GHANA AND SOUTH AFRICA CELEBRATE FIRST SUCCESS OF AFRICAN NETWORK OF TELESCOPES

PAGE 04

IAU AND SKA SA COLLABORATE TO PROMOTE SCIENCE COMMUNICATION IN AFRICA

PAGE 13

BIG DATA PROJECT LAUNCHED IN GHANA

PAGE 20

DARA
DEVELOPING HUMAN CAPITAL AND DRIVING ECONOMIC PROGRESS IN AFRICA

PAGE 8
SKA IN AFRICA
Thousands of SKA antenna dishes will be built in South Africa (in the Karoo, not far from the Northern Cape town of Carnarvon), with outstations in other parts of South Africa, as well as in eight African partner countries.

HERA
The HERA (Hydrogen Epoch of Reionisation Array) radio telescope will be instrumental in detecting the distinctive signature that would allow astronomers to understand the formation and evolution of the very first luminous sources: the first stars and galaxies in the Universe.

C-BASS
The C-Band All Sky Survey project (C-BASS) is a project to map the sky in microwave (short-wavelength radio) radiation.

KAT-7
The seven-dish MeerKAT precursor array, KAT-7, is the world’s first radio telescope array consisting of composite antenna structures.

KUTUNSE
The antenna in Kutunse, Ghana, which is part of the SKA African Very Long Baseline Interferometry (VLBI) Network (AVN).

MeerKAT
The South African MeerKAT radio telescope is a precursor to the Square Kilometre Array (SKA) telescope and will be integrated into the mid-frequency component of SKA.
“A vital part of the effort towards building SKA on the African continent over the next decade is to develop the skills, regulations and institutional capacity needed in SKA partner countries to optimise African participation in the SKA.”

The South African Minister of Science and Technology, the Honourable Grace Naledi Mandisa Pandor, is the Chairperson of the Interministerial Committee of the AVN.
Ghana and South Africa celebrate first success of AFRICAN NETWORK OF TELESCOPES
The Ministries of Ghana and South Africa announced the combination of ‘first light’ science observations which confirm the successful conversion of the Ghana communications antenna from a redundant telecoms instrument into a functioning Very Long Baseline Interferometry (VLBI) radio telescope in July 2017. Ghana is the first partner country of the African Very Long Baseline Interferometry (VLBI) Network (AVN) to complete the conversion of a communications antenna into a functioning radio telescope.

The 32-metre converted telecommunications antenna at the Ghana Intelsat Satellite Earth Station at Kutunse will be integrated into the African VLBI Network (AVN) in preparation for the second phase construction of the Square Kilometre Array (SKA) across the African continent. The combination of ‘first light’ science observations included Methanol Maser detections, VLBI fringe testing and Pulsar observations.

Reaching these three objectives confirm that the instrument can operate as a single dish radio telescope and also as part of global VLBI network observations, such as the European VLBI network. Following the initial ‘first light’ observations, the research teams from Ghana and South Africa together with other international research partners, continue to do more observations and are analysing the data generated with the aim to characterise the system and improve its accuracy for future experiments.

"The Ghanaian government warmly embraces the prospect of radio astronomy in the country and our radio astronomy development plan forms part of the broader Ghana Science, Technology and Innovation Development Plan," says Professor Kwabena Frimpong-Boateng, the Ghana Minister of Environment, Science, Technology and Innovation (MESTI). As an SKA Africa partner country, Ghana welcomed and collaborated with the SKA South Africa (SKA SA)/Hartebeesthoek Radio Astronomy Observatory (HartRAO) group to harness the radio astronomy potential of the redundant satellite communication antenna at Kutunse. A team of scientists and engineers from SKA SA/HartRAO and the Ghana Space Science and Technology Institute (GSSTI) which is under MESTI, has been working since 2011 on the astronomy instrument upgrade to make it radio-astronomy ready. In 2012, Ghana launched the GSSTI as the vehicle through which to grow its astrophysics programme.

The South African Department of International Relations and Cooperation (DIRCO) has been funding a large part of the conversion project through the African Renaissance and International Cooperation Fund (ARF). The South African Minister of DIRCO, Ms Maite Nkoana-Mashabane says, “The African Renaissance Fund is aimed at strengthening cooperation between South Africa and other African countries and to support the development of skills and build institutional capacity on the continent.” Nine African partner countries are members of the SKA AVN, including Botswana, Ghana, Kenya, Madagascar, Mauritius, Mozambique, Namibia, South Africa, and Zambia.

