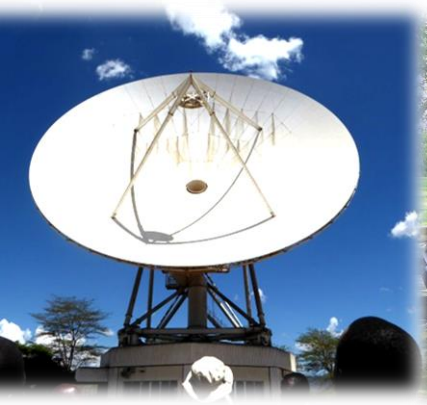
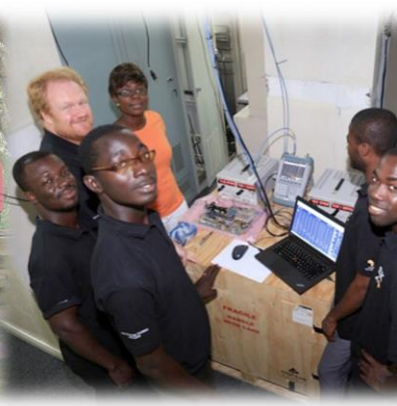
Development in Africa with Radio Astronomy

Basic Training Programme

[Technical University of Kenya]





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, a network of radio telescopes called the African Very Long Baseline Interferometry Network (AVN) is being built in the African partner countries. To support this effort the Development in Africa with Radio Astronomy project (DARA**:** www.dara-project.org) has setup a basic training programme 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 Hartebeesthoek Radio Astronomy Observatory (HartRAO) in South Africa or at Ghana Space Science & Technology Centre (GSSTI) in Ghana. The training will be provided by experts in radio astronomy from the UK, EU 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:

- 8 weeks of lectures, workshops and hands-on sessions spread out over a year
- students who require additional English language study will be given the opportunity to attend a course prior to the start of the programme
- 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 DARA, 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 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 DARA, 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, the practical training venue and annual network meeting in South Africa. 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 copy (if in possession) and transcripts to the host institute: **Prof. Paul Baki, Ph.D, FKNAS**

Director, School of Physical Sciences and Technology, Technical University of Kenya, P.O Box 52428-00200, Nairobi.

Email: paulbaki@gmail.com

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

Deadline for applications: 30th June 2018

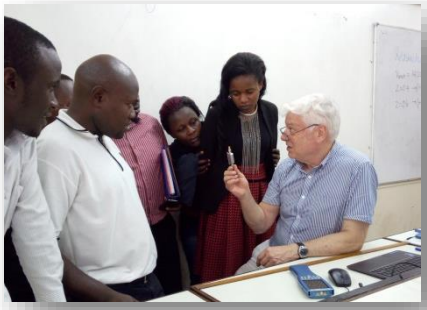
Applications received after this date will not be considered.

Basic Training Programme

The training programme will consist of four units spread throughout the year as well as an annual network training meeting and an optional English language course.

Unit 1: Two-week course at the host institute

Usually scheduled to take place sometime during September-November (2018) 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

- In addition to the above there will be a 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 HartRAO in SA or GSSTI in Ghana

Usually scheduled to take place sometime during March-April (2019) and will be delivered by UK, EU and SA 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 HartRAO. Students will write a report and present a talk.

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

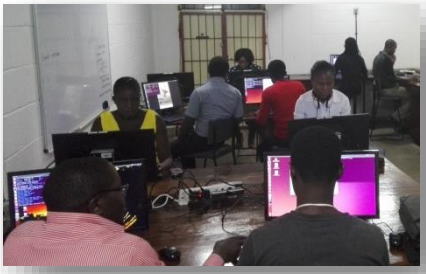
- Observation theory - total power measurements, the two-element interferometer, synthesis arrays, VLBI and calibration. Astrometric VLBI measurements will be covered to introduce the concept of parallax, proper motion determination, the International Celestial Reference Frame and geodetic VLBI.
- Observation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

Usually scheduled to take place sometime during May - June (2019) 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.

Annual Network Meeting

Three day event in South Africa

In addition to the basic training units, trainees will attend an annual network training meeting that will be held near Johannesburg, South Africa. This meeting is scheduled to take place sometime between March-May 2019. Here you will meet other trainees from the other AVN countries; Botswana, Ghana, Kenya, Madagascar, Mozambique, Mauritius, Namibia and Zambia, and, students on the DARA advanced training programme, academics from each of the DARA 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 hear 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.

English Course

For students in Madagascar and Mozambique who require additional English language study to prepare them for the basic training programme that will be delivered in English, students will be given the opportunity to attend a suitable English course prior to unit 1. The University of Leeds will arrange and fund this course direct with a suitable delivery partner in the host country. Students who attend this course must arrange their own accommodation and subsistence.