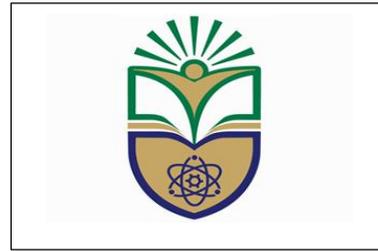# DARA

Radio Astronomy Training Programme

Technical University of Kenya

IN PARTNERSHIP WITH

UK

SA

Introduction

Africa is becoming the focus for the world of radio astronomy. It will host 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 eight African partner countries, including Kenya. Prior to the SKA, the 32m Longonot dish in Kenya is earmarked for conversion into a radio telescope and will be part of a network of radio telescopes called the African Very Long Baseline Interferometry Network (AVN). To support this effort a basic training programme has been set up with the aim of offering any suitably qualified person the opportunity 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 host institute: Technical University of Kenya. Hands-on training in radio astronomy will take place at the Ghana Space Science and Technology Institute (GSSTI) in Accra located near Johannesburg in South Africa. The training will be provided by experts in radio astronomy from the UK and South Africa. The programme is funded by the UK's Newton Fund together with matching efforts from South Africa. Additional training in the industrial opportunities afforded by knowledge of radio astronomy techniques will be provided by experienced entrepreneurs from the satellite communications business. The basic training programme will consist of 7 weeks of lectures, workshops and hands-on sessions spread out over a year. On completion trainees will receive a certificate of completion and can request a reference letter from their trainers. Trainees will then be in a position to apply for advanced training places in radio astronomy at Masters or PhD level, a few 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 the host country.

Eligibility

The programme is open to any suitably qualified person in the host country 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 basic training programme into their schedule. More experienced people are also very welcome to apply. No prior experience of astrophysics is required.

Training Package

The basic training programme is fully funded by the Newton Fund, therefore students will not have to pay a fee. The training package includes:

- accommodation, meals and travel to the training venue at the host institute, practical training venue and annual network meeting in SA. An out-of-pocket allowance will also be included.

How to Apply

Applicants should complete the DARA application form and send it together with a CV, passport photo and transcripts to the host institute: **Prof. Paul Baki, Technical University of Kenya. Email: paulbaki@gmail.com; paulbaki@tukenya.ac.ke**

The application must also be copied by e-mail to p.grant@leeds.ac.uk

Deadline for applications: August 21, 2017

Applications received after this date will not be considered.

Training Programme

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

Unit 1: Two-week course at the Technical University of Kenya

Scheduled to take place sometime during for October 23- November 4, 2017 and will be delivered by UK trainers. This unit will be taught using a mixture of lectures and workshops.

U1 - Astrophysics, Radio Astronomy Theory and Multi-Wavelength Astronomy

- 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.

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

Computing Course – Introduction to Linux and Python

- It is also planned to have an additional one-week computing course at the end of the unit 1 astrophysics training. This will introduce students to the Linux operating system and python scripting language that is widely used in astronomy as well as in industry and commerce. The course will be delivered by experts from the Centre for High Performance Computing in South Africa. It will take place at the host institute using the cluster of computers provided by the project.

Unit 2 & 3: Combined three-week course at GSSTI in Ghana

Scheduled to take place sometime during March-April 2018 and will be delivered by UK and GSSTI staff. These units will be taught using a mixture of lectures, workshops and hands-on training using the 32 m telescope and training instruments at GSSTI.

U2 - Technical Training

- 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

U3 - Observational Training

- 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 groups, 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, spectral line observations,

recording of observing logs, data quality control and trouble-shooting. If available, pulsar timing observations will be included as well as the recording of fringes between Ghana and HartRAO.

• 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 4: Two-week course at the Technical University of Kenya

Scheduled to take place sometime during May - June 2018 and delivered by UK trainers from partner universities. This unit will be taught using a mixture of lectures and hands-on workshops using real data. Using the DARA computer suite, each student will use software and dataset provided. The python-based CASA software will be used.

U4—Radio Astronomy Data Reduction and Analysis

• 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 Meeting

Three day event in SA

In addition to the basic training units, trainees will attend an annual network training meeting that will be held near Johannesburg, SA. This meeting is scheduled to take place sometime between March-April 2018. Here you will meet other trainees from the other AVN countries; Botswana, Ghana, Kenya, Madagascar, Mozambique, Mauritius, Namibia and Zambia, and, students on the Newton funded advanced training programme, 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. The industrial representatives will provide training on opportunities in related areas such as space science, satellite communications, telecommunications and big data. There will also be a workshop on the use of astronomy for development from our partners at the IAU Office of Astronomy for Development. A CV workshop will allow you to discuss your potential future directions with the academics and industrial partners.