Monster Black Holes Across Cosmic Time

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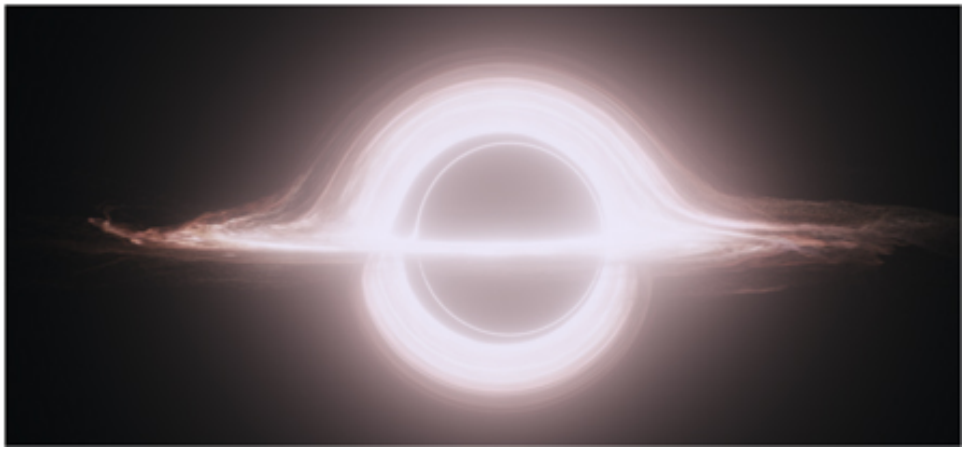
Description: Most galaxies harbour a gargantuan black hole at their centres. Occasionally these black holes become highly active, emitting powerful radio jets which are often associated with extreme rates of material being accreted. These are known as `radio galaxies' and the most extreme examples of these occur in the early Universe when the black hole and its host galaxy are evolving rapidly. These radio galaxies are often found in dense environments with many other galaxies as members of the same `proto-cluster'. The radio jets have a strong and complex interaction with the environment of the radio galaxy.

Powerful radio galaxies represent a key stage in the evolution of the most massive black holes and their host galaxies. This project aims to improve our understanding of super-massive black holes by obtaining and combining detailed multi-wavelength observations. You will use these observations to test models of how black holes accrete and produce jets, as well as how they affect the evolution of their hosts. In particular this project will use data from many different radio telescopes including the Murchison Widefield Array, the Australian Telescope Compact Array as well as the Australian Square Kilometre Array Pathfinder.

In order to understand these enigmatic beasts you will:

(i) analyse and curate multi-wavelength data on a large sample of known radio galaxies in the early Universe;
(ii) model their emission across optical to radio wavelengths in order to constrain the properties of the host galaxy (star formation rate, stellar mass, dust content) and the black hole (accretion rate, jet power, age);
(iii) combine this information to constrain models of black hole evolution. In particular, compare radio galaxies to galactic black holes whose evolution is well studied as well as to test models based on the jet power arising from the spin of the black hole;
(iv) search for new radio galaxies in the early Universe (particularly in the Southern Hemisphere which has been poorly studied historically) - such searches will be augmented by new optical surveys coming on line in the coming years e.g. with NASA's Euclid mission and the Australian Skymapper survey.;
(v) study the impact of the radio jets on their environments.

Black holes are no longer an esoteric area of study. We now know that super-massive black holes play a key role in the evolution of galaxies, hence they are important in explaining the observed state of the local Universe. This project will demonstrate the power of combining highly detailed radio observations with multi-wavelength data to reveal new knowledge about black holes. It will also demonstrate the science that the Square Kilometre Array will eventually do on a much larger scale. This project will be co-supervised by a Square Kilometre Array staff member with the possibility of conducting observations during the commissioning and scientific verification phases. This project may provide an internship at the SKA Australian headquarters.



A realistic simulation of the view of an accretion disk around a spinning black hole seen up close (James et al., 2015, CQG, **32** 065001). Not shown are the accompanying radio jets which would be emitted perpendicular to the accretion disk. These radio jets would allow the black hole to be detected across cosmic time.