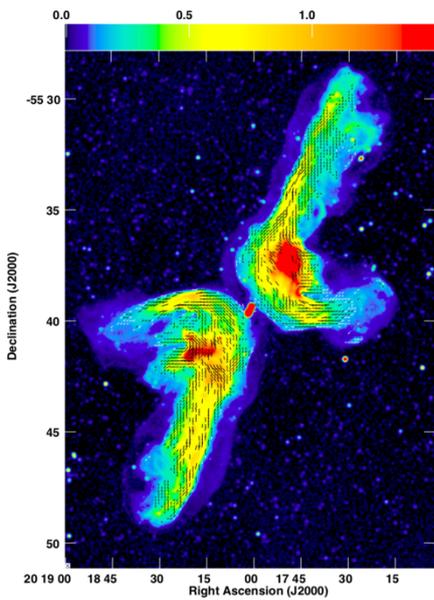


1. **Level of the project:** Masters
2. **Name of the Primary Supervisor:** Dr Sarah White
3. **Institution of the Primary Supervisor:** South African Astronomical Observatory
4. **Contact details of the Primary Supervisor:** sarahwhite.astro@gmail.com
5. **Name of the Co-supervisor:** Dr Moses Mogotsi
6. **Institution of the Co-supervisor:** University of Cape Town / SAAO
7. **Contact details of the Co-supervisor:** moses@sao.ac.za
8. **Project title:** Spectra of G4Jy radio-galaxies
9. **Description of the project:**



Radio telescopes, such as MeerKAT, give us an unparalleled view of the Universe, thanks to being able to detect star formation (i.e. the growth of galaxies), black-hole accretion (i.e. the growth of supermassive black-holes), and diffuse radio-emission (e.g. how radio-jets interact with the surrounding medium). It is also unaffected by dust along the line-of-sight, allowing us to build the most-complete picture of physical processes in these intriguing objects. Furthermore, by observing galaxies at multiple radio-frequencies, we can construct spectral-index maps (Figure 1) and infer the age of the radio emission by measuring the degree of ‘spectral curvature’ in the radio part of the spectrum (Figure 2).

Figure 1: Radio spectral-index map of G4Jy 1613 (Cotton et al., 2020)

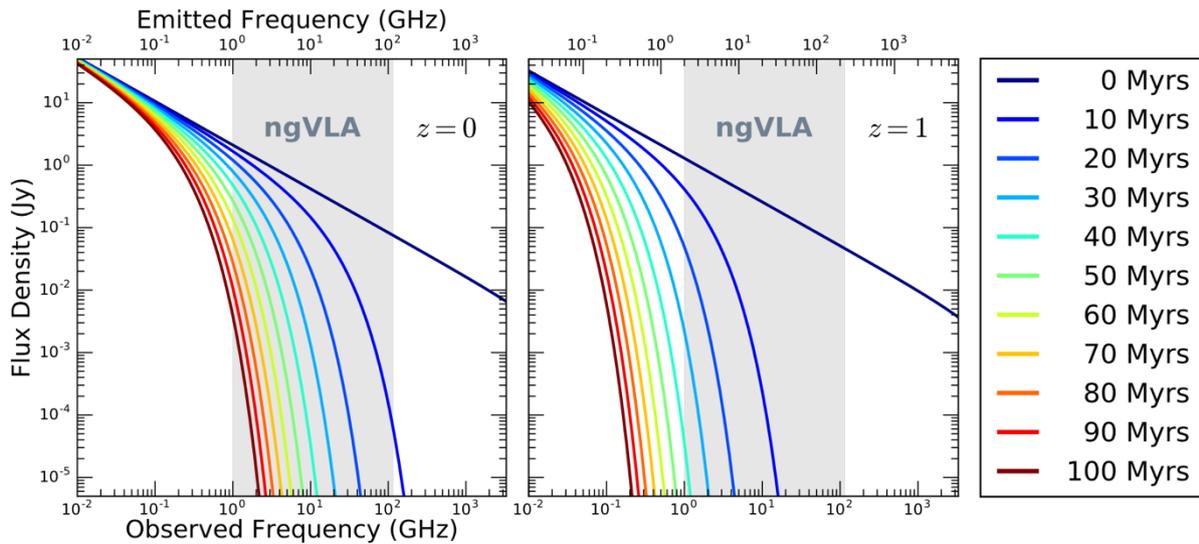


Figure 2: Estimating the age of radio emission via spectral curvature (Harwood et al., 2013; Nyland et al., 2018)

However, we also need to know how far away the galaxies are in order to break the degeneracy between different spectral-age models within a specific observing band. (For illustration, Figure 2 shows the observing band of the next-generation Very Large Array [ngVLA] shaded in grey.) For this we have optical spectroscopy from the Southern African Large Telescope (SALT), where spectral features in the optical part of the electromagnetic spectrum (e.g. Garcia-Perez et al., 2024) allow us to calculate the redshift, z (i.e. a measure of distance), of these radio galaxies for the first time. These redshifts are also crucial for calculating *any* intrinsic property of the radio galaxy, such as its radio power (typically in units of $W \text{ Hz}^{-1}$) and its linear size (in units of kiloparsec, kpc).

This project will provide the student with a valuable *multiwavelength* appreciation of powerful radio-galaxies by: reducing SALT spectra, collating radio images, and constructing radio spectra from radio flux-density ($W \text{ m}^{-2} \text{ Hz}^{-1}$) measurements. They will also develop an understanding of the (now-famous!) G4Jy Sample (White et al., 2020a, 2020b), which is a compilation of $\sim 1,860$ of the brightest radio-galaxies in the southern sky – an excellent, legacy dataset, in preparation for the multi-radio-frequency capabilities of the Square Kilometre Array (SKA).

References for further reading:

- Harwood et al. (2013) – <https://arxiv.org/pdf/1308.4137>
- Nyland et al. (2018) – <https://arxiv.org/pdf/1803.02357>
- Cotton et al. (2020) – <https://arxiv.org/pdf/2005.02723>
- White et al. (2020b) – <https://arxiv.org/pdf/2004.13125>
- White et al. (2020a) – <https://arxiv.org/pdf/2004.13025>
- García-Pérez et al. (2024) – <https://iopscience.iop.org/article/10.3847/1538-4365/ad159e/pdf>

10. Skills required:

The student is expected to demonstrate good programming skills in Python, and excellent organisation aided by diligent book-keeping skills. Their ability to problem-solve when working with new software (such as TOPCAT) is also highly desirable. If interested in this project, the student should contact *both* supervisors as soon as possible.

11. Data availability and resources:

The G4Jy catalogue is available here: <https://github.com/svw26/G4Jy/tree/master/catalogue> and SALT spectroscopy is provided via the multi-semester campaign, 2020-1-MLT-008 (PI: White). These spectra will be reduced using the updated RSS Science Data Pipeline: <https://astronomers.salt.ac.za/software/rss-pipeline/>. Also readily available are radio images from the Rapid ASKAP Continuum Survey (<https://research.csiro.au/racs/>), and radio flux-density measurements from the Australia Telescope Compact Array (ATCA).