UCT Astronomy MSc Project 2024

Level : MSc (Upgradable to PhD)

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ADFS-MeerKAT : Time-Domain Extragalactic Astronomy with MeerKAT Observations of the Akari Deep Field South

Astrophysics is undergoing a data deluge. Over the past decade the advent of large-format digital detectors and automated survey telescopes have increased the size and complexity of datasets available for astrophysical studies by several orders of magnitude. Over the next few years an extra layer of complexity and related discovery potential will be provided by the coming of age of time-domain astronomy, with telescopes scanning the whole sky every night at multiple wavelengths to detect transient phenomena. Making sense of these datasets calls for a new approach toward the automated study of many millions (and soon billions) of astronomical objects. In this context, Machine Learning algorithms that can 'learn' from the data with a small degree (if any) of interaction/supervision on the scientist's side are increasingly being used.

Extragalactic radio surveys currently underway with MeerKAT, the South African precursor to the Square Kilometre Array (SKA), provide us with unprecedented opportunities to study the formation and evolution of Galaxies and AGNs in the distant Universe. In this context, between 2019 and 2021 we obtained 10 single-epoch observations of one MeerKAT/MeerLICHT pointing centred on the sky area known as the Akari Deep Field South (ADFS, `https://mattiavaccari.net/adfs/`), which are currently being reduced on IDIA's cloud computing facilities. There are thus several opportunities for students to join our team and work on this newly acquired data as well as on the large body of multi-wavelength data already available in this field, which will allow us to study source variability as a function of its physical properties. As part of this project, the student will work on the optimisation of the radio source extraction and variability detection pipeline and on the multi-wavelength properties of radio-variable candidate sources compared to the general extragalactic population. Conventional approaches toward source detection and classification e.g. based on fitting multi-wavelength spectral energy distributions will be combined with machine learning approaches to put constraints on the variability of the faint radio source population.

The project will allow the student to develop a good background in multi-wavelength extragalactic astronomy as well as in data analysis and machine learning techniques, 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 UCT/IDIA Senior Lecturer Lucia Marchetti within the HIPPO (`https://www.mattiavaccari.net/hippo/`) research group, and (s)he will have access to IDIA's ilifu cloud computing facilities (`https://docs.ilifu.ac.za`). There will also be opportunities for collaborative visits to our colleagues at the University of Missouri (USA), University of Bologna (Italy) and elsewhere. The project requires a basic 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`; Graham et al. 2012, "Data challenges of time domain astronomy", `https://arxiv.org/abs/1208.2480`;

Ball & Brunner 2010, "Data Mining and Machine Learning in Astronomy", https://arxiv.org/pdf/0906.2173.pdf; scikit-learn tutorials, https://scikit-learn.org/stable/tutorial/index.html.