South African Square Kilometre Array Project

Postgraduate Scholarship Programme

PhD and MSc Bursaries for 2012

Information Manual

Application forms should be completed electronically at

http://phoenweb.nrf.ac.za/FPF2/
1. **Background of the South African Square Kilometre Array Project**

The South African SKA Project is a project of the Department of Science and Technology and the National Research Foundation and comprises Africa’s bid to host the Square Kilometre Array Radio Telescope (SKA), the design, construction and operation of the Karoo Array Telescope (MeerKAT) and a youth into science and engineering programme focused on supporting science and engineering students and postdoctoral fellows.

Africa has been short-listed with Australia to host the SKA. If Africa is selected to site the SKA, the core of the telescope will be located in the Karoo region of the Northern Cape with additional stations distributed throughout South Africa, Zambia, Mozambique, Namibia, Botswana, Mauritius, Madagascar, Ghana and Kenya.

The SKA will:

- Revolutionize our understanding of the Universe
- Be completed by 2025 with a life-span of at least 50 years
- Be the next generation radio telescope for the global community
- Be continually upgradeable as computer power increases
- Use new technology antennas, signal transport, signal processing and computing in a marriage between radio frequency technology and information and communication technology.
- Consist of an array of 3000 antennas spread over 3000 km

To contribute towards the development of technology and science for the SKA, South Africa is building MeerKAT at the same site selected for the SKA. MeerKAT will be the most sensitive centimeter-wavelength radio telescope in the southern hemisphere, and will make significant contributions to both galactic and extragalactic astronomical research. MeerKAT will explore phenomena such as cosmic magnetism, the evolution of individual galaxies and clusters of galaxies, the influence of dark matter on galaxies and clusters, and the nature of transient radio sources. The first seven-antenna prototype array (KAT-7) is already being commissioned and will do science in 2012. The full MeerKAT array of to 64 dishes will start to do science in 2013.

For more information visit [www.ska.ac.za](http://www.ska.ac.za) and [www.skatelescope.org](http://www.skatelescope.org)
2. **The SOUTH AFRICAN SKA Project’s Youth into Science and Engineering Programme**

To increase the number of highly-skilled scientists and engineers able to support the SKA and MeerKAT during the design, construction and operational phases of the telescopes, the South African SKA Project Office initiated a youth into science and engineering programme in 2004. Part of this programme supports postgraduate students. The objective in the first instance is to provide sufficient numbers of scientists and engineers to participate in the design and construction of the MeerKAT and the SKA, and to use these telescopes once they are operational, so further developing a vibrant South African astronomy research and teaching community. MSc and PhD bursaries have been awarded to South African students and students from other countries in Africa, studying at South African universities or at universities in the African countries that have partnered with the South African SKA site proposal.

3. **Eligibility for bursaries from the South African SKA Postgraduate bursaries Programme**

The following students may apply for South African SKA Project postgraduate bursaries:

3.1. South African citizens and permanent residents of South Africa who wish to complete an MSc or PhD degree at a South African university.

3.2. Non-South Africans from other countries in Africa who wish to complete an MSc or PhD degree at a South African university.

3.3. Non-South Africans from other countries in Africa who wish to complete an MSc or PhD degree at a university in an South African SKA Partner Country: Namibia, Zambia, Botswana, Mozambique, Madagascar, Mauritius, Kenya and Ghana.

4. **Research topics and supervisions of research**

4.1. The research focus for the SKA PhD and MSc bursaries must align very closely with specific areas of MeerKAT, SKA, PAPER and C-BASS science and technology where research is required.

4.2. The MSc and PhD projects (particularly the astronomy projects) must include a component of practical skills development (e.g. data analysis and / or computer simulations) so that the student acquires the necessary skills to become a competent (radio) astronomy researcher or engineer.

4.3. For 2012, the research projects must be in the following general fields:
• **Observational radio astronomy and cosmology:**
  - The evolution of galaxies
  - The low HI column density universe
  - HI distribution in nearby galaxies and groups
  - HI absorption surveys (and OH mega-masers)
  - Galactic structure and the magellanic clouds
  - Cosmic magnetism
  - Pulsars and transients
  - High – z CO
  - PAPER and C-BASS observations, data processing and scientific analysis
  - Science based on VLBI observations

• **Experimental cosmology**
  - Computer simulations with a direct link to the above observational science.

• **Radio astronomy engineering and instrumentation technologies including:**
  - Broadband feeds with matched low noise amplifiers
  - High speed digital signal processing systems
  - Implementation of radio astronomy algorithms on high performance and reconfigurable computing platforms (including CPUs, GPUs and FPGAs)
  - Packaging and interconnection of highly integrated subsystems (EMI, power & cooling considerations)

**Note:**

Projects deemed to directly address critical aspects of MeerKAT science and engineering will be given priority over those with a more generic scope

4.4. All applicants (except students who wish to complete their MSc degree through the National Astrophysics and Space Science Programme - NASSP) **MUST** complete the Research Project Information section of the application form. This section refers to the details of the research project being proposed. **Any application that does not include details of the research project being proposed will not be considered for a scholarship.**

4.5. The South African SKA Project has partnered with a number of supervisors who are available to supervise students. Table 1 lists the research topics that the partner
supervisors have specified. Students will have to conduct their studies at the university where the partner supervisor is based.

4.6. Alternatively, if a student wishes to undertake a project that does not appear on this list, he/she is free to submit a proposal for consideration, together with motivation for why the proposed project is relevant to the design, construction and scientific research goals of the MeerKAT and/or SKA. However, the research projects must be in the following general fields as indicated in section 4.3.

4.7. Students who wish to pursue MSc or PhD research in **Digital Signal Processing** must refer to Annexure A of this document to ensure that their proposed research is aligned with the current MeerKAT Digital Signal Processing research programme.

4.8. Students who wish to pursue MSc or PhD research in **High Performance Computing** must refer to Annexure B of this document to ensure that their proposed research is aligned with the current MeerKAT High Performance Computing research programme.

4.9. All South African SKA Project postgraduate scholarship-holders are required to be supervised by appropriately qualified and experienced academics linked to the university at which the student will be registered. Co-supervision by domain specialists within and outside the university is acceptable. All applications **MUST** include the details of the supervisor and **MUST** be submitted with the approval of the supervisor. **Any application that does not include the details of the supervisor and the approval of the supervisor will not be considered for a scholarship.**

4.10 **MSc degree with the National Astrophysics and Space Science Programme (NASSP)** The South African SKA Project will also consider applications from students who wish to pursue an MSc degree through the National Astrophysics and Space Science Programme (NASSP) hosted by the University of Cape Town (UCT). For details on the MSc and programme at NASSP visit their web site: [http://www.star.ac.za/](http://www.star.ac.za/)

Students must apply to NASSP at the same time as their application for an SKA scholarship.
Note:

- For the NASSP MSc course, students will spend the first semester at UCT completing the taught component of the MSc. This consists of 6-8 courses taught by South African researchers.

- Thereafter, students will work on a research topic under the supervision of scientists from one of the institutions participating in NASSP and the student will then be registered for an MSc at that institution.

- A student wishing to complete their MSc degree through NASSP does not have to have chosen their research topic when applying for the South African SKA Project scholarship. Students will be given the opportunity to select a research topic with a supervisor during the taught component of the MSc. However, the research chosen by a NASSP MSc student must be in the fields of research listed in section 4.3.