"A vital part of the effort towards building SKA on the African continent over the next decade is to develop the skills, regulations and institutional capacity needed in SKA partner countries to optimise African participation in the SKA," says the South African Minister of Science and Technology, Mrs Naledi Pandor. The AVN programme is aimed at transferring skills and knowledge in African partner countries to build, maintain, operate and use radio telescopes. Minister Pandor continued by saying: “It will bring new science opportunities to Africa on a relatively short time scale and develop radio astronomy science communities in SKA partner countries.”

The Leverhulme-Royal Society Trust and Newton Fund in the UK are co-funding extensive human capital development programmes in the SKA AVN partner countries. A seven-member Ghanaian team has undergone training in South Africa and have been trained in all aspects of the project including the operation of the telescope. Several PhD students and one MSc student from Ghana have received SKA SA bursaries to pursue further education in various fields of astronomy and engineering while the Royal Society has awarded funding in collaboration with Leeds University to train two PhDs and 60 young aspiring scientists in the field of astrophysics.

Based on the success of the Leverhulme-Royal Society programme, a joint UK-South Africa Newton Fund intervention (the Development in Africa with Radio Astronomy (DARA)) has since been initiated in other partner countries to grow high technology skills that could lead to broader economic development in Africa. This Newton Fund programme is providing a pool of talented young people who have been inspired by astronomy to ultimately play a leading role in the emergence of new economies.
A Ministerial Forum comprising Ministers from the nine SKA AVN partner countries convenes on an annual basis to provide strategic and political leadership on the cooperation with the SKA and AVN projects, and on other relevant radio astronomy programmes and initiatives. The next SKA AVN Ministerial Forum will be held in Accra, Ghana in August when the Kutunse radio telescope will officially be launched.

The Ghana Intelsat Satellite Earth Station

The Ghana Intelsat Satellite Earth Station at Kutunse is situated at an elevation of 70 metres above sea level. Kutunse is a suburb located about 25 kilometres northwest of the national capital, Accra. The station was commissioned on 12 August 1981, and was operated by the Ghana Telecommunications Corporation until 3 July 2008, when Ghana Vodafone took over as major shareholder with a 70% share of the station.

The SKA SA/HartRAO team assessed the suitability of the 32-metre Beam Waveguide antenna and the Kutunse control station for radio astronomy through two successive working visits in March and May 2011. The conversion work started when the station was handed over from Vodafone to the Ghanaian state under the management of GSSTI.

Once the refurbishment and conversion was completed, a commissioning team looked at how the telescope performed during the process of blind tracking and how it is affected by factors such as gravity as the antenna rotates. The team checked the effect of Radio Frequency Interference (RFI) and how well the antenna does a full rotation. For Phase 1, the existing telecommunication feed horn was used in the frequency range 3.8 – 6.4 GHz (C-band). For the actual science observations (Phase 2), an uncooled 5 GHz and 6.7 GHz (C-band) receivers were fitted.

Future receiver developments may include replacing the original C-band feed horn with a wider band design covering more VLBI bands and introducing cryogenic receivers for improved sensitivity and adding more frequency bands. Future changes could be according to the science programme of the GSSTI, in collaboration with global partners.

The science requirements

The newly refurbished radio telescope has two modes of operation: to form part of global VLBI networks [including the African VLBI Network, as it grows] and also operate as a single radio telescope. To meet both these needs, each function has its own set of required capabilities that the station has to satisfy. Ghana will lead and determine the single-dish programme.

For the single-dish component, the uncooled C-band receivers have been fitted. This allows the antenna to do: radio continuum flux measurements [with a wideband multi-channel radiometer]; pulsar observations [with a wideband multi-channel pulsar timer]; and emission lines spectroscopy [with a narrow band multi-channel spectrometer].

For the VLBI component, the station requires capacity for: mapping interstellar masers in star-forming regions in the Milky Way; determining the distances to star-forming regions in the Milky Way through methanol maser parallax measurements; using trigonometric parallax measurements to determine accurate pulsar distances as well as pulsar proper motions; imaging active galactic nuclei (AGN); and other important functionalities. The longitude and latitude geographic location of the station is significant for astrophysics research.

'First Light' observations

1. Methanol maser detection

2. The detection of masers has been a priority goal since the start of the engineering commissioning phase of Kutunse radio telescope. Not only were maser detections one of the three major objectives of the engineering commissioning phase, it also supported the Leverhulme-Royal Society Trust training objectives.

