Monster black holes at the dawn of cosmic time

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Description:

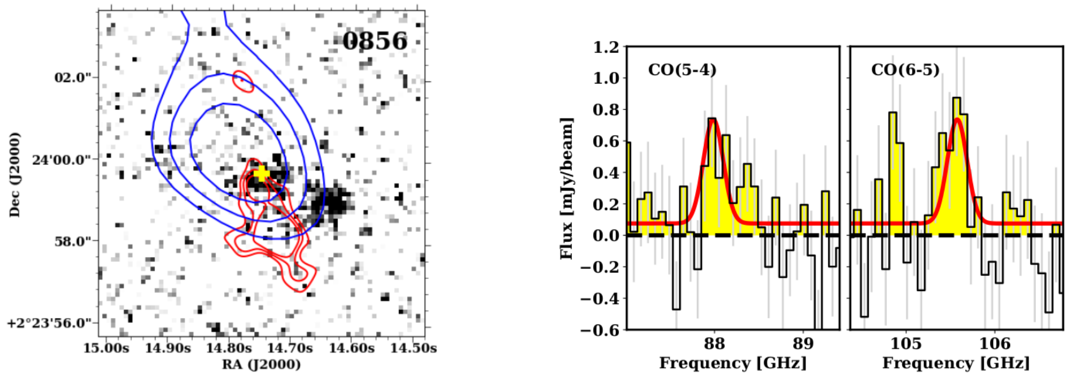
Understanding galaxy formation and evolution across cosmic time is a fundamental topic in astrophysics. Because their emitted light must travel huge distances to reach the Earth, very distant radio galaxies (the so-called high-redshift radio galaxies or HzRGs) are an important window into the Universe's past: we observe these galaxies how they looked over 10 billion years ago! In particular, HzRGs are luminous beacons for investigating how the most massive galaxies formed in the early Universe, and their link to the massive 'red and dead' giant ellipticals that are the brightest cluster galaxies in the more nearby Universe. We can also gain vital insights into the extreme processes responsible for the growth of their central supermassive black holes (of order a billion solar masses) on very short timescales after the Big Bang.

We have developed a new HzRG selection technique using radio data from the Murchison Widefield Array (MWA). From a pilot study of four sources, we uncovered the second-most distant radio galaxy currently known, observed when the Universe was less than a tenth of its current age! A second radio galaxy from our pilot might be even more distant, and we are currently analysing *Hubble Space Telescope* data to better understand this mysterious source.

Our goal is to find HzRGs within the Epoch of Reionisation (EoR), an early phase of the Universe when the first stars and galaxies formed from the pristine neutral hydrogen gas. For a new sample of 53 HzRG candidates, you will play a leading role reducing, analysing and interpreting the multi-wavelength data that we are currently acquiring from a range of world-class telescopes. The datasets include radio observations from the MWA, Australia Telescope Compact Array (ATCA), Australian Long Baseline Array (LBA), Atacama Large Millimetre/submillimetre Array (ALMA), and the Low-Frequency Array (LOFAR). Additionally, our deep near-infrared data from the Very Large Telescope (VLT) in Chile will form a crucial part of this project.

Your analysis of these rich datasets will provide novel insights into the co-evolution of the supermassive black hole and host galaxy during the first billion years of the Universe. How does the central supermassive black hole grow so quickly? How does it affect the host galaxy and the ambient environment? Do these black holes play an important role in reionising the Universe? How do the powerful radio jets trigger or suppress star formation? Can we detect neutral hydrogen absorption in the environment of a very distant radio galaxy?

The successful candidate will join an experienced international collaboration who have been working on HzRGs for several decades. There will be opportunities to present your research at national and international conferences, as well as to visit European Southern Observatory (ESO) headquarters in Garching, Germany.



Caption: *Left*: GLEAM J0856+0223 at redshift z = 5.55 from our pilot project. This is the second-most distant radio galaxy currently known and seen when the Universe was just one billion years old. Greyscale: VLT near-infrared *K*-band image; red: ALMA 100-GHz radio continuum emission; blue: ALMA 100-GHz molecular emission from CO; yellow cross: where an ALMA spectrum was determined at the host galaxy position. Right: ALMA CO line detections used to determine the redshift.