- Students who wish to complete a NASSP MSc degree, and who are short listed for a South African SKA Project scholarship will have to provide proof of acceptance by NASSP before the South African SKA Project will confirm award of a scholarship.
Table 1: PhD and MSc Research Projects for 2012

<table>
<thead>
<tr>
<th>Project title</th>
<th>Level</th>
<th>Supervisor</th>
<th>University</th>
<th>Project Description</th>
<th>Qualifications required</th>
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<tbody>
<tr>
<td>The cosmic evolution of molecular hydrogen in galaxies</td>
<td>MSc</td>
<td>Prof. Roy Booth <a href="mailto:roy@hartrao.ac.za">roy@hartrao.ac.za</a></td>
<td>University of the Witwatersrand</td>
<td>Neutral atomic hydrogen (HI) and molecular hydrogen (H$_2$) play a primordial role in the cosmic evolution of galaxies. However, little is known about the molecular hydrogen or the co-evolution of the two gas phases. This discrepancy and the design of future telescopes like ALMA and SKA require further information of the relative importance of the two species, especially at high red-shift, so that important observations are not designed out! In this project we will examine published data on the molecular content of galaxies as a function of their type and red-shift, where carbon monoxide, CO, has been used as a tracer of molecular hydrogen since the latter has no easily observable transitions save when in an excited state. We will also use theoretical data (e.g. that of Obreschkow and Rawlings) and statistically check their predictions against the observational data.</td>
<td>Honours in physics or astronomy</td>
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<tr>
<td>Various projects available</td>
<td>MSc, may lead to PhD.</td>
<td>Dr. Girish Kumar Beeharry (Projects 1-5) and associates <a href="mailto:gkb@uom.ac.mu">gkb@uom.ac.mu</a> Dr. Shailendra Oree (Projects 4 and 5) <a href="mailto:gkb@uom.ac.mu">gkb@uom.ac.mu</a> Dr. Roddy Lollchund (Projects 4 and 5) <a href="mailto:gkb@uom.ac.mu">gkb@uom.ac.mu</a></td>
<td>University of Mauritius</td>
<td>1-Imaging for wide field non-coplanar Interferometers 2-Clusters 3-Supernova remnants 4-Reconfigurable Receiver System: USRP/ROACH etc. 5-GPU based correlation &amp; analysis</td>
<td>BSc (Hons) Physics/Astronomy BEng (Hons) Electronics &amp; Communications Good computational skills</td>
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<tr>
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<tr>
<td>CO Probe of High-z Galaxies</td>
<td>PhD and MSc</td>
<td>Dr. Lerothodi Leeuw, <a href="mailto:Lerothodi@alum.mit.edu">Lerothodi@alum.mit.edu</a></td>
<td>University of Johannesburg</td>
<td>Observations and reduction of high-z CO spectroscopy data as a probe of redshift, structure, and evolution of high-z galaxies, some newly discovered in ongoing surveys we are involved in.</td>
<td>In the case of MSc and PhD candidates respectively, Honours and Masters Degrees in Astrophysics or Physics are required, together with some computing skills and a strong interest in observational astrophysics.</td>
</tr>
<tr>
<td>Radio Recombination Line Modelling</td>
<td>PhD and MSc</td>
<td>Prof Derck Smits, 082 388 2705 / (012) 429 6345, <a href="mailto:smitdp@unisa.ac.za">smitdp@unisa.ac.za</a></td>
<td>UNISA</td>
<td>The physics of gaseous nebulae is well understood and can be used in models to determine physical conditions in many different astronomical environments. However, parameters of gasses derived from observations of radio recombination lines give different results to those from optical lines. Approximations used for optical lines are not appropriate for radio lines so the models for radio recombination lines need to be revised. The physics of all processes will be carefully assessed and appropriate models developed. The results from the revised codes will be checked against observations from single dish radio telescopes and array observations. These models will also be used to interpret ALMA observations, which fall in between the radio and optical regime. The models for the ALMA wavebands require careful consideration of the approximations used in the models.</td>
<td>BSc Hons or MSc in astronomy</td>
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<tr>
<td>Project title</td>
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<tr>
<td>Polarization of astronomical masers</td>
<td>PhD and MSc</td>
<td>Prof Derck Smits 082 388 2705 / (012) 429 6345 <a href="mailto:smitsdp@unisa.ac.za">smitsdp@unisa.ac.za</a></td>
<td>UNISA</td>
<td>Zeeman splitting of OH masers provides a method of measuring magnetic fields in the cosmos at the milliGauss level. However, there are conflicting results regarding theoretical modelling of polarization in masers which needs to be investigated so that a reliable interpretation of maser polarization can be achieved. Theoretical results will be checked against the archival data from VLA, EVN and MERLIN of events such as the excited OH maser flare in Mon R2.</td>
<td>BSc Hons or MSc in astronomy</td>
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<tr>
<td>Structure and Dynamics of Massive Star-forming Regions</td>
<td>PhD and MSc</td>
<td>Prof Derck Smits and Dr Gordon McLeod 082 388 2705 / (012) 429 6345 <a href="mailto:smitsdp@unisa.ac.za">smitsdp@unisa.ac.za</a></td>
<td>UNISA</td>
<td>Massive star forming regions reside in cool dark giant molecular clouds that are difficult to penetrate using optical telescopes as a result of dust obscuration. As a giant molecular cloud coalesces into a star it warms and becomes visible in the far-infrared portion of the spectrum detectable by both the IRAS and SPITZER satellites. The structure and the dynamics of the HII region and its interaction with the parental cloud also can be studied via radio astronomy techniques. MeerKAT will be an excellent facility to carry out detailed investigations of massive star-forming regions. Until MeerKAT is available for use the student will utilise archival data from the Very Large Array, Socorro NM USA, and Merlin, Great Britain, telescopes. In particular the student will investigate the relationship between the HII region and the associated OH, H2O and CH3OH astrophysical masers. The student will apply for observing on existing interferometers and Very Long Baseline Interferometry networks. This project can be divided into an MSc and PhD level thesis project.</td>
<td>BSc Hons or MSc in astronomy</td>
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This project may identify areas requiring further investigation using observations at various observatories including KAT-7 and MeerKAT.

This Doctoral level project will entail: (a) detailed analysis of archival data, both continuum and spectroscopic data, from the VLA and Merlin (b) follow-up observations of selected massive star forming regions on existing observatories including KAT-7 once operational, EVN, ATCA, LBA, etc. The student shall endeavour to determine the evolution and dynamics of the massive star-forming region.

