PAWSEY supercomputing centre

PARTNER INSTITUTIONS

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

Outrigger tile at night (30 sec exposure, full moon) (Credit, Pete Wheeler, ICRAR)

PROJECT LEADER
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SYSTEM
GALAXY

TIME ALLOCATED
350,000HOURS

AREA OF SCIENCE
Radio Astronomy

LET THERE BE LIGHT

After the Big Bang, there was a period of darkness in the universe lasting hundreds of millions of years. During these Cosmic Dark Ages, the first stars and galaxies began to form. During the Epoch of Reionisation, these first sources of light ignited, and the universe was illuminated.

However, little is known about the Epoch, which occurred around 13 billion years ago.

The Curtin Institute of Radio Astronomy's Dr Cathryn Trott and her team have been using The Pawsey Supercomputer's Galaxy system to assist with their research into the Epoch of Reionisation.

"From an observational point of view, over the past 20 years there's been a realisation that the Epoch could potentially be observable, but we've never had the telescope to be able to detect it, because it is such a weak signal," Dr Trott says.

Dr Trott and her team are using the Murchison Widefield Array (MWA) – a low-frequency radio telescope in the Murchison Desert, ten hours Northeast of Perth – to detect when reionisation began.

"[the Epoch] is in the very distant universe, and from an observational point of view, the best way to measure this is through looking at the hydrogen, because the hydrogen is what has changed in that period," she says.

2016

DETECTION OF THE EPOCH OF REIONISATION USING THE MURCHISON WIDEFIELD ARRAY

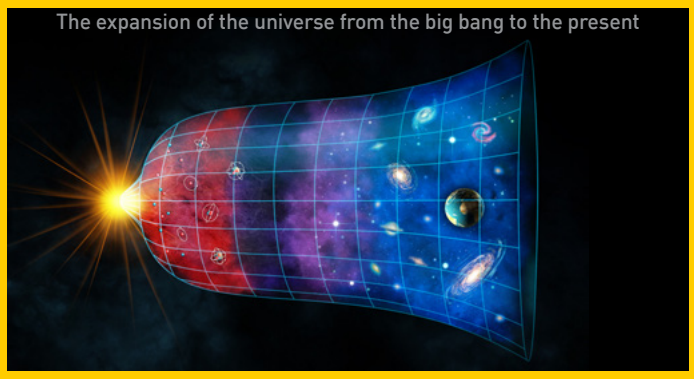
THE CHALLENGE

Dr Trott's research involves the MWA collecting 24 gigabytes of data every two minutes – roughly one top-of-the-line iPhone's worth of data every 10 minutes - over 1000 hours of observation.

"There's a lot of information we need to process simultaneously, otherwise it would take us tens of years to process enough data such that we could conduct the experiment," she says.

Dr Trott says her experience in medical imaging physics had been helpful in detecting weak signals in complex data.

"For me, that was really inspiring, because I had the skill to be able to understand how we might actually go about detecting this needle-in-a-haystack hydrogen signal," she says.



The expansion of the universe from the big bang to the present

THE SOLUTION

"We need to distil that 720 petabytes, or one terabyte if you like," she says.

"Initially we use the Galaxy Supercomputer to distil that by a factor of 12, down to about 60 petabytes, and then through the final processing step, which also happens on Galaxy, the final outputs on this project go from a terabyte to a gigabyte.

"We're talking about a factor of one million, and you just can't do that on your own machine."

Dr Trott says the Galaxy system's ability to process such a volume of raw data had been critical to her project's success.

"For us being in Perth, and having the Pawsey Centre available to us, is absolutely crucial to the science that we've done, because it's so much data that we've had to distil down," she says.

OUTCOME

Dr Trott's research is informing the development of the low-frequency component of the Square Kilometre Array (SKA), another Murchison-based radio telescope, which will be 50 times more sensitive and 10, 000 times faster than the world's most advanced telescope, and which is the product of collaboration between more than 20 countries.

"With the Murchison Widefield Array and those telescopes that exist at the moment, we want to really detect the Epoch, so we get a glimpse of that period; with the Square Kilometre Array, we'll be able to explore it and really understand how the universe evolved over that period of a billion years," she says.

Dr Trott said the Murchison Widefield Array and Square Kilometre Array were highly interdependent telescopes.

"We're doing the design work now, saying 'this is what we've learned from our current suite of telescopes, and this is how we want to design the SKA' in terms of how the telescope is laid out, and what frequencies it looks at, these kind of things," she says.

The Square Kilometre Array will be commissioned between 2021 and 2022, and will commence operations by 2024.

Dr Trott says continued research into the Epoch of Reionisation could provide revelatory information about the evolution of the universe.

"It's not that we can just explore this Epoch and move on, this is a gateway to really understanding some of the astrophysics, rather than just the cosmology ... so the formation of stars, the evolution of the stars, the evolution of the elements," she says.

"The Big Bang gave us hydrogen and helium, well, we have everything else now ... we're made of carbon, we breathe oxygen – where did that come from?

"It really is a gateway to all of that science."