Curtin University

# Finding Ultra-High-Redshift Radio Galaxies Using GLEAM

**Research Field**
Radio Astronomy

**Project Suitability**
PhD
Masters
Honours

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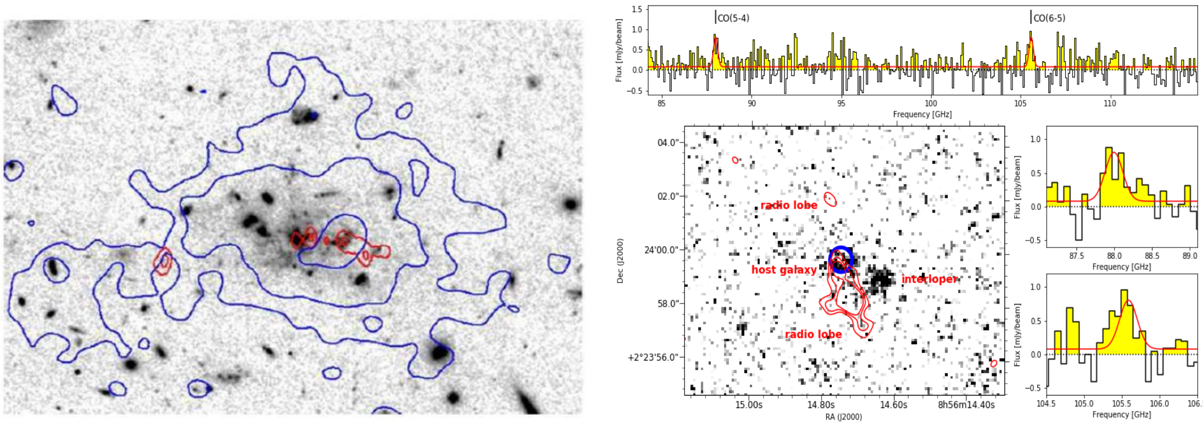
Understanding galaxy formation and evolution across cosmic time is both a fundamental topic in astrophysics and a key science driver for the forthcoming Square Kilometre Array (SKA). In the early Universe, high-redshift radio galaxies (HzRGs; e.g. review by Miley & De Breuck 2008, A&AR, 15, 67) are crucial beacons for investigating how the most massive galaxies form (e.g. left panel below), and their link to the massive 'red and dead' ellipticals that are the brightest cluster galaxies in the more local Universe.

We have developed a new selection technique to find HzRGs by using radio spectral curvature in the broadband 70–230 MHz GLEAM survey (Hurley-Walker et al. 2017, MNRAS, 464, 1146), conducted with the Murchison Widefield Array (MWA). From a pilot study of four sources (Drouart et al. 2020, PASA, in press) we uncovered the second-most distant radio galaxy currently known (right panel below), observed when the Universe was less than a tenth of its current age!

We are now building on the success of our pilot by investigating the properties of a further 100 HzRG candidates selected using the same technique. Our goal is to find the first massive galaxies that formed during the Epoch of Reionization (EoR; redshift $z > 6$), when the Universe was less than a billion years old, which would facilitate a number of exciting, cutting-edge scientific opportunities.

You will play a leading role reducing, analysing and interpreting the multi-wavelength data that we are currently acquiring for these targets from the following world-class telescopes: MWA, ATCA, ASKAP, ALMA, LOFAR and the VLT. Key investigations in the project will be (i) to locate the immediate descendants of the first supermassive black holes that formed in the Universe; (ii) build an orientation/obscuration-free sample of active galactic nuclei at $z > 6$; (iii) study the co-evolution of the supermassive black hole and host galaxy during the first billion years of the Universe; (iv) characterise the intergalactic medium during the EoR via the observation of redshifted 21-cm neutral hydrogen absorption; and (v) better understand the accretion processes that power the radio jets in these sources, which in turn can affect the ambient environment (so-called 'feedback').




*Left:* The 'spiderweb galaxy' at redshift $z = 2.2$: witnessing the formation of a dominant cluster galaxy in the early Universe. The grey-scale is a Hubble Space Telescope image, while Lyα (blue) and radio contours (red) are also shown. Figure from Miley et al. 2006 (ApJ, 650, L29). *Right:* A newly discovered, GLEAM-selected high-redshift radio galaxy at $z = 5.55$ from Drouart et al. 2020 (PASA, in press). The top figure is a 30-GHz ALMA spectrum of the host galaxy, showing 5σ detections of two CO transitions (extracted over the blue aperture in the lower left figure). In the lower left figure, the grey-scale VLT HAWKI *K*-band (near-infrared) image has been overlaid with contours (red) from the collapsed ALMA continuum image (84–115 GHz), identifying the host of the radio emission. The extended, albeit asymmetric radio emission suggests it is powered by synchrotron processes. The lower right plot shows zoom-ins on the two CO detections.