<table>
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<tr>
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<tbody>
<tr>
<td>Many project options</td>
<td>PhD and MSc</td>
<td>1. Prof. Erwin de Blok <a href="mailto:edeblok@ast.uct.ac.za">edeblok@ast.uct.ac.za</a></td>
<td>University of Cape Town</td>
<td>The projects include:</td>
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<td>2. Prof Renée Kraan-Korteweg <a href="mailto:kraan@ast.uct.ac.za">kraan@ast.uct.ac.za</a></td>
<td></td>
<td>1. Reducing and analysing HI data, mostly galaxy dynamics</td>
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<td>3. (Partly in collaboration with other departmental staff members and/or international co-supervisors)</td>
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<td>2. HI surveys of the Zone of Avoidance</td>
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<td>3. HI surveys in general</td>
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<td>4. Tully-Fisher studies (in ZOA, whole-sky, deep MeerKAT field)</td>
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<td>5. Preparation for MeerKAT projects</td>
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<td>6. MeerKAT simulations of HI surveys</td>
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<td>7. Deep HI surveys with MeerKAT</td>
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1. Previous radio astronomy experience is an advantage, but not required for these projects.
2. Some background in astrophysics.
3. People with an engineering background who are interested in doing astronomy research. UCT has had extremely good experiences with students in this regard.
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<tbody>
<tr>
<td>HI in the Galaxy Cluster Abell 1437</td>
<td>MSc</td>
<td>Dr. Sarah Blyth <a href="mailto:sarblyth@ast.uct.ac.za">sarblyth@ast.uct.ac.za</a></td>
<td>University of Cape Town</td>
<td>Galaxy clusters are ideal laboratories to study galaxy evolution in dense environments. We aim to investigate the distribution of HI in galaxies in the cluster A1437 by analysing observations taken using the Giant Metrewave Radio Telescope (GMRT).</td>
<td>BSc. Hons: Physics or Astrophysics</td>
</tr>
<tr>
<td>Optimising/Parallelising Algorithms for Radio Astronomy Data Reduction</td>
<td>MSc</td>
<td>Dr Sarah Blyth <a href="mailto:sarblyth@ast.uct.ac.za">sarblyth@ast.uct.ac.za</a>, Dr. Kurt van der Heyden <a href="mailto:heyden@ast.uct.ac.za">heyden@ast.uct.ac.za</a>, Dr Michelle Kuttel <a href="mailto:mkuttel@cs.uct.ac.za">mkuttel@cs.uct.ac.za</a></td>
<td>University of Cape Town</td>
<td>With the large data volumes expected from MeerKAT and other SKA pathfinders, optimisation of existing data reduction algorithms is necessary in order to analyse data in reasonable time frames. This project will address issues of parallelisation of algorithms for reduction and source-finding using appropriate architectures (e.g. GPUs).</td>
<td>BSc Hons: Computer Science or Electrical Engineering</td>
</tr>
<tr>
<td>Multiwavelength Extragalactic Astronomy in the era of SALT and MeerKAT</td>
<td>PhD and MSc</td>
<td>Dr. Kurt van der Heyden <a href="mailto:heyden@ast.uct.ac.za">heyden@ast.uct.ac.za</a>, Prof. Bruce Bassett <a href="mailto:bruce@saao.ac.za">bruce@saao.ac.za</a>, Dr. Matt Jarvis <a href="mailto:MJJarvis@herts.ac.uk">MJJarvis@herts.ac.uk</a></td>
<td>University of Cape Town, AIMS/SAAO, University of Hertfordshire</td>
<td>MeerKAT will provide a wide array of exciting continuum radio science that can be powerfully combined with data at other frequencies. This project will allow you to develop skills in continuum radio science as well as broad multi-wavelength skills with the chance to work with overseas collaborators on current datasets such as LOFAR, VISTA and SDSS. The detailed nature of the project within this framework will be determined in discussions with the chosen student to match their interests while maximally preparing for MeerKAT and SALT, but examples include radio lensing and probing the magnetic fields in clusters and the field.</td>
<td>BSc Honours / MSc (Maths / Physics / Astronomy) or BSc / MSc (Eng)</td>
</tr>
<tr>
<td>Various projects available</td>
<td>PhD and MSc</td>
<td>1. Prof. Kaviulan Moodley <a href="mailto:moodleyk41@ukzn.ac.za">moodleyk41@ukzn.ac.za</a>, 2. Dr. Mirjana Povic, 3. Dr. Caroline Zunckel, 4. Dr. Ryan Warne, 5. Dr. Matt Hilton</td>
<td>University of KwaZulu-Natal (Astrophysics &amp; Cosmology Research Unit)</td>
<td>1. Pulsar timing: modelling and analysis of pulsar timing data 2. The baryonic Tully Fisher relation as a cosmic distance measure 3. Multiwavelength studies of active galactic nuclei: from radio to X-rays 4. Constraining primordial non-Gaussianity with HI galaxies and the 21 cm background</td>
<td>Relevant background courses in astronomy/ cosmology; computational skills will be useful</td>
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| Radio Galaxy Evolution studies using Multiwavelength Cross-Correlations | PhD and MSc | Prof Matt Jarvis  
M.J.Jarvis@herts.ac.uk | University of the Western Cape | Feedback from radio galaxies plays an important role in the evolution of galaxies and understanding galaxy evolution is essential if galaxies are to be used for cosmological studies. Optical and IR surveys have finally reached depths where redshifts of large numbers of faint radio galaxies can be obtained and one can measure the evolution of the radio luminosity function and the environment of these sources. This project will potentially use data from FIRST, NVSS, GAMA, SDSS, UKIDSS, GMRT and the INT to make the first measurements of parameters which are key to understanding radio galaxy evolution and hence important for feedback and cosmological studies. | Honours with some Astronomy background and good computational skills                                        |
| Galaxy Evolution and Cosmology Simulations       | PhD and MSc   | Prof. Catherine Cress and Dr. Andreas Faltenbacher  
ccress@uwc.ac.za | University of the Western Cape | Cosmological-scale simulations provide an essential tool for testing theories of galaxy evolution and cosmology. In this project, Active Galactic Nuclei will be modelled within the Millennium simulation providing estimates of (a) AGN contamination of X-ray fluxes from clusters of galaxies, (b) AGN contamination of Sunyaev-Zeldovich signatures of clusters in CMB experiments and (c) source counts of faint radio sources in MeerKAT/SKA observations. These estimates are essential for extracting cosmological information from CMB data, radio surveys and cluster data. The project could be extended and upgraded to a PhD project. | Honours with some Astronomy background and good computational skills                                        |
| Multi-Wavelength Studies of Star forming cluster populations | PhD and MSc | Dr. Steve Crawford  
crawford@saao.ac.za and Prof. Catherine Cress  
ccress@uwc.ac.za | SAAO  
University of the Western Cape | Student will undertake a multi-wavelength study of star forming galaxies and other cluster populations in intermediated redshift galaxy clusters to better understand the physical process driving the evolution in the most massive structures in the Universe. |                                                                                                            |
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<tr>
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<tbody>
<tr>
<td>Modelling Heterogeneous Signal Processing Backends for Radio Astronomy</td>
<td>MSc</td>
<td>Prof. Mike Inggs (ph) 021 6502799</td>
<td>University of Cape Town</td>
<td>Next generation radio astronomy backends will be implemented using combinations of custom digital hardware, GPUs and multicore technologies. This project will involve the review and development of system models that can be used to verify the performance of radio astronomy instruments on a system level.</td>
<td>BSc (Eng) or BSc(Comp Sci) or BSc(Math) or BSc (Phy)</td>
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<tr>
<td>Python SystemC interface</td>
<td>MSc</td>
<td>Prof. Mike Inggs (ph) 021 6502799</td>
<td>University of Cape Town</td>
<td>SystemC is an IEEE standard for system level modelling which provides simulations speeds thousands of times more than signal event simulators for verilog and vhdl. This project will involve the development of a python interface to System C to allow development of System C models from within the Python. This will then be used to model a spectrometer running on ROACH 2 hardware.</td>
<td>BSc (Eng) or BSc(Comp Sci) or BSc(Math) or BSc (Phy)</td>
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<tr>
<td>Design of the signal processing frontend for MeerKAT digital receiver</td>
<td>MSc</td>
<td>Prof. Mike Inggs (ph) 021 6502799</td>
<td>University of Cape Town</td>
<td>MeerKAT will include a digital receiver close to the antenna feed with the responsibility to sample the sky frequency directly and extract frequency bands for processing by the downstream digital backend. This project will involve the design (included detailed simulation) of the digital frontend.</td>
<td>BSc (Eng) or BSc(Comp Sci) or BSc(Math) or BSc (Phy)</td>
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</tbody>
</table>
| Electromagnetic Systems and EMI Mitigation for SKA | Postdoctoral / PhD / MSc (as indicated) | Profs Davidson, Meyer, Palmer, Reader and Drs de Villiers and Geschke | University of Stellenbosch | This project is envisaged to cover a variety of topics at different levels, relating to the field of the chair. Many of these projects will be closely linked to the local industries involved in MeerKAT/SKA. The topics include the following:  
• Extensions of the Characteristic Basis Function Method to arrays (Post-doc/PhD). (This is a method for accelerating computational simulation using the moment method. Good results have already been obtained in a previous MSc, but further work is needed to make the method fully usable for MeerKAT.)  
• Simulation of infinite and finite arrays using the finite element method (Post-doc/PhD/MSc). (The FEM is particularly suitable for modelling complex | For MSc projects: A BSc Eng or BEng degree which included modules on Electromagnetics and Radio Frequency/High Frequency techniques.  
For PhD projects: An MSc Eng with a thesis in the field of Electromagnetics/Antennas/RF Electronics.  
For post-docs: A PhD |
- Feed network issues for arrays (PhD/MSc). (Feeding a large array is a non-trivial issue, in particular with non-ideal transmission lines, and this project focuses on the antenna/RF front end issues – another project investigates the RFI problems.)
- RFI Mitigation for MeerKAT (Post-doc/PhD) (This is a continuation of work on the RFI hardening of the single-dish prototype to the full 80 dish system).
- RFI Mitigation for Aperture Array Schemes Including Bunkers and Cables (PhD/MSc) (This couples closely with the above, but considers the new issues raised by aperture arrays and the associated complex cable layouts. In addition to this, protection of these systems against environmental RFI and direct/indirect lightning is a challenge that we wish to address.)
- Electronically Reconfigurable Wide-band Filters for MeerKAT (PhD/MSc) (Using new multilayer technology and manufacturing ability available at our research partner institution, Heriot-Watt University in Edinburgh, this project aims to investigate the design of a wide-band filter for MeerKAT. Using LTCC (Low-Temperature Co-fired Ceramic) technology, multilayer filters can be obtained that are compact and permit design flexibility not available in standard planar designs, such as fine-tuning of the passband response and moveable transmission zeros to eliminate in-band spurious signals. The student will spend a few months of her/his time at Heriot-Watt.
- Wideband feeds. (MSc) (Central to the current MeerKAT design is the feed horn, and investigations on broadening its bandwidth are ongoing.)

