

## Section A: Overview of the Research Project Proposal

1. Title: **Imaging classical radio galaxies with MeerKAT and uGMRT. Is a classification revision necessary?**
2. Broad field of research: **Science**
3. Academic level of research project: **Doctoral**
4. Abstract: 45 years after the publication of the citation-record paper *The morphology of extragalactic radio sources of high and low luminosity* (Fanaroff & Riley, 1974, MNRAS 167, 31), the topic of the morphological classification of radio galaxies is again very hot. This project aims to revisit the classification, based on MeerKAT and uGMRT observations of a sample of radio galaxies.
5. Primary supervisor: **Prof Oleg Smirnov**, [o.smirnov@ru.ac.za](mailto:o.smirnov@ru.ac.za), Rhodes University
6. Research supervisors: **Dr Tiziana Venturi**, INAF-IRA (Italy), **Dr Bernard Fanaroff (SARAO)**

## Section B: Research Project Proposal

**Scientific merit:** The Fanaroff & Riley classification, based on images obtained by the 1970's Cambridge interferometer operating at 178 MHz, 408MHz and 5GHz, paved the way to the study of the origin of the radio emission in galaxies and the physics of the propagation of the radio plasma in the intergalactic medium. The sensitivity, frequency and angular resolution of radio interferometers such as the Very Large Array and the Australia Telescope Compact Array, allowed major progress in the field. FRI (low luminosity) and FR II (high luminosity) classes are now known to be associated with different types of galaxies, but no systematic relationship has been established. The two populations of radio galaxies studied in the 3C survey occupy different regions in the redshift space, FRI being mainly found in the local Universe ( $z < 0.2$ ) and FR II being found at cosmological distances. LOFAR has shown that there are low power FR IIs, contrary to the original relationship identified by Fanaroff and Riley (1974) between morphology and radio power.

The advent of the SKA precursors and pathfinders allows a major step forward in the parameter space of observations, and the obvious question is whether this classification is still adequate to represent the radio galaxy population: images from the LOFAR Two-Metre Sky Survey (LoTSS) show emission on much larger angular scales, whose connection with the previously known morphology is so far unclear. The case of NGC326 (Hardcastle et al. 2019, MNRAS, 488, 3416) is a remarkable example.

Research work structure for Year 1. The first year will be fully devoted to the data reduction. During this period the PhD student is expected to become acquainted with the fundamentals of radio interferometry, with the principles of data analysis and with the details of the software developed to reduce the uGMRT and MeerKAT observations. During the first year a new observing proposal will be submitted to MeerKAT and uGMRT to complete the observations of the full sample. The PhD student will be in charge of the observing proposal.

Research work structure for Year 2. The second year will be devoted to the image analysis. In particular, images with both interferometers at various angular resolutions will be produced,

to study the various components of the radio emission in the most suitable way. A spectral analysis will be carried out.

Research work structure for Year 3. The results will be discussed in the framework of the FRI/FRII classification on the basis of the outcome of the imaging process and LOFAR and other surveys. The fundamental questions we have highlighted in the previous sections will be addressed: i.e. is it necessary to amend the FRI/II classification and which other characteristics should be included, and how?

**Feasibility:** The project is based on the data available from two uGMRT and MeerKAT observing proposals, where a starting sample of 12 radio galaxies has been selected, 4 of which have already been observed with both interferometers.

Storage and computing resources for this project will be provided by the compute cluster of the Rhodes Centre For Radio Astronomy Techniques & Technologies (RATT).

**Link to SRAO research priority areas for 2020:** The proposed research project will exploit MeerKAT data awarded in the Open Time call for proposals issued in December 2018. It is therefore directly linked to the highest priority area of the call.

**Any particular qualifications, academic abilities, skills and/or experience that a student should have in order to successfully deliver on the objectives of the research proposed:** familiarity with radio interferometry and observational radio astronomy would be an advantage but it is not strictly required.

**Supervisor**



Oleg Smirnov

7 February 2020