MSc AND PhD BURSARIES FOR 2022

CENTRE FOR RADIO COSMOLOGY

UNIVERSITY OF THE WESTERN CAPE

DEADLINE: 24 May 2021

The Centre for Radio Cosmology (CRC) at UWC is internationally recognised for its research in cosmology and galaxy evolution with MeerKAT, the Square Kilometre Array (SKA) and other telescopes. The CRC is heavily involved in the South African and international SKA Projects. In 2021, 25 PhD/ MSc students and 13 postdoctoral fellows are doing astrophysics research at UWC. See http://astro.uwc.ac.za for further details. The CRC is closely linked to IDIA (Inter-University Institute for Data Intensive Astronomy) at UWC: see https://www.idia.ac.za

The CRC is offering MSc and PhD bursaries for 2022. Successful applicants will be supervised by Prof Mario Santos, Prof Roy Maartens, Prof Lerothodi Leeuw, Dr Ed Elson or Dr Michelle Lochner, on cutting-edge projects described briefly below. The available topics cover the Key Science goals of the SKA in cosmology and galaxy evolution – which have synergies with the science goals of the major upcoming optical/ infrared surveys, such as DESI, *Euclid* and LSST.

Students also have the possibility to be co-supervised by UWC IDIA researchers Prof Russ Taylor and Prof Mattia Vaccari, and by visiting Professors Romeel Davé (University of Edinburgh), Matt Jarvis (Oxford University), Stefano Camera (University of Turin), Phil Bull, Chris Clarkson and Alkistis Pourtsidou (Queen Mary University of London). Students will also have opportunities to spend time in institutions abroad (depending on the pandemic), in particular the ones just mentioned.

APPLICATIONS

Applicants should email a single PDF document containing the following:

- a CV
- transcripts of all university-level results
- a brief statement of research interests, related to the topics below (1 page)

Applicants should also arrange for 2 reference letters to be sent directly to us by referees, with the same closing date.

Email address: mgrsantos@uwc.ac.za
Deadline: 24 May 2021

Preference will be given to students who fit into the demographic guidelines provided by the NRF and SARAO (SA Radio Astronomy Observatory).

BURSARY VALUES

CRC bursaries are at the same level as bursaries from the SARAO. The 2022 levels for **Full Cost of Study** are:

MSc: 2 years at R172,900 per year
+ travel grant (up to R29k/year) + equipment grant (up to R27k for 2 years)
PhD: 3 years at R180,430 per year
+ travel grant (up to R36k/year) + equipment grant (up to R40k for 3 years)

(Please check NRF/SARAO rules for eligibility requirements.)

BURSARY CONDITIONS

Bursaries are granted on a year by year basis - i.e. continuing into the next year depends on satisfactory progress.

RESEARCH TOPICS

We offer a range of topics that tackle some of the big questions at the forefront of international cosmology and galaxy evolution. Research students in South Africa have a historic opportunity provided by MeerKAT and the future SKA. In each topic below, there is a focus on MeerKAT and SKA, and their synergy with other surveys.

Training in cutting-edge theory, computation, simulations and data science will be provided.

1. Measuring neutral hydrogen (HI) across cosmic time with MeerKAT.
We will use MeerKAT observations to make statistical detections of neutral hydrogen intensity on cosmological scales. There are several projects, from more technical data analysis to simulations of the signal. These include the measurement of the power spectrum and detection of the elusive Baryon Acoustic Oscillations that can constrain Dark Matter and Dark Energy. The data analysis techniques use state of the art statistical methods including machine learning algorithms.

2. Unveiling the properties of HI galaxies.
Using existing multi-wavelength observations and upcoming MeerKAT data, we will investigate the properties of HI in galaxies, giving new information on the HI and Dark Matter content of the Universe. There are 2 possible projects. (a) Statistical techniques like ‘stacking’ will allow us to probe the mass function of HI galaxies down to low flux limits. (b) Using HI spectral line observations from current data, in particular MeerKAT, to study nearby HI galaxies and quantify their dynamics, mass distribution and star formation properties.

3. Probing the first galaxies in the Universe.
We will investigate the Epoch of Reionization and use HERA (https://reionization.org) data to probe the HI 21cm signal from the early Universe. There are several projects, including simulations of the signal, the observation pipeline and data analysis techniques (such techniques can include machine learning methods as well).

4. The radio continuum sky below the detection threshold.
We will develop and apply statistical techniques (e.g. stacking, P(D)) to radio continuum data from current surveys, in particular MeerKAT, to study the properties of radio galaxies below the detection threshold. This will allow us to constrain their source counts, luminosity functions and even 2-point correlation functions at very low flux limits.

5. Machine Learning in Astronomy
Telescopes such as the SKA and the Vera C. Rubin Observatory in Chile will produce enormous quantities of data that will require novel techniques to analyse. This research topic aims to develop machine learning techniques for astronomical datasets, including those from MeerKAT. Of particular interest is the development of anomaly detection algorithms capable of discovering rare or even never seen before objects in large data.

6. Probing Dark Energy.
Dark Energy is thought to be the source of the accelerating expansion of the Universe, and its properties can be accurately measured by using the probes extracted from HI and other surveys – such as the power spectrum, bispectrum, BAO scale, redshift-space distortions (RSD) and weak lensing. There are several possible projects, associated with different probes.

7. Testing Einstein's theory of General Relativity.
We will explore whether the acceleration of the Universe is possibly not from Dark Energy, but instead from a modification of General Relativity – again, using the probes from HI and other surveys (especially RSD). There are several possible projects, associated with different probes and different tests.

8. Extracting 'fossil' information from the very early Universe.
The primordial fluctuations generated in the first instants of the Universe provide the seeds for the formation of CMB anisotropies and large-scale structure. Imprints of the primordial Universe are 'frozen' in the large-scale distribution of matter. Using HI and other surveys, we can extract this 'fossil' information using some of the probes listed in Topic 5. There are several possible projects, associated with different probes and different properties.

We can also consider **other topics** on a case by case basis.