Additionally, other topics may be addressed.
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<tbody>
<tr>
<td>MeerKAT/SKA reflectors and feeds</td>
<td>PhD/MSc</td>
<td>Dr DIL de Villiers</td>
<td>Stellenbosch University</td>
<td>The reflectors and feed antennas form the first part of a radio telescope receiver chain, and ultra high performance systems are required here to meet the final specifications set for MeerKAT and eventually the SKA. It was recently decided to use a dual offset reflector configuration for both telescopes, since it holds several performance advantages over symmetrical prime focus systems. The antennas feeding the reflector system should be designed to operate over a wide bandwidth, and must conform to certain characteristics to yield a high performance system. Several types of feed antenna are currently under consideration for especially the SKA, where each has its own advantages and disadvantages. Also, the final shape of the reflector system can be influenced by the specific feed antenna to be used. A thorough understanding of the performance of each feed type coupled with a reflector system is therefore required before any final decisions can be made. This should include the effect on performance under different loading conditions caused by gravity, wind and temperature gradients on the structure. This project presents several exciting research opportunities – each one or a combination of some ideas below can be possible thesis topics on Masters or PhD level: 1. Investigation of the performance of electrically small offset dual reflector systems. 2. Wideband feed design and evaluation. 3. Focal Plane Array performance in shaped reflector systems (Possible collaboration with Chalmers University of Technology in Sweden) 4. Effects of gravity, wind and temperature loading on the performance of dual reflector systems and possible compensation techniques.</td>
<td>For MSc projects: A BSc Eng or BEng degree which included modules on Electromagnetics and Radio Frequency/High Frequency techniques. For PhD projects: An MSc Eng with a thesis in the field of Electromagnetics/Antennas/RF Electronics.</td>
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<td><a href="mailto:ddv@sun.ac.za">ddv@sun.ac.za</a></td>
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can gain some valuable industry exposure. More active involvement with the antenna group at Chalmers is envisaged for some aspects of the project, including some exchange visits as well as joint supervision.

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<tr>
<td>Supported Nitrogen base-substituted metal carbonyl complexes of Molybdenum</td>
<td>PhD/MSc</td>
<td>Dr Martin O Onani</td>
<td>University of the Western Cape</td>
<td>Epoxides are a sub-class of epoxy compounds containing saturated three-member cyclic ether; oxirane derivatives. They are inherently polar and strained in the three member ring which makes them readily undergo stereo specific ring opening reactions with nucleophiles to form mono-and bi-functional compounds [1]. These mono-and bi-functional organic compounds are important both in chemical and pharmaceutical industries [2,3]. Epoxides are therefore used in the manufacture of surface active agents, solvents, synthetic resins, cements, adhesives, drugs, agrochemicals, food and anti-freezing additives, glycols, glycol ethers, alkanolamines, and can be used as building blocks for polymers, (e.g. Polysterse among others) [Error! Bookmark not defined.4,5,6]. Because of these diverse applications of the epoxides, there is increasing demand for epoxides [7]. They are catalytically prepared through an oxidation reaction between the olefins and oxidant (oxygen source). The olefins are oxidized at the double bond with various oxygen sources such as molecular oxygen, hydrogen peroxide or alkyl hydrogen peroxides catalyzed by transitional metal complexes [8,9,10].</td>
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<td>and Tungsten for olefin epoxidation</td>
<td></td>
<td><a href="mailto:monani@uwc.ac.za">monani@uwc.ac.za</a></td>
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![Scheme1 General catalytic epoxidation reaction](image)

In the epoxidation reaction, the catalysts (transition metal complexes) can be in the same phase (liquid) as the olefins and the oxidants; homogenous system or in the solid phase while the olefin and the oxidant are in the liquid; heterogeneous system. The latter system makes it easy to separate the product from the catalysts and also enable re-use of the catalyst. Combination of the selectivity of the
homogeneous catalysts with the advantages of heterogeneous processes (ease of recovery of products and recycling of the catalysts) forms the main reasons behind the development of heterogeneous catalytic systems [11]. The other reason behind the development of heterogeneous systems is the growing environmental concern. Therefore the foremost challenge for the chemical manufacturing industries is to seek cleaner processes to minimize the production of harmful waste since the laws and regulations governing the disposal of industrial effluents are becoming increasingly tighter [12]. This project therefore aims at developing heterogeneous nitrogen-base molybdenum and tungsten systems capable of improving the efficiency, selectivity, lowering the cost of production and use of catalyst and foremost addressing the environmental challenges experienced by using other systems in the production of epoxides for chemical and pharmaceutical use.

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<td>Neutral Hydrogen in the</td>
<td>MSC</td>
<td>Dr Sarah Blyth</td>
<td>University of Cape Town</td>
<td>Galaxy clusters and superclusters at a range of different redshifts provide cosmic laboratories to study galaxy evolution and transformation in dense environments. Various models exist to describe the processes causing galaxy transformation, however they are still not well constrained in some areas. A primary constraint to the models is the observed neutral hydrogen (HI) content of galaxies within clusters. We recently made 21cm observations of the rich galaxy cluster Abell 1437 at a redshift of z=0.14 using the Giant Metrewave Radio Telescope (GMRT) to investigate the HI distribution in galaxies in the central region of the cluster. In this project we will investigate whether any of the galaxies can be observed directly in HI and we will also estimate the average HI content of the cluster galaxies using spectral stacking techniques in preparation for the types of analyses planned for the MeerKAT. The project will cover the full data analysis pipeline from reduction of the raw data from the telescope through to the</td>
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<td>Galaxy Cluster Abell 1437</td>
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<td><a href="mailto:sarblyth@ast.uct.ac.za">sarblyth@ast.uct.ac.za</a></td>
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<td>BSc Hons: Computer Science or Electrical Engineering</td>
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final science analysis. The spectral stacking techniques we will use to extract the average HI content of galaxies will be used particularly in the LADUMA large MeerKAT survey which will be making the deepest HI observations of galaxies to date. Therefore, a further aim will be to refine and optimise the method in advance of the future large datasets.

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| SKA Requirements in terms of optical Fibre (SKARF) | PhD/MSc | Dr Timothy B. Gibbon              | Nelson Mandela Metropolitan University (NMMU) | A fundamental challenge in the SKA project is the need to transfer extreme amounts of information at phenomenal bit rates. This is well illustrated by the following text from the SKA promotional brochure: “After undergoing fast, high resolution sampling, up to 160Gbit/sec of data will be transmitted from each dish to a central processor. Data transport from the dishes will produce 10 times the current global internet traffic. The use of wide field of view expansion technologies could increase total data rates for the SKA to many petabits (1015) per second of data, which represents over 100 times the internet traffic data rates today.”