3. The first observations aimed at the detection of a maser (G9.621+0.196E) were carried out on 21 November 2016. Since the initial detection other masers have been detected routinely.

4. Fringe test

5. In VLBI signals from an astronomical radio source such as a quasar are collected at multiple radio telescopes on Earth. Data received at each antenna in the array include precise time stamping from a local atomic clock, such as a hydrogen maser. Off line, the data are correlated to remove the arrival time delays of the signal and derive a band of contrasting brightness produced by the interference of the signals from antenna pairs (fringes). The resolution achievable using interferometry is also proportional to the observing frequency. The VLBI technique enables the distance between telescopes to be much greater than that possible with conventional interferometry, which requires antennas to be physically connected by coaxial cable, waveguide, optical fibre, or other types of transmission lines.

6. VLBI is most well-known for imaging distant cosmic radio sources, spacecraft tracking, and for applications in astrometry. However, since the VLBI technique measures the time differences between the arrival of radio waves at separate antennas, it can also be used “in reverse” to perform earth rotation studies, map movements of tectonic plates very precisely, and perform other types of geodesy. Using VLBI in this manner requires large numbers of time difference measurements from distant sources [such as quasars] observed with a global network of antennas over a period of time.

7. The Kutunse telescope ‘gate-crashed’ one of the C-band VLBI test observations that was carried out on 28 February 2017. The European VLBI Network supported the observation from Kutunse with great enthusiasm and assisted in the data analysis and correlation through experts from the Joint Institute
for VLBI [JIVE] European Infrastructure Research Consortium (ERIC) in the Netherlands.

8. Pulsar observations

9. The primary initial goal for Kutunse pulsar observations was to detect a known pulsar at the correct period, demonstrating basic time-domain functionality. On 30 April 2017, Professor Ben Stappers and his student Tom Scragg from the University of Manchester, alongside the SKA South African and Ghanaian team, made observations of two pulsars at Kutunse using the 5 GHz receiver.

Collaborators and acknowledgments

The following groups of individuals and institutions are recognised for the participation, collaboration and support in realising this momentous milestone.

The telescopes involved in the successful detection of fringes during a VLBI test experiment were part of the European VLBI Network (EVN) and included: Badary Radio Astronomical Observatory [Institute of Applied Astronomy, Russia], Effelsberg Radio Telescope [Max-Planck Institute for Radio Astronomy, Germany], Hartebeesthoek Radio Astronomy Observatory [National Research Foundation, South Africa], Jodrell Bank Observatory [University of Manchester, UK], Medicina Radio Observatory [National Institute for Astrophysics, Italy], Onsala Space Observatory (Chalmers University of Technology, Sweden), Svetloe Radio Astronomical Observatory [Chinese Academy of Sciences, China], Ventspils International Radio Astronomy Centre (Latvia), Westerbork Synthesis Radio Telescope (ASTRON, the Netherlands), Yebes Observatory [National Geographic Institute, Spain], and Zelenchukskaya Observatory [Institute of Applied Astronomy, Russia].

The scientists at the JIVE ERIC in the Netherlands and the broader European network added tremendous value through Dr Jay Blanchard, Support Scientist for the JUMPING JIVE project.

For the pulsar timer, Professor Ben Stappers, University of Manchester and his student Tom Scragg, University of Manchester, were key contributors, also providing equipment funded through the Leverhulme-Royal Society intervention.

What is the Square Kilometre Array (SKA) and the African Very Long Baseline Interferometry Network (AVN)?

The SKA project is an international effort to build the world’s largest radio telescope. It will require data processing facilities and capabilities beyond what is currently available, producing data volumes in excess of current global internet traffic.

The scale of the SKA represents a huge leap forward in both engineering and research and development towards building and delivering a radio telescope, and will deliver a correspondingly transformational increase in science capability when operational.

Deploying thousands of radio telescopes, in three unique configurations, it will enable astronomers to monitor the sky in unprecedented detail and survey the entire sky thousands of times faster than any system currently in existence.

The African Very Long Baseline Interferometry (VLBI) Network (AVN) is an Africa-owned network of VLBI-capable radio telescopes on the African continent, that will strengthen the science which the international VLBI community can do.

The AVN will help to develop the critical and enabling skills, regulations and institutional capacity needed to optimise African participation in the SKA and enable participation in SKA pathfinder technology development and science.

The AVN programme will transfer skills and knowledge in African partner countries to build, maintain, operate and use radio telescopes and its high performance computing equipment.

