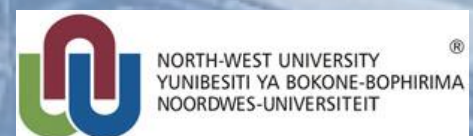


# Radio Astronomy Training Programme at the Technical University of Kenya



## **Introduction**

As part of an exciting new project in which Kenya is joining with South Africa and other African partner countries to enter into the field of radio astronomy a new training programme has been set up. This is an opportunity for any suitably qualified person to undertake the training and become familiar with the basics of astrophysics and radio astronomy and gain hands on experience. The programme will take place at the Technical University of Kenya in Nairobi. Hands-on training in radio astronomy will take place at the Hartebeesthoek Radio Astronomy Observatory (HartRAO) in South Africa on its 26 and 15 m radio telescopes. The programme will enable the trainees to use the 30 m dish at Longonot in Kenya, which is being converted from telecommunications usage to radio astronomy and will form part of the African Very Long Baseline Interferometry Network (AVN). This project is a forerunner to the mid-frequency Square Kilometre Array (SKA) – the next generation global radio astronomy facility that will be built initially in South Africa, and then rolled out across the partner countries. Training will be provided by radio astronomy experts from the UK and South Africa. The programme is funded by the UK's Newton Fund together with matching funds from South Africa. Additional training in the commercial opportunities afforded by knowledge of radio astronomy techniques will be provided by experienced entrepreneurs from the satellite communications business. The training programme will consist of 8 weeks of lectures, workshops and hands-on sessions spread out over a year. On completion trainees will receive a certification of completion. Trainees will then be in a position to apply for advanced training places in radio astronomy at Masters or PhD level, some of which are also funded by the Newton Fund project, or use their new skills to aid the development of related high tech industries in Kenya.

## **Eligibility**

The programme is open to any suitably qualified person who wants to undertake the training or to be re-trained in radio astronomy. Applicants would normally be expected to be graduates in physics or a related subject. Students who are currently studying for a Masters qualification are particularly welcome if they can fit the training programme into their schedule. More experienced people are also very welcome to apply. No prior experience of astrophysics is required. The training programme is fully funded by the Newton Fund so trainees will not have to pay a fee, and accommodation, meals and travel to the training will be provided.

## **Application**

Applicants should send a CV and a personal statement on why they want to undertake the training to Prof Paul Baki, Department of Physics and Space Science, Technical University of Kenya, P.O Box 52428-00200 Nairobi, Kenya. Heads of other institutions can also nominate applicants by sending similar information. Applications received before 30 July 2015 will be considered for the training session starting in September 2015. Heads of institutions can also nominate applicants by sending similar information.

## **Training Team**

This project is collaboration involving the following partners. In the UK it consists of the universities of Leeds, Manchester, Oxford and Hertfordshire as well as Goonhilly Earth Station Ltd. In SA the partners are HartRAO, SKA-SA, the Office of Astronomy for Development, along with the universities of Cape Town, Rhodes, Western Cape, North West and South Africa, as well as the South African Space National Agency.

The Kenyan training this year will be provided principally by:

Prof Peter Wilkinson (University of Manchester, UK) who has 45 years of experience in radio astronomy. He was a founder member of the European SKA consortium and has a keen interest in the interface between radio astronomy technology and industrial applications, particularly in the development of 'radio cameras'.

Prof Ludwig Combrink (HartRAO, SA) Acting Managing Director of the HartRAO observatory. He has many years experience in the application of VLBI to geodetic applications.

Dr Alet de Witt (HartRAO, SA) An experienced operations astronomer at HartRAO.

Dr Jonathan Quick (HartRAO, SA) VLBI Manager at the HartRAO observatory.

Dr Aris Karastergiou (University of Oxford, UK and Visiting Professor at the University of the Western Cape and Rhodes University, SA) Expert in radio studies of pulsar and fast transient sources.

Mr Ian Jones (CEO of Goonhilly Earth Station Ltd) who has many years experience as an entrepreneur in the satellite communications business. He is now in charge of the public-private partnership that is converting 30 m telecommunications dishes to dual commercial/radio astronomy use at Goonhilly in the UK in collaboration with a consortium of universities.

## **The Training Programme**

The training programme will consist of four different units spread throughout the year as well as an annual network training meeting.

### **Unit 1: Astrophysics, Radio Astronomy Theory and Multi-Wavelength Astronomy**

*2 weeks scheduled for September 28th - October 9 2015 provided by Prof Wilkinson at Technical University of Kenya*

*Mornings:* lectures on:

Introduction to Astrophysics: the physics of stars, stellar birth, death and the lifecycle of interstellar material, galaxies including starburst and active galaxies.

Radio Astronomy: radio emission processes including free-free emission from H II regions, synchrotron from magnetised jets, atomic and molecular lines, masers, the Zeeman effect and polarization.

*Afternoons:* workshops:

Assignments and exercises that apply the material taught in the lectures and utilize actual astronomical data.