Optical fibre technology is the only possible solution for handling such tremendous data volumes. As such, a high speed optical fibre network will essentially be the buried backbone of the SKA project. The Nelson Mandela Metropolitan University (NMMU) Physics Department has the premier optical fibre research group in South Africa, with around 10 years of experience in this field. The NMMU Optical Fibre Unit has the best equipped telecommunication research laboratory facilities in the country. NMMU has worked extensively together with Telkom and a number of fibre manufacturing, cabling and component companies over the years. Furthermore, the group has a number of international collaborators and a healthy publication record.

As such, NMMU would be extremely well positioned to work together with SKA in hosting a number of PhD and MSc projects based on the following goals/ steps:

1. An Initial step would be for the NMMU research team and students to meet with existing SKA astronomers and engineers to gain a deeper understanding...
of the network and data transfer requirements. Based on this interaction a system requirements document for the SKA optical fibre network would be drafted. 2) Based on these system requirements, a project would be defined around network design and choosing the optimum technologies to use. Factors to consider include optical power budget, wavelength plan, chromatic and polarization mode dispersion (PMD), cross-talk and nonlinear effects etc. It should be noted that the SKA architecture is unique from a network viewpoint. In the SKA scenario 50% of the collecting area is concentrated in the central core region (which consists of three 5km diameter circular clusters) and yet there are also outer stations arranged in a log-spiral pattern some 200km in diameter (and even envisaged up to 3000km). This is very different from typical long haul/metro network architectures. As such, employing a commercial turnkey network solution (as opposed to a custom researched solution) could prove to be unsuitable and disastrous in terms of performance and cost implications. A current researcher at NMMU has relevant experience in network design, having worked on a 6.9 million Euro EU funded project in developing next generation WDM-PON networks. 3) A further student project would involve onsite measurements and characterisation of the deployed SKA fibre network in the Karoo. NMMU has extensive experience characterising fibre in terms of dispersion properties, loss profiles, network impairments etc. To this end, NMMU has the relevant equipment for measurement purposes including PMD test sets, a fusion splicer, an optical time domain reflectometer. In addition the equipment NMMU further has the experience in the comprehensive interpretation of the measurement results. 4) A further student project would involve the building and testing of a mini-SKA fibre testbed in the NMMU lab. This would be a proof of concept demonstration based on the optimum network design and technologies as determined.
by point 2) above. The properties of the testbed could be set to precisely mirror the onsite SKA network as measured in 3) above. The testbed could be implemented well ahead and independently of the real onsite SKA implementation. Such a trial testbed would be extremely useful in trouble shooting and avoiding any costly hiccups which may occur in the real onsite SKA implementation.

5) In the coming years the SKA telescope detectors and infrastructure may be upgraded and improved, demanding even higher bit rates. There could be a project dedicated specifically to investigating the path towards future optical network upgrades to SKA. NMMU already has the relevant software simulation packages for modelling such network upgrades based on any upgrades to the SKA telescope detectors that astronomers may foresee.

6) Data synchronization is a further challenge in the collection of data by the individual detectors in the SKA. Due to the spatial separation of the individual detectors, extremely accurate timing calibration is required. Without this mechanism the precise collection timestamp of the data arriving at the central station for processing will not be known. A project would be defined whereby the optical fibre deployed in the SKA network is used to determine the spatial separation of the detector elements and synchronize the timing. This could be done through, for example, an interferometric approach or the use of signal tones.

The vision of the proposed SCARF projects between NMMU and SKA is that the students hosted at NMMU work very closely with the SKA astronomers and engineers. This would include regular information sharing and updates between NMMU and SKA, visits of the students to SKA facilities, and the opportunity for students to perform onsite measurements on the SKA network. By so doing the students will undoubtedly receive invaluable training and experience within the exciting framework of the SKA project.
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<tr>
<td>Nanomaterials Synthesis and Characterization</td>
<td>PhD/MSc</td>
<td>Prof. F B Dejene <a href="mailto:dejenebf@qwa.uovs.ac.za">dejenebf@qwa.uovs.ac.za</a></td>
<td>University of the Free State (Qwa-Qwa Campus)</td>
<td>Nanotechnology is pervasive in many applications, including polymer reinforcement, display, solid state lighting, sensors and medical probes. The materials previously used for this various application have different limitation and will be addressed in different investigations of this project. In polymer reinforcement a primary disadvantage of traditional composites is that some of the favored characteristics of the base polymer, such as the processability and certain mechanical properties, are sacrificed to some extent when the reinforcement scheme is applied. In the case of polymer nano composites, however the base polymer retains its inherent properties to a much greater degree, provided the distribution of the nano scale reinforcement is relatively uniform. Additionally the property of the base polymer can be improved through strict control of the distribution of the arrangements of nano particles, all while maintaining the processability and low-cost characteristic of the polymer. Nano composites consisting of organic polymers and semiconductor or metallic nano crystals often exhibit a host of mechanical, electrical, optical and magnetic properties, which are far superior to those of the individual components. These properties which depend on the size have stimulated a lot of interest from both fundamental and applied point of view. Advances in this field have been hindered by lack of reproducible preparations of homogenous size and the corresponding surface properties. As a result much of the recent research have focused on finding ways to prepare mono dispersed nano crystals of phosphors, semiconductor or metallic in a matrix, or to assemble nano particles in an orderly form in a matrix. The interaction between particles, the particle size distribution and its influence on the optical, thermal, magnetic and mechanical performance are then investigated. Hence in the first part of the project, we will synthesis and characterize controlled dispersion of colloidal metallic and semiconductor nanoparticles (Ag, Au, CdSe, ZnS, ZnO, CdSe, ZnS, ZnO, PbS and Cd:ZnS and Cd:ZnS) in a polymer matrix, in order to investigate its effects on</td>
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In the second part of the project we will synthesis short and long after glow phosphors and characterize using various technique. In phosphor research to date, most of the works in phosphors for display applications have been in the area of powders. While powders do present some attractive advantages in terms of simplicity of synthesis, several problems with the performance have been noted. The largest of these is the degradation mechanism that phosphors undergo while being excited by an electron beam. This electron-stimulated surface chemical reaction leads to the formation of a dead layer at the surface of the particle, reducing the luminance of the phosphor, and to the formation of gaseous components, eroding the vacuum between the anode and cathode. However, by producing a thin film instead of a powder, the surface area can be reduced because the material will be fully dense. A thin film would also have the advantage of the improved thermal and electrical conductivity, and the adherence will be improved in the event of arcing from cathode and rough handling from usage. Therefore in part of the investigation we will quantify the properties of powder and thin film phosphors (GaN, $Y_2O_3$:Eu,Ce, $SrAl_2O_4$:Eu,Dy, ZnO, Cd:ZnS, $Gd_2O_3$:Eu,Tb, $Y_2O_3$:Eu,Tb, $La_2O_3$:Eu,Tb, $SrAl_2O_4$:Eu$^{2+}$,Dy$^{3+}$ and $Y_2O_3$:Er,Eu,Tb phosphors and Cd:ZnS) using various experimental techniques, many more doped with rare earth elements such as Tb, Ce e.t.c.

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<td>The MITRA radio telescope at DUT</td>
<td>Master’s</td>
<td>Mr Gary Janse van Vuuren</td>
<td>University of Technology</td>
<td>The MITRA radio telescope is a project initiated by Prof Girish Kumar Beeharry of the University of Mauritius (UOM), in 2011. The core of the telescope will be in Mauritius, with planned outstations in the SKA SA African Partner Countries. The telescope will operate in the 100 MHz to 900 MHz band and will consist of a number of arrays of dual polarised log periodic dipole antennas (LPDA’s). Each outstation will consist of at least 16 antennas when complete. The outstations will be able to operate as standalone telescopes with the long term goal of correlating the signals from the outstations with those of</td>
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the core in Mauritius to form an interferometer. The Durban University of Technology is currently constructing the first outstation. The first two antennas will be operational by December 2011.

This project will consist of the following:

- An in-depth evaluation of the performance of the first two antennas culminating in any recommendations for improvements to the remaining antennas.
- Layout design, construction and commissioning of the full array of 16 LPDA’s.
- Installation and commissioning of the back-end electronics, including cabling, to the control room.
- Implementation of the software required to do the filtering, signal processing, correlation, etc, to complete the telescope.