It will bring new science opportunities to Africa on a relatively short time scale and develop radio astronomy science communities in the SKA partner countries.

The African VLBI Network will take centre stage this year with the launch of the 32-metre observatory at Kutunse in Ghana, which will be the first telescope in die AVN to be ready to do science with global networks.

The establishing of this network of radio telescopes on the African continent is an important step in preparation for readiness to optimise African benefit from the second phase of the Square Kilometre Array (SKA).

While establishing the AVN, technical and science teams are being trained to maximise the long-term support of the instruments and activities of the SKA for Africa. The Ghana radio telescope will operate either as a single dish telescope or as part of global VLBI networks such as the European VLBI network. As a single dish telescope, it will initially be used to monitor masers over long periods of time.

Nine African partner countries are members of the Square Kilometre Array project and these countries are also the initial partners in the AVN. The countries are South Africa, Botswana, Ghana, Kenya, Madagascar, Mauritius, Mozambique, Namibia and Zambia.
The Development in Africa with Radio Astronomy programme (DARA) is a joint UK-South Africa project which is designed to develop human capital and to drive economic development in Africa.

The project benefits from funding from the British Council’s Newton Fund – money available as a result of the UK government’s commitment to spending 0.7% of Gross Domestic Product (GDP) on Overseas Development Assistance. A portion of the fund aims to train and inspire a next generation of scientists in developing countries through collaboration with the UK.

History and funding

The programme owes its existence to an almost serendipitous course of events.

Melvin Hoare, a member of the International Square Kilometre Array Science Working Group and Professor at the School of Physics and Astronomy at the University of Leeds, was aware that there was a pot of funding from the Royal Society which had been earmarked for exposing people in Ghana to the basics of radio astronomy and ultimately to train people to run observations, specifically of methanol masers in star-forming regions. The original objective was to train a cohort of about 60 potential scientists who could monitor up to 100 masers as a single dish programme on the Ghana telescope.

In 2012, Prof. Hoare realised that the window during which the funds could be applied for was running out. In spite of concerns from others in the Working Group that the Ghana telescope may be ready for observational training and that he would need the funds for his programme there, he decided to go ahead and apply for the funds.

He added a provision for PhD bursaries even though, at the time, there were not many PhD students expected to be part of the programme. This has subsequently changed to the extent that there are more students now who are able and willing to do a PhD than there are bursary allocations.
The project started with a £180 000 Royal Society funded project in Ghana which was run from August 2014 to July 2017.

Right from its inception, DARA has benefited from a coordinated approach that has facilitated access to a number of different funding sources.

At the same time, the South African Department of Science and Technology was engaging with the British Council. Daan du Toit, currently Deputy Director-General: International Cooperation and Resources at the South African Department of Science and Technology (DST), encouraged the working group to apply for funding for a capacity development programme which would be co-funded by DST.

When the Newton Fund was launched by the British Council in 2014, with a mandate to use science and innovation partnerships to promote economic development and social welfare of partner countries, Prof. Hoare suggested that the programme would be an ideal fit.

At the same time, Prof. Hoare put together a group of British academics to work with the countries in the African Very Long Baseline Interferometry network (AVN). The AVN is a network of Very Long Baseline Interferometry (VLBI) capable telescopes (some new and others upgraded from redundant satellite earth-station antennas) which are hosted in Botswana, Ghana, Kenya, Madagascar, Mauritius, Mozambique, Namibia, and Zambia.

The process of converting ex-telecommunications dishes and establishing newly built antennas is mainly funded and driven by SKA SA. These dishes will provide a focus for the development of radio astronomy in each partner country so that a skilled local team is ready to install, maintain and operate the SKA outstations when they arrive. Moreover, the aim is to establish astrophysics education and research communities in these countries as a springboard for wider development.

This is a very ambitious objective since in most partner countries astrophysics is starting from scratch and thus a significant amount of training is required. The AVN is helping to develop the skills, regulations and institutional capacity needed in SKA partner countries to optimise African participation in the SKA and enable participation in SKA pathfinder technology development and science.

The partnership between DARA and the AVN programme is ensuring that skills and knowledge exist in African partner countries to build, maintain, operate and use radio telescopes. It will also bring new science opportunities to
Africa on a relatively short time scale and develop radio astronomy science communities in the SKA partner countries.

As part of DARA, each of the AVN countries was assigned a British lead academic, and funds were applied for from the Royal Society and the Newton Fund.