### **Unit 2: Observational Training**

*2 weeks scheduled for Feb 22- Mar 4 2016 led by Dr de Witt and Dr Karastergiou at HartRAO*

*This unit will be taught using a mixture of lectures, workshops and hands-on training using the 7.5 and 15 m telescopes at HartRAO*

Observation theory: Total power measurements, the two-element interferometer, synthesis arrays, VLBI and calibration. Astrometric VLBI measurements will be covered to introduce the concept of parallax, proper motion determination, the International Celestial Reference Frame and geodetic VLBI.

Observation Preparation: Astronomical coordinate systems, selection of targets, sky positions, flux calibrators, pointing calibrators and polarization calibrators

Observation Practical: In pairs, students will gain hands-on experience of slewing, tracking and recording data, sky subtraction using frequency and position switching, pointing corrections, flux calibration, polarization calibration, system temperature measurements and monitoring, spectral line observations, recording of observing logs, data quality control and trouble-shooting. If available, pulsar timing observations will be included. Hands-on experience of two-element interferometry using a local demonstrator setup and if possible the recording of fringes between HartRAO and an AVN dish.

Survey Astronomy and Data Mining: Publically available astronomical datasets, image cut-out servers, catalogue data, metadata, quality flags, cross-matching catalogues, sample selection, window functions, selection effects, biases, correlation techniques and statistical tests. Bibliographic resources will be used to research targets and compile and present a report.

### **Unit 3: Technical Training**

*2 weeks scheduled for 7-18 March 2016 led by Prof Combrinck and Dr Quick at HartRAO*

*This unit will be taught using a mixture of lectures, workshops and hands-on training using the 7.5 and 15 m training telescopes and training receiver at HartRAO*

Radio Telescopes: astronomical drive and tracking systems, encoders, limits, cable wraps, focus, stowing during high winds and lightening and use of back-up generators for the telescopes, maintenance, health and safety procedures, Radio Frequency Interference and mitigation procedures.

Receiver Systems: feedhorn, low noise amplifier, cryogenics, filter, downconverter, local oscillator, IF amplifier and digital spectrometer.

VLBI Techniques: recording systems, e-VLBI, hydrogen masers and GPS,

### **Unit 4: Radio Astronomy Data Reduction and Analysis**

*2 weeks provisionally scheduled for a 2 week period in April - June 2016 provided by University of Manchester staff at Technical University of Kenya*

*This unit will be taught using a mixture of lectures and hands-on workshops using real data. Each student will have a computer, software and dataset provided. The python-based CASA software will be used where possible as well as AIPS.*

Single Dish Data Reduction: sky correction; identifying and flagging bad data; averaging over all scans and polarizations; baseline fitting and removal, and absolute flux calibration.

Interferometric Data Reduction: flagging, fringe finding, flux calibration, phase calibration, polarization calibration, self calibration and imaging.

Data Analysis: flux densities, source sizes, image fidelity, missing flux considerations, astrometry, parallax and proper motions. Spectral line strengths, velocities and widths.

Students will also learn about telescope time application procedures.

### **Annual Network Training Meeting**

In addition to the basic training units trainees will attend an annual network training meeting that will be held at the end of units 2 and 3 in HartRAO. Here you will meet other basic trainees from Zambia, students on the Newton funded advanced training programme from the other participating AVN countries, academics from each of the Newton partner institutions in the UK and SA and representatives from related industries. There will be status update talks on the AVN, SKA and precursor telescopes, as well as astrophysics research talks from the advanced trainees and academic partners. Trainees will here about potential advanced training projects and make contact with potential supervisors from the UK and SA. Partners from the Office of Astronomy for Development will provide training on outreach. The industrial representatives will provide training on opportunities in related areas such as space science, satellite communications, telecommunications and big data.

### **Contacts and Further Information**

#### **Principal Investigators:**

Programme Leader (Kenya): Prof Paul Baki, Department of Physics and Space Science, Technical University of Kenya. email: paulbaki@gmail.com

Principal Investigator (UK): Prof Melvin Hoare, School of Physics and Astronomy, University of Leeds, UK, email: [m.g.hoare@leeds.ac.uk](mailto:m.g.hoare@leeds.ac.uk)

Principal Investigator (SA): Prof Ludwig Combrinck, Hartebeesthoek Radio Astronomy Observatory, Krugersdorp, South Africa, email: [ludwig@hartrao.ac.za](mailto:ludwig@hartrao.ac.za)

#### **Host Institutions:**

Hartebeesthoek Radio Astronomy Observatory, P.O.Box 443, Krugersdorp 1740, South Africa, website: [www.hartrao.ac.za](http://www.hartrao.ac.za)

Department of Physics and Space Science, Technical University of Kenya, P.O Box 52428-00200 Nairobi, Kenya.

#### **Funding:**

The Newton Fund, website: [www.newtonfund.ac.uk](http://www.newtonfund.ac.uk)

**Related projects:**

The Square Kilometre Array – South Africa, website: [www.ska.ac.za](http://www.ska.ac.za)

Goonhilly Earth Station, UK, website: [www.goonhilly.org](http://www.goonhilly.org)