While not tying in directly with the specific areas of MeerKAT, SKA, PAPER and C-BASS science, it is planned that aspects of the technology (for example the hardware used for signal processing will be similar). In addition a significant aspect of the MITRA project is to develop human capital in the African Partner Countries. The MITRA project is ideally placed to assist the African Partner Countries in establishing an astronomy capability as it is extremely cost effective with much simpler technology. Perhaps more importantly the successful completion of this project will put practical expertise at the disposal of one of the African Partner Countries.

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<tr>
<td>Galaxy Evolution and Cosmology Studies: Preparing for MeerKAT/SKA</td>
<td>PhD/MSc</td>
<td>Prof Catherine Cress</td>
<td>University of the Western Cape</td>
<td>Radio observations can be used to probe many questions in galaxy evolution and cosmology including the growth of supermassive black holes and the evolution of the star formation rate over cosmic time, as well as the nature of dark matter or, alternatively, the possibility that General Relativity does not give a full description of gravity. The UWC group is involved in studies which use existing radio data from, for example, the VLA and LOFAR to tackle</td>
<td>Honours with some Astronomy background and good computational skills</td>
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These questions and in studies of the optimal design of observational programs for future telescopes such as MeerKAT, ASKAP and the SKA. The group has also carried out a state-of-the-art N-body simulation of galaxy evolution which models neutral hydrogen and starformation distributions and can be used for interpretation of data and for design of future experiments. Students can work on a combination of observational, computational and/or theoretical research.

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| EMC, RFI mitigation and Lightning Protection for MeerKAT Telescopes and Infra-structure | PhD/MSc| Prof Howard C Reader | Stellenbosch University | Since 2005, our group has been developing techniques to study electromagnetic compatibility (EMC), radio frequency interference (RFI) mitigation and lightning protection for the complex systems required for the Karoo Array Telescope (KAT). In broad terms, this has required the study of:  
  - electromagnetic sensors, such as current probes, Rogowski coils, and broadband antennas,  
  - initially rough and then appropriately-refined physical scale models of, for example, the final KAT-7 telescopes and power lines,  
  - simulation techniques that can be ratified and both scale and full-size systems,  
  - in-house EMC testing beds,  
  - field RFI emissions in the Karoo environment, which includes the properties of the time and frequency domain receivers, and  
  - techniques to show that suggested engineering policies have worked in EMC and RFI mitigation terms on finally-implemented structures.  
  PhD research is envisaged for a study of enclosure and cable shielding effectiveness definitions. A Master’s study is just concluding where reverberation chamber (RC) and cable common-mode injection current schemes have been used to classify cables for RFI hardness. The extension of this work into a PhD research topic on the optimised testing of enclosures and cable schemes in a RC is regarded as an important contribution to the evolving system roll out for MeerKAT. | For MSc projects: A BSc Eng or BEng degree which included modules on Electromagnetics and Radio Frequency/High Frequency techniques.  
For PhD projects: An MSc Eng with a thesis in the field of Electromagnetics/Antennas/RF Electronics. |
During a recent evaluation of emission from farms and electronic systems in the proclaimed quiet areas for MeerKAT and the SKA, it was found that transient analysis of RFI using ROACH board based technologies was invaluable. A master’s project is proposed which will study dynamic range, bandwidth, sensitivity and sensors for this time domain analysis. This will contribute to the RFI classification of signals within the broader proclaimed area.

The issue of propagating signals in the Karoo environment has also been a subject of investigation during 2011. The attenuation of signals through soil and their propagation along flat AND hilly regions of the Karoo needs further study. This should be compared to international telecommunication union predictions, and other software tools with a similar purpose. A master’s programme will need to look at both field and laboratory means of this evaluation. Data from a commercial cellphone network may also provide valuable input to the study. A parallel post-doctoral programme looking at optimised lightning protection earthing systems will benefit from this investigation.

In all the projects, there is a close interaction with other members of the electronics and electromagnetics group in the department, particularly in respect of computational electromagnetic codes and the use of our extensive laboratory facilities. We also have extensive collaboration with equivalent groups in the Universities of Cambridge and Manchester and the Dutch Radio Astronomy Research Institute, Astron.

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<td>ThunderKAT: Transients</td>
<td>PhD/MSc</td>
<td>Prof Patrick Woudt</td>
<td>University of Cape Town</td>
<td>Extreme astrophysical events such as relativistic flows, cataclysmic explosions and black hole accretion are a key area for astrophysics in the 21st century. The extremes of physics, density, temperature, pressure, velocity, gravitational and magnetic fields experienced in these environments are beyond anything achievable in any laboratory on Earth, and provide a unique glimpse at the laws of physics operating in extraordinary regimes. Nearly</td>
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all such events are associated with transient radio emission, a tracer of the acceleration of particles to relativistic energies and their interaction with the local magnetic field. By studying radio bursts from these phenomena we can pinpoint the sources of explosive events, probe relativistic accretion, and understand the budget of kinetic feedback by such events in the ambient medium. The combination of a wide field of view, wide frequency coverage (0.6 -- 14.5 GHz) with sub-band capabilities and excellent sensitivity makes MeerKAT the most powerful southern hemisphere radio telescope to study the transient radio sky.

ThunderKAT is one of the ten approved MeerKAT Large Survey Projects, which aims to study all aspects of transient radio (synchrotron) emission associated with accretion and explosive events, including relativistic jets, nova explosions, supernovae and gamma-ray bursts. The ThunderKAT project has been awarded a nominal 3000 hours of telescope time in the first five years of operation of MeerKAT, the South African SKA precursor telescope.

Through a comprehensive and complementary programme of surveying and monitoring Galactic synchrotron transients (across a range of compact accretors and a range of other explosive phenomena) and exploring distinct populations of extragalactic synchrotron transients (microquasars, supernovae (SNe) and possibly yet unknown transient phenomena) -- both from direct surveys and commensal observations -- we will revolutionise our understanding of the dynamic and explosive transient radio sky.

In this project you will be involved in the early stages of the ThunderKAT project with options to focus on various aspects of ThunderKAT. A range of topics will be offered:
- Analysis of early science commissioning data taken with KAT-7 of bright radio transients,
- Detailed simulations of the transient radio sky, characterizing the expected performance of KAT-7 (the initial array of seven dishes) and MeerKAT (the final array consisting of 64 dishes) for transient detections, and
automating the transient detection pipeline.

- Scientific exploration of radio transients (micro-quasars, dwarf novae, novae and supernovae) using affiliated facilities (LOFAR, ATCA).

In 2011, the ThunderKAT team will apply for science commissioning observations of bright radio transients, e.g. the accreting neutron binary star Circinus X-1. You could be involved in the analysis of these data as well as obtaining and analysing associated multi-wavelength observations of Circinus X-1, including simultaneous optical and near-infrared observations.

You will be part of a team of scientists involved in radio transients. Besides the three identified supervisors (A/Prof Woudt, Prof Fender and Dr McBride), two SKA-supported postdocs in radio transients are based at UCT and work on the above mentioned aspects of ThunderKAT (early commissioning, simulations and pipelines, scientific exploration).

At the first ThunderKAT workshop, held in South Africa on 19-21 April 2011, the main science themes of ThunderKAT were addressed by ThunderKAT co-investigators and related experts in the field. A particular focus was given to discussions for developing software towards real-time transient detections in the image plane with MeerKAT and KAT-7, and the involvement of ThunderKAT in early commissioning science with KAT-7. A full record of the workshop (including the programme, participants and a copy of all the talks) is available at the workshop web site: [http://www.ast.uct.ac.za/arniston2011/](http://www.ast.uct.ac.za/arniston2011/)

We advise you to visit the workshop website and identify topics that you’d like to explore further within ThunderKAT and contact us for details and prospects of a postgraduate study in radio transients.