With the funding in place, DARA was formed in mid-2016. According to the requirements of the Newton Fund, the Principal Investigator (PI) needed to be a recognised, rated researcher employed by a South African institute and Professor Ludwig Combrinck, Acting Director of the Hartebeesthoek Radio Astronomy Observatory (HartRAO) was appointed to lead the project. A steering committee was also established and Phase 1 of the programme began.

When DARA was established, it was co-funded by the Newton Fund through the Science and Technology Facilities Council and the DST through the National Research Foundation (NRF), but there is no indication that the DST contribution will be a long term commitment. This raises some concerns that the project could be perceived as a ‘British project’ so there is a concerted effort by the AVN to contribute towards bursaries.

DARA has now entered Phase 2 of its rollout, and has received funding from the UK government that ensures its continuation until 2021. It is expanding to cover all AVN partner countries as well as into the European Union and other parts of the world.

DARA structure and management plan

**UK Partners:** The University of Leeds, the University of Manchester, the University of Hertfordshire, the University of Oxford and the Goonhilly Earth Station. Goonhilly is a public-private partnership where academics work together with entrepreneurs to explore commercial opportunities in deep space research. The University of Central Manchester and the University of Bristol are expected to join soon.

**South African Partners:** The South African team is led by astronomers at HartRAO together with SKA, the South African National Space Agency (SANSA), Rhodes University, Unisa, the University of Cape Town, the University of the Western Cape and North West University.

**African Partners:** The Botswana International University of Science and Technology, the Ghana Space Science and Technology Institute, the Technical University of Kenya, the University of Namibia, and the University of Zambia are active participants.

**AVN Partners:** Currently Botswana, Kenya, Namibia and Zambia are hosting the basic training programmes, with Madagascar, Mauritius and Mozambique joining later this year. Ghana is involved in the advanced training programme.

**Outreach Partners:** The Office of Astronomy for Development and SKA.

The DARA programme has been divided into two phases, and is beginning to gain traction outside the African continent.

### PHASE 1

- **Year 1 (Jan - Mar 2015)**
  - Funding for computers, books, pulsar backend

- **Year 2 (Apr 2015 - Mar 2016)**
  - Basic training starts in Zambia and Kenya
  - Advanced training starts in UK and SA

- **Year 3 (Apr 2016 - Mar 2017)**
  - Basic training starts in Namibia/Botswana
  - Big Data Summer School

- **Years 4 and 5 funded (Apr 2017 - Mar 2019)**
  - £100k per year from UK matched by SA

### PHASE 2

- **UK doubles size of Newton Fund**
  - New 4 year DARA project (Apr 2017 - Mar 2021)
  - An 8-fold increase as funding ramps up to £800k per year. In kind match from SA
  - Extend to all AVN countries
  - Extend basic training programme to Madagascar and Mozambique starting in Sep 2017
  - Run unit 2/3 practical training three times per year
    - Zambia and Namibia/Mozambique in HartRAO
    - Kenya and Ghana in Ghana
    - Madagascar and Mozambique in HartRAO
  - One large annual network training meeting

- **New PhD and MSc training places in UK starting Oct 2017**
- **New MPhil training places in Mauritius starting Apr 2018**
The Purpose

An assessment of the importance and role of DARA begins most naturally with the full name of the initiative. The Development in Africa with Radio Astronomy programme is not just about radio astronomy, or solely about sharing skills in the radio telescope space. The broader picture has always been to support the development of science capacity in Africa, and to provide young people in Africa with transferrable skills that will boost the economic growth of their home countries.

Radio astronomy encompasses all of the science, technology, engineering and mathematics (STEM) skills that underpin the emergence of a strong developed economy. The modern astronomer needs knowledge in physics, mathematics, chemistry and computing. To develop, maintain and run the telescopes and instrumentation requires key skills in technology and engineering.

The DARA programme aims to inspire and train a new and diverse generation of young people to engage with these skills. It will engender a research ethos as well as communication and diagnostic skills that are transferable to many aspects of a developing economy. The training team includes experienced entrepreneurs from the telecommunications and space industry who will impart their drive and enthusiasm to open the minds of the trainees to a world of possibilities in the industrial, knowledge and commercial sectors. In this way a pool of talented young people who have been inspired by the Universe is created and empowered to play a leading role in the emergence of new economies.
This spillover into other fields is not unique to Africa. As Prof. Hoare commented in an interview:

“We get 30 people or so studying astrophysics [at Leeds], because they’re interested in the topic. One or two or half a dozen may go on and do a PhD, and then one might make it to being an academic at the end. Where have all those others gone? They’ve gone out with high-level maths, computing – transferable skills while they’ve been doing a degree – into the economy to help drive economic growth. Why should it be any different in a developing country?”

