The Life and Times of High-redshift Radio Galaxies

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Description:
There is now compelling evidence that nearly all galaxies host a super-massive black hole at their centres. Furthermore, these black holes are believed to play a key role in the evolution of their host galaxy. As black holes accrete matter, this matter heats up and radiates intensely, driving material away from the centre of the galaxy. Sometimes this accretion drives powerful bipolar 'jets' that we observe at radio wavelengths, and which can also drive material out from the core. The radio galaxies with the most powerful jets in the early Universe are associated with rapidly growing black holes in massive galaxies with high star-formation rates. These radio jets also drive lots of energy into the galaxy and its environment, influencing them in ways we have yet to fully understand.

We have curated a vast amount of data covering the electro-magnetic spectrum (X-ray to radio including data from the Hubble Space Telescope) on a sample of ~70 radio galaxies which lie in the first half of the Universe's history. Previous studies have used the mid and far-infrared data in order to measure stellar masses, black hole accretion rates and star formation rates for these galaxies. These observations have also revealed how these radio galaxies are commonly found in over-dense regions which are the precursors to massive galaxy clusters in the local Universe.

You will use new radio observations from the Murchison Widefield Array and the Australian Square Kilometre Array Pathfinder and other radio telescopes to determine the mass and growth rate of the black hole and to investigate its interaction with its environment. Specifically:

1. This modelling will obtain the ages and jet power (in Watts) of these galaxies, which can be used to make estimates of the black hole mass and accretion rate. By comparing these values to measurements via other means you will help constrain models of how these jets are related to accretion events onto the black hole, a key unknown in black hole evolution.
2. Polarised radio emission can be used to probe the magnetic fields and the electron density of the galaxy environment. Furthermore, some high frequency radio observations could be used to search for the Sunyaev-Zeldovich effect, which can constrain the mass of the hot gas in the proto-cluster via its interaction with the cosmic microwave background.
3. The effects of the radio jet on a galaxy's environment can also be probed using Hubble data to search for interactions with the radio jets. The radio jet modelling can also predict emission at high energies (UV with Hubble or X-ray) due to inverse-Compton scattering, which can be compared to observations to improve the radio jet modelling.

The successful candidate will join an experienced international collaboration who have been working on radio galaxies for several decades. There will be opportunities to present your research at national and international conferences, as well as to visit the European Southern Observatory headquarters in Garching, Germany, to collaborate with project team members. Additionally there is an option for CSIRO industry internship.

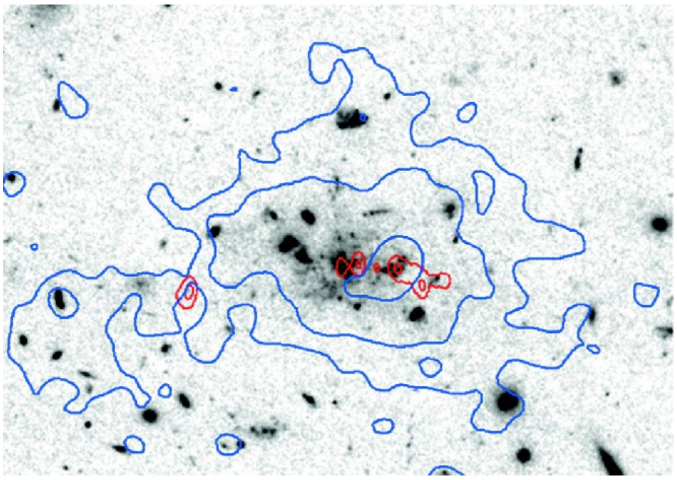

Fig 1: Hubble optical image of the Spiderweb cluster at z=2.16 when the Universe was around one fifth of its current age. The Hubble image reveals a large overdensity of smaller galaxies around the central radio galaxy. The ~100 kpc extent of the powerful radio jets are indicated by the red contours. The blue contours represent the large-scale emission of ionised gas in this proto-cluster providing the fuel for star formation and black hole growth. Credit: Miley et al. (2006).