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<tr>
<td>Differential Low-Noise Amplifiers for SKA</td>
<td>PhD/MSc</td>
<td>Prof P Meyer</td>
<td>Stellenbosch University</td>
<td>The low-noise amplifiers (LNA’s) form a critical part of the SKA receiver chain, with the challenge to design amplifiers with both wide bandwidth and ultra low noise. Currently,</td>
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differential antenna feeds are normally combined via balun structures and then amplified through single-ended LNAs. For wideband structures, low-loss wide-band baluns are difficult to obtain.

Extremely low-loss single-ended amplifier chips are currently available on the market, which offers excellent opportunities for wide-band LNA’s. By using these chips in wide-band configurations as the first stage of the antenna feed (ie without a balun), followed by a wide-band balun (which can be lossy as the gain of the LNA precedes this loss), a potentially very wide-band AND very low-loss structure can be obtained.

However, the current state-of-the-art of differential LNA structures is very limited. Very little information is available with respect to the relative drift of amplifier characteristics with time and design topologies. This project will focus on three areas, namely:

1. Differential LNA design (topologies, stable biasing, ultra-wideband matching, good input and output matching, tracking of gain between transistors etc.)

2. Ultra-wideband differential passive circuits to provide a differential output from the output of the differential LNA pairs.

3. Integration of dual-differential (i.e. 4 channels) LNA’s with proposed MEERKAT feeds in conjunction with EMSS Antennas, including cooling mechanisms and optimal LNA positioning.

As technology varies quite substantially for the various frequency bands of interest to MEERKAT and the SKA, this project will firstly focus on the 1-2GHz range and the 5-15GHz range. The project will follow on a Master’s project and Post-doc work which ends at the end of 2011. Active involvement of the Chalmers group (Prof Per-Simon Kildal) and the ASTRON group is already ongoing in this activity, and will be further expanded.
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<tr>
<td>Integrated Circuit RF Solutions for the SKA</td>
<td>PhD/MSc</td>
<td>Prof Saurabh Sinha</td>
<td>University of Pretoria</td>
<td>Positioning of CEFIM as a home for postgraduate students: The Carl and Emily Fuchs Institute for Microelectronics (CEFIM), an institute of the Dept. of Electrical, Electronic and Computer Engineering, University of Pretoria, has pioneered microelectronics research (both at electron device level and at circuits/systems level) in South Africa over the past 30 years. CEFIM is home to the Electronics and Microelectronics research group, where RF and mm-Wave integrated circuit (IC) design has emerged prominently as a research focus area over the past 10 years: The particular research focus grew from the interest of 2 postgraduate students (2002) to host more than 20 postgraduate (MEng and PhD(Eng)) students in 2011. As a whole, the group is supported by four full time academics or research personnel (1 Professor; 1 Associate Professor and 2 Lecturers) and one full-time departmental administrator. As of 2011, Dr Golovins, a post-doc fellow has also joined the research group. Additional to the personnel and student resources, the group grew in terms of technical deliverables, including journal outputs and patents (South Africa and USA). Key milestones accomplished by the institute: a) Acquisition of world-class IC simulation tool: Cadence Virtuoso (20 active on-site licences). b) Memorandum of understanding and access to proprietary process design kits (PDKs) from various foundries: CEFIM has access to leading foundries (IBM, IHP Microelectronics, STMicroelectronics, Austriamicrosystems (AMS), etc). Streamlined student access to PDKs via online non-disclosure agreements (NDAs). At this point, some 30 students/engineers and personnel are bound by NDAs. c) International collaboration with leading European/American labs and Universities in this field (formalized and funded bilaterals – Germany (TU-Dresden), Romania, USA (Georgia State, Ohio State), etc). d) Hosting of world-renowned researchers (IEEE Society</td>
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Presidents, distinguished lecturers, etc).

d) Acquisition, with support of funding agencies, such as National Research Foundation (NRF), cutting-edge measurement equipment: 70 kHz - 110 GHz Vector Network Analyzer (VNA) for practical measurements.

e) Recipient of several international awards and publications in ISI accredited journals.

f) Developing improved infrastructure (office space), including a floating office project enabling shared access to part-time students/researchers.

g) Upgraded departmental clusters (added our own server) for advancing computation resources.

h) Access to microwave simulation packages, such as CST, IE3D and Microwave Office.

i) Well positioned and working collaboration with industry (SAAB Electronic Defence Systems, Grintek Ewation, etc.) and Science Councils (Meraka Institute and Defence, Peace, Safety and Security (DPSS), Council for Scientific and Industrial Research (CSIR)).

j) Parameterized by University enterprises such as BE at UP (Pty) Ltd and CE at UP (Pty) Ltd furthering selected research outputs (such as electronic design and automation (EDA) software) via commercialization, and further supported via continuing education courses.

k) As a leading engineering research institute in South Africa, the group is well acquainted and committed to technology transfer and commercialization.

Research experience as relevant to this proposal: CEFIM’s initial experience included the design of voltage controlled oscillators (VCOs), phase detectors, phase-locked loops (PLLs), frequency synthesizers, for the 2.4-2.5 GHz (ISM) band.

Our research focus grew organically, with some financial support (primarily from the South African defence industry), and more recently to include the millimetre-wave spectrum (around 60 GHz).

The group has continued to follow a process of identifying a research gap, developing a hypothesis, validating the hypothesis via rigorous simulations and measurements, leading to scholarly and measurable outputs. The group
has also taken selected academic outputs forward in form of software algorithms or routines prompting for adoption of outputs by industry associated, and at times funding part of the research programme.

Expression of Interest relating to the MeerKAT/SKA: This research group expresses interest in supporting the SKA initiative by addressing innovative concepts relating to IC receivers in the nominal mid-band SKA RF range (250 MHz to 2.5 GHz).

Topics of research interest could include: ultra-low-noise amplifier development (dynamic range > 40 dB), variable gain control, improved I/Q phase and amplitude mismatch, Instrumentation or mixed-signal IC design, identification of model parameters influencing circuit performance (research contribution at device characterization level), etc.

- Note: some of the investigative directions are analogous to our current/past research and development (including consulting) experiences – for example, low-noise and ultra-wide-band specifications are also applicable to transceiver design (of interest to our defence sector). For defence applications, CEFIM has also utilised SiGe based IC technology, which is also considered most suitable for receiver subsystems associated to SKA.

- It is envisaged that the SKA project will require tens of thousands of focal-plane arrays, where the total number of front-end receiver chipsets could range from hundreds to thousands: this calls for an integrated solution, which will also reduce the cost of each receiver array.

The figure below, supported by chipset images (developed at CEFIM), captures the SKA integration that could be provided as a result of a partnership between CEFIM and SKA.

| Postgraduate human capacity development at CEFIM, Dept. of Electrical, Electronic & Computer Eng.: | BEng(Hons) → “course work” component of the Master’s degree → MEng → PhD(Eng) |
| → MEng → PhD(Eng) |
| *CEFIM has active student exchange programmes, and students are generally exchanged with a leading |
laboratory during the course of their postgraduate studies. CEFIM is supported by funding via international bilateral programmes or via our Dept.: International Relations (DIR), University of Pretoria, South Africa.