In the same interview, Paul Baki, Professor of Physics at the Technical University of Kenya and project lead in the country, said that “developing nations cannot simply focus on academic fields that feed into immediate social and economic challenges.”

Prof. Baki called the project a “godsend”, because it is “bridging the gap” in skills and expertise needed for hard science on the continent, and also provides students with expertise that in turn could help them address pressing societal concerns.

The Newton Fund, with its mandate to support the economic and social welfare of partner countries by strengthening their science and innovation capacity, was a natural funding partner.

Of course, as the SKA project gains traction and the building phase nears completion, there is a pressing need for young astrophysicists to be produced and nurtured. This is a challenge on a continent where very few universities offer postgraduate degrees in astronomy, and many high school science teachers are not aware that astronomy offers a viable career path. It is with this in mind that outreach into schools has been established as an integral part of the DARA programme.

When South Africa was shortlisted with Australia for the hosting of SKA, the fact that there were few astronomers or engineers and scientists with relevant experience was flagged as a concern. As a result, skills development and outreach were built into the DNA of South Africa’s radio astronomy projects. The development of human capacity included the development of young talent in science, as well as artisan training for infrastructure development.

The AVN has been a part of this development since the announcement that South Africa had won the bid to host the SKA.

The aims of the AVN dovetail perfectly with the work of DARA:

• to develop the skills, regulations and institutional capacity needed in SKA partner countries to optimise African participation in SKA and enable participation in SKA pathfinder technology development and science;
• to transfer skills and knowledge in African partner countries to build, maintain and operate radio telescopes independently; and
• to bring new science opportunities to Africa on a relatively short time scale and develop strong radio astronomy science communities.

---


---

African students who received AVN training at HartRAO.
IAU and SKA SA collaborate to promote science communication in Africa

The International Astronomical Union (IAU) Office for Young Astronomers (OYA) and SKA SA collaborated to host a science communication training workshop for 30 African postgraduate astronomy students in Addis Ababa, Ethiopia from 20-21 May 2017.

The workshop was an extension of the IAU 2017 International School for Young Astronomers (ISYA), a two-week school that offered students selected by the IAU OYA the opportunity to broaden their perspectives on astronomy through a series of lectures, practical exercises, observations and exchanges facilitated by an international faculty.

Students participating in the science communication training workshop were introduced to the theory of science engagement, and were required to complete various practical components that transferred basic skills in message strategy, public speaking, science journalism, social media, and science engagement project design.

The workshop, coordinated by the SKA SA Communications Unit, was facilitated by IAU Office of Astronomy for Development (OAD) staff, IAU ISYA faculty members, SKA SA content specialists and communications staff, and science communicators from East Africa.

“Scientists have a responsibility to communicate the content and value of their research to society, so that citizens are empowered to make informed decisions and hold their leadership accountable about research that affects their daily lives or the future of their country,” says Ann Ng’Endo, an MSc student in astrophysics at the University of Nairobi.

“This workshop provided me with the tools I need to develop a message about why astronomy and my research is important for the development of Kenya and Africa, and to communicate this clearly to non-scientific audiences.”

African partner country students complete AVN training at HartRAO

Students from four African SKA partner countries completed training on the African Very Long Baseline
Interferometry Network (AVN) at the Hartebeesthoek Radio Astronomy Observatory (HartRAO) in Gauteng from 6-24 March 2017.

The 19 participants included postgraduate students in various science and technology related fields of whom 10 were from Zambia, three from Namibia, five from Botswana and one from South Africa.

The training is part of the Development in Africa with Radio Astronomy (DARA) project, which seeks to provide people in the targeted countries with training to use radio telescopes.

The training is part of the Development in Africa with Radio Astronomy (DARA) project, which seeks to provide people in the targeted countries with training to use radio telescopes.

It also has an outreach programme to encourage young people to study the technological aspects of radio astronomy and pursue science, technology, engineering and mathematics subjects. The project is funded by the Newton Fund.

During the three weeks the students were lectured and taught on various aspects of radio astronomy and to use radio telescopes within the AVN. The students were hosted at HartRAO and also treated to various social activities and excursions in and