Proposed MSc Project – 2026

Probing the nuclear activity of radio AGN in the Boötes field

Supervisor: Dr Zara Randriamanakoto (zara@saao.ac.za)

Student will be expected to register at UCT.

Background: Radio galaxies (RGs) are a subclass of radio-loud AGN in which the accreting supermassive black hole (SMBH) releases energy into the host galaxy environment and ambient medium via relativistic jets. An interesting class of RGs arises when the central engine is subject to intermittent phases of activity and quiescence, that constitute the AGN life cycle, and whereby a quiescent phase can be followed by repeated switching on and off of the accretion onto the central SMBH. The life cycle of these objects is important to study given that they are commonly invoked in models of AGN feedback mechanisms to help understand galaxy evolution. Because of the rapid timescale of particle energy decay, and the paucity of high sensitivity data at multiple wavelengths, only a handful of remnant (or quiescent) and restarted radio galaxies have been detected so far. Nevertheless, these sources may be recognizable in deep low-frequency images as relatively bright and diffuse emission devoid of a core and jets for remnant radio AGN and objects with a compact new core co-existing with dying radio lobes for the restarted ones (see Fig.1). What trigger(s) the jet activity to go through multiple cycles? Which physical mechanisms constrain the AGN duty cycle, i.e. the ratio of active to dormant phases? These are some key questions that we hope to address in this research project.

Project description: This project mainly uses LOFAR/LoTSS and WSRT/Apertif wide-field radio continuum surveys to systematically search for remnant and restarted radio source populations in the LoTSS Boötes Diep Field. Other complimentary catalogues from (u)GMRT as well as the LOFAR international telescope are also retrieved to build the integrated radio spectra of the sources, and hence to help reconstruct the history of the AGN activity. Radio spectral criteria (e.g. spectral index and spectral curvature parameter) combined with visual inspection of the radio emission will be used to classify the nuclear activity of the radio sources, i.e. active vs. quiescent vs. restarted.

Special requirements: Familiarity with Python and any other programming language. Familiarity with radio astronomy software such as CARTA.

References: Brienza et al. 2017, A&A, 606, A98 • Dutta et al. 2023, ApJ, 944, 176 • Morganti 2017, Nature Astronomy, 1, 596 • Morganti, R. 2024, Galaxies, 12, 2 • Murgia et al. 2011, A&A, 526, A148 • Nair et al. 2024, A&A, 691, A287 • Randriamanakoto et al. 2020, MNRAS, 496, 3381 • Williams et al. 2021, A&A, 655, A40

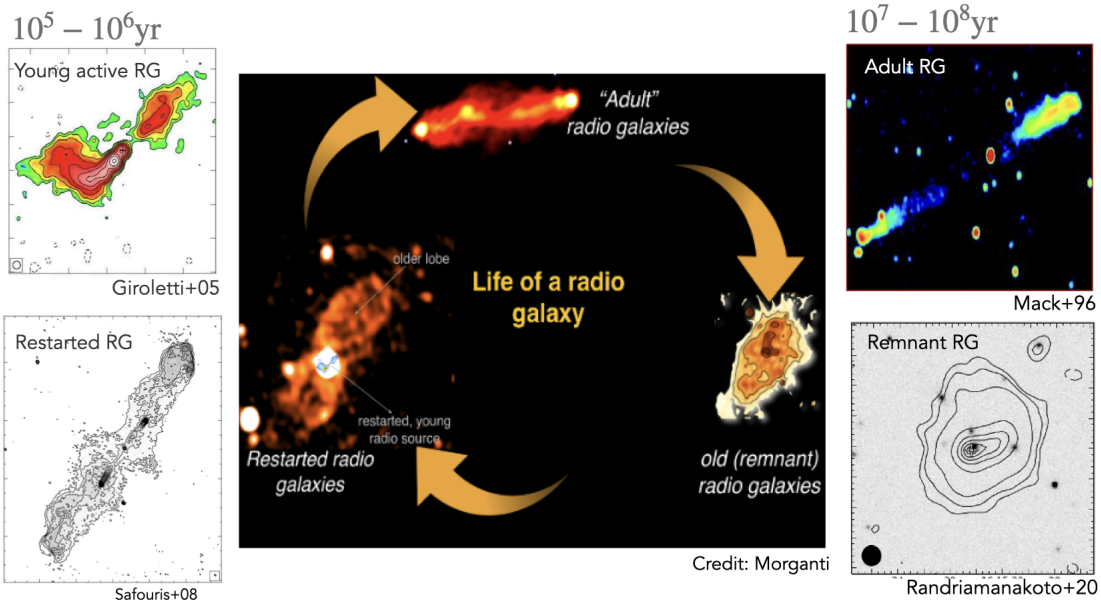

Figure 1: The life cycle of a radio galaxy as illustrated by Morganti (middle panel). Typical examples of young and adult active RGs as well as remnant and restarted ones are shown on both sides of the image.