*Participation at internal group symposia, international peer-reviewed conferences and an experience of developing journal papers (online collaborative platforms – enabling for inputs from international research partners).
5. **Structure of the South African SKA Project Postgraduate Bursaries for 2012**

5.1. South African citizens and permanent residents of South Africa who wish to complete a PhD or MSc degree at a South African university

1. **PhD**
   
   Scholarship Duration: 3 years (subject to satisfactory progress)
   
   Maximum scholarship for 2012: R 110 000.00
   
   Maximum travel grant for 2012: R 19 000.00
   
   Maximum equipment grant for 2012: R 13 500.00

2. **MSc**
   
   Scholarship Duration: 2 years (subject to satisfactory progress)
   
   Maximum scholarship for 2012: R 84 000.00
   
   Maximum travel grant for 2012: R 14 500.00
   
   Maximum equipment grant for 2012: R 11 500.00

5.2. Non – South Africans, from other countries in Africa who wish to complete a PhD or MSc degree at a South African university

1. **PhD**
   
   Scholarship Duration: 3 years (subject to satisfactory progress)
   
   Maximum scholarship for 2012: R 110 000.00
   
   Maximum travel grant for 2012: R 19 000.00
   
   Maximum equipment grant for 2012: R 13 500.00
   
   Maximum Home travel grant for 2012: R 12 500.00
   
   Repatriation fee for 2012: Paid in full, if required and as specified by country of residence
   
   Emergency Medical Insurance 2012: Paid in full
2. **MSc**

Scholarship Duration: 2 years (subject to satisfactory progress)

- Maximum scholarship for 2012: R 84 000.00
- Maximum travel grant for 2012: R 14 500.00
- Maximum equipment grant for 2012: R 11 500.00
- Maximum Home travel grant for 2012: R 12 500.00
- Repatriation fee for 2012: Paid in full, if required and as specified by country of residence
- Emergency Medical Insurance 2012: Paid in full

5.3. Non - South Africans, from other countries in Africa, who wish to complete a PhD or MSc at a university in a South African SKA Partner Country: Zambia, Namibia, Botswana, Mozambique, Madagascar, Mauritius and Kenya

1. **PhD**

Scholarship Duration: 3 years (subject to satisfactory progress)

- Maximum scholarship for 2012: R 110 000.00
- Maximum travel grant for 2012: R 19 000.00
- Maximum equipment grant for 2012: R 13 500.00

2. **MSc**

- Scholarship Duration: 2 years (subject to satisfactory progress)
- Maximum scholarship for 2012: R 84 000.00
- Maximum travel grant for 2012: R 14 500.00
- Maximum equipment grant for 2012: R 11 500.00
6. **Conditions of the Scholarship Awards**

6.1. The award of a South African SKA scholarship to a student will be based on potential and academic performance. Selection criteria will include equity targets of the project, academic merit, promise of research ability, leadership qualities and previous award of various prizes and honours.

6.2. In addition to the above criteria, the award of a South African SKA scholarship will be based on the student’s research project proposal.

6.3. A travel grant of up to R19 000-00 (nineteen thousand rand) for PhD students and R 14 500-00 (fourteen thousand five hundred rand) for MSc students per annum may be paid for approved travel related to studies. The grant includes subsistence and accommodation. A motivation for travel must be provided at least two months before any trip is to be undertaken and a written report must be provided to the South African SKA Project within two weeks after returning from the trip. Travel grants cannot be carried over from one academic year to the next.

6.4. An equipment grant of up to R13 500-00 (thirteen thousand five hundred rand) for PhD students and R 11 500-00 (eleven thousand five hundred rand) for MSc students per annum will be available for approved equipment related to your studies. This includes laboratory equipment, software for data analysis, personal computers and laptops etc. Equipment grants cannot be carried over from one academic year to the next.

6.5. After a scholarship is awarded, a change in course of study or institution where the studies are to be undertaken or change of supervision requires prior approval from the South African SKA Project.

6.6. Continued funding is dependent on satisfactory performance determined through the submission of progress reports twice a year (in the standard format, which will be provided).

6.7. Based on the assessment of your progress, the South African SKA Project in its sole discretion may extend your scholarship for a period not exceeding one further year for MSc studies and two further years for PhD studies. The maximum total period is two years for an MSc and three years for a PhD.

6.8. Scholarship-holders who do not obtain the degree for which the scholarship was awarded, relinquish their studies or leave the tertiary institution during the period for which the scholarship was awarded, will have to refund all payments already received. The South African SKA Project may waive this at its sole discretion.

6.9. Scholarship-holders may be required to present their work at national or international conferences and/or symposia at the request of the South African SKA Project.
6.10 Scholarship-holders will be required to present at the annual South African SKA Project Postgraduate Scholarship Conference.

6.11 On completion of the studies supported by means of the scholarship, students are required to submit proof of obtaining the degree concerned.

6.12 Students may, on the completion of their degrees, be requested to take up posts offered by the South African SKA Project for a limited period.

7. How to apply:

- Applications must be submitted through an online application process to the National Research Foundation (NRF).
- Applicants can apply for the SKA Project Scholarships – Master’s and Doctoral Scholarship Call by accessing the link: http://phoenweb.nrf.ac.za/FPF2
- Register/ Login using your email address and password.
- Go to “Select one of the open calls below”
- Select the call for which you are applying to: “SKA Project Scholarships – Master’s and Doctoral Scholarship”
- Select “Apply now”.
- Complete all screens and sub-screens online for application summary, application and biographic information, research project information, supervisor and referees (please ensure you select the invite button after entering their details) and outputs. Please complete your application before inviting the supervisor and referees.
- Once complete click on the “Check completeness and submit form” tab to check if all sections are complete.
- Click on the “Submit application” tab.
- Your application will be directed to the NRF via the university financial aid/research office for further assessment and selection through an NRF panel review process.
- Successful applicants will be notified through the university research office.
- **Deadline: Applications should be submitted by / on 31 August 2011**
8. **Contacts**

Questions may be directed to SKA Helpdesk at the NRF on NRF Student Support email at Studentsupport@nrf.ac.za

Online applications will be submitted via the Financial Aid / Research Office at the university where you intend registering for the degree, to reach the NRF by 31 August 2011. Please consult the university with regard to their internal closing dates which may be prior to 31 August.
Annexure A: The MeerKAT Digital Signal Processing for Radio Astronomy Programme

Modern radio telescopes, including the MeerKAT and the SKA, are heavily dependent on digital signal processing systems. The trend is to digitize the voltage signal as early as possible in the signal path, and this has lead to an increase in the demand for processed signal bandwidth. Such bandwidths are only achievable with specialized hardware platforms, such as ASICs, FPGAs and multi-core CPUs and GPUs.

To achieve the DSP requirements of the MeerKAT, the SKA SA Project’s DSP Programme scope of work includes:
1. The design, implementation and analysis of reconfigurable and heterogeneous computing platforms, both for educational and production use.
2. The design of DSP algorithms for radio astronomy applications.
3. The implementation of DSP algorithms on appropriate hardware platforms.
4. The development of open-source tools for DSP programming.

The programme will limit the scope of hardware and software platforms to those deemed appropriate by the MeerKAT DSP engineering team. In practice this will mean close alignment with the CASPER collaboration, and the exploration of GPUs as DSP platforms.
Annexure B: The MeerKAT High Performance Computing for Radio Astronomy Programme

The next generation of radio telescopes, including MeerKAT and SKA, will rely heavily on high performance computing (HPC) in order to effectively deal with the very large datasets collected by the telescopes while fulfilling their science missions. The sheer scale of the data requires a new paradigm in how data is handled with increasing automation and fewer iterations through the data. This requires sophisticated algorithms, the development of data pipelines and significant investment in HPC systems.

Increases in processing power are also enabling the exploration of new areas of telescope parameter space, not previously accessible, and may pave the way for major new discoveries. Key in this exploration is the development of skills and techniques in the processing, visualization, storage and retrieval of data using the latest available hardware.

This programme focuses on optimal use of off-the-shelf / mainstream hardware such as multi-core CPUs, GPUs, and cluster technology for scientific exploration in radio astronomy, rather than the development of new specialist hardware. An associated programme, the MeerKAT Digital Signal Processing (DSP) for Radio Astronomy Programme, focuses on the development of more specialist hardware platforms. Note, however, that there is the possibility of collaboration between the programmes.

The scope of the Programme includes:
1. The design, implementation and analysis of data processing, visualization, storage and retrieval systems for very large datasets (TB+ scale), both for educational and production use. This relates to both imaging and non-imaging radio astronomy applications.
2. The design of HPC algorithms for radio astronomy applications. Important areas of focus here are algorithms assisting with unattended pipeline processing, algorithms for detection and location of radio transients and also detection and removal of radio frequency interference.
3. The implementation of HPC algorithms on appropriate hardware platforms