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START OF ON-SITE CONSTRUCTION SPECIAL

WALLABY builds an intergalactic map in the outback

BY ICRAR AND CSIRO

A survey conducted using CSIRO's ASKAP radio telescope in Western Australia is helping to build a 3D map of the night sky, mapping galaxies up to a billion light years away.

The WALLABY (Widefield ASKAP L-band Legacy All-sky Blind surveY) Pilot Survey will be sharing its first data release with the scientific community, helping us to better understand nearby galaxies and galactic clusters. Hundreds of galaxies have been surveyed in Phase 1 of WALLABY, covering 180 square degrees of the observable sky. A second phase of the survey is already under way.

Over the course of the survey 250,000 galaxies are expected to be catalogued – almost an order of magnitude more than the current state-of-the-art ALFALFA survey on the Arecibo telescope – helping researchers to measure dark matter distribution and how galaxies evolve and interact.

Lead author Dr Tobias Westmeier (ICRAR/UWA) said the data WALLABY collects will help us investigate the Universe at a scale we never could with just optical telescopes.

"If the plane of the Milky Way is between us and the galaxy we're trying to observe, the sheer number of stars and dust makes it incredibly hard to see anything else," Dr Westmeier said. "WALLABY isn't affected by these limitations. It's one of the great strengths of radio surveys; they can simply peer through all the stars and dust in our own Milky Way."

It's the first full 3D survey of this scale, with over 30 terabytes of data collected each day from eight hours of ASKAP observations. This is an ingest rate of around 4TB per hour, which is like streaming 4,000 standard definition movies at the same time.

Co-author Dr Karen Lee-Waddell (ICRAR/UWA & CSIRO), WALLABY Project Scientist and Director of the Australian SKA Regional Centre, said the project will show us where these galaxies really are in relation to one another, splitting up galaxies which appear clustered together but are millions of light years apart.

"WALLABY will enable us to directly map and detect the fuel for star-formation: hydrogen gas," Dr Lee-Waddell said.

WALLABY is one of nine pilot surveys being undertaken with ASKAP before it becomes fully operational later this year.

CSIRO's Australia Telescope National Facility Science Program Director Dr George Heald said these projects have been made possible through ASKAP's ability to collect data at a scale never seen before.

"Inyarrimanha Ilgari Bundara, CSIRO's Murchison Radio-astronomy Observatory is one of the most radio-quiet locations in the world, allowing projects like WALLABY to find narrow and faint astronomical signals without being swamped by radio interference," said Dr Heald.

ABOVE: *A dish from CSIRO's ASKAP radio telescope. Credit: Alex Cherney/CSIRO*

India's GMRT discovers the oldest known remnant radio bubbles

BY DR SURAJIT PAUL (SAVITRIBAI PHULE PUNE UNIVERSITY, PUNE AND RAMEN RESEARCH INSTITUTE, BANGALORE)

A team of Indian astronomers has discovered the oldest ever remnant radio "lobes" of a galaxy residing inside the cluster Abell 980.

The discovery was made mainly using data from India's GMRT, with additional data from fellow SKA pathfinder telescopes LOFAR and the VLA, as well as the Chandra X-Ray Observatory.

Galaxies are the assembly of billions of stars, often residing in clusters containing hundreds of them, all held together by their mutual gravity. Among them, the largest galaxies host supermassive black holes at their centre, and in their active phase (when they're known as active galactic nuclei or AGN) usually they spew relativistic electrons in the form of two oppositely expanding collimated jets. These expand into balloon-like clouds, or "lobes", of magnetised relativistic plasma radiating in radio waves, and become visible to sensitive radio telescopes.

Like living beings, these radio lobes also have a lifespan which depends on how they are fed with the plasma by the AGN of their parent galaxy. Once the feeding stops, these lobes start losing their energy rapidly by radiation and fade away beyond detection.

Usually, they remain visible for only a few tens of millions of years. However, the team [led by the author of this piece] has serendipitously spotted an extremely old but surviving pair of radio lobes with an estimated record age of about 260 million years, trapped inside the intra-cluster medium of Abell 980.

While highly aged radio bubbles of around 100 million years are not something completely unknown, they are usually the fossil remains of once active radio jets, and only detected in massive merging clusters; their electrons revived by the shock of the merger. This discovery is unique and puzzling as these lobes are not revived fossils and are surprisingly found inside a non-merging, low-mass cluster, as confirmed by an analysis of Chandra X-ray data, thus indicating that they have been continuously emitting detectable radio signals for 260 million years after the cessation of jet activity, which is next to impossible in usual cases.

The team thinks this is an atypical example where confinement of radio lobes inside the hot but relaxed cluster medium has prolonged the life of the lobes to such an extent. The fact that the cluster is comparatively a low-mass one may also have provided a rare favourable environment. This discovery has therefore opened up a unique opportunity for scientists to study radio jet evolution over the longest period of time.

This technically challenging detection of these extremely faint sources was possible due to the high sensitivity of the GMRT and LOFAR telescopes. While this is the first one found, it may not be the only one in the sky. In fact, the Universe is likely to be infested with faded relics of radio lobes of various ages blown up by billions of large galaxies during their multiple active phases over the cosmic time scale. The SKA telescopes will therefore be the game changer to unravel the radio sky with many such extreme events.

The entire research has been recently published in two research articles in Astronomy & Astrophysics (A&A) and in Publications of the Astronomical Society of Australia (PASA).

BELOW: *Optical photograph of the cluster of galaxies, whose central giant elliptical galaxy (white elliptical patch) is the parent of the radio lobes shown in blue. The red-shaded region displays the halo of X-ray emission due to the hot intra-cluster medium.*