-Walker.

The GLEAM extragalactic catalogue paper was published in Monthly Notices of the Royal Astronomical Society Volume 464, Issue 1, p.1146-1167. Visit: **http://gleamoscope.icrar.org** to experience the Universe in radio colours.