

# UCT Astronomy MSc Project 2024

Level : MSc (Upgradable to PhD)

Supervisor : Prof Mattia Vaccari (UCT/IDIA)

Co-Supervisor : Mr Eslam Hussein (UWC/IDIA)

mattia@mattiavaccari.net      <https://www.mattiavaccari.net>  
eslam@idia.ac.za      <https://www.mattiavaccari.net/hippo>

14 May 2023

## Machine Learning Approaches to Study Star Formation and Black Hole Accretion in the MeerKAT/MIGHTEE survey

Galaxy formation and evolution are driven by two main physical processes: star formation and black hole accretion. Both of these processes can be traced via the synchrotron emission at radio wavelengths. However, a reliable classification of radio sources as star-formation-dominated sources (Star-Forming Galaxies, SFGs), and black-hole-accretion-dominated sources (Active Galactic Nuclei, AGNs), is non trivial and often requires extensive use of multi-wavelength data. Although a lot of progress has been made in this field recently, the rapid growth of radio data from facilities such as MeerKAT, ASKAP, and eventually the Square Kilometer Array (SKA, which will be the world's largest radio telescope), requires the development of efficient and reliable automated techniques for this classification process.

Extragalactic radio surveys currently being performed with MeerKAT, the South African precursor to the SKA, will provide unprecedented radio continuum, spectral line and polarization information for us to study the formation and evolution of SFGs and AGNs in the distant Universe. The rapid growth of radio data from MeerKAT surveys thus provides an excellent opportunity to apply Machine Learning approaches. In this NASSP project, we will optimise machine learning techniques for the classification of MeerKAT radio sources detected in the MeerKAT International GHz Tiered Extragalactic Exploration (MIGHTEE) survey. MIGHTEE (<https://www.idia.ac.za/mightee/>) is a project being undertaken by an SA-led international collaboration of researchers to explore SFG and AGN evolution over cosmic time with MeerKAT, covering over 20 deg<sup>2</sup> of well-studied extragalactic fields. The student will optimise our machine learning methods (An et al. 2018) to classify radio sources detected by the MIGHTEE survey as SFGs and AGNs. The project is expected to lead to the development of original machine learning software as well as a high-impact publication with a publishable catalog of accurately classified SFGs and AGNs of radio sources from the MIGHTEE Survey.

In this project we will develop machine learning algorithms to accurately classify SFGs and AGNs by using MeerKAT data in combination with some of the best multi-wavelength extragalactic survey datasets obtained to date. A reliable classification of radio sources is essential to answer key science questions in modern galaxy formation and evolution studies. The project will thus allow the student to develop a solid background in machine learning and in extragalactic astronomy, but it will also have important implications for science topics to be pursued with MeerKAT and SKA survey projects, and it would thus lend itself to be upgraded to a PhD project. The student will be co-supervised by UCT/IDIA Professor Mattia Vaccari and UWC/IDIA Data Scientist Mr Eslam Hussein within the HIPPO (<https://www.mattiavaccari.net/hippo/>) research group at UCT/UWC/IDIA where (s)he will have access to the ilifu cloud computing facility (<https://docs.ilifu.ac.za>). There will also be an opportunities for collaborative visits to our colleagues at the University of Oxford (UK), University of Bologna (Italy) and elsewhere. The project requires a good understanding of extragalactic astronomy and a good proficiency in python software development as well as the willingness to develop both.

**Please get in touch over e-mail to discuss the project in person!**

**References** : Djorgovski et al. 2013, "Sky Surveys", <https://arxiv.org/pdf/1203.5111v2.pdf>; Ball & Brunner 2010, "Data Mining and Machine Learning in Astronomy", <https://arxiv.org/pdf/0906>.

2173.pdf; Jarvis, Taylor et al. 2016, "The MeerKAT International GHz Tiered Extragalactic Exploration (MIGHTEE) Survey", <https://pos.sissa.it/277/006/pdf>, An et al. 2018, "A Machine-learning Method for Identifying Multiwavelength Counterparts of Submillimeter Galaxies", <https://arxiv.org/pdf/1806.06859.pdf>; Liu et al. 2019, "A machine learning approach for identifying the counterparts of submillimetre galaxies and applications to the GOODS-North field", <https://arxiv.org/pdf/1901.09594.pdf>; scikit-learn tutorials, <https://scikit-learn.org/stable/tutorial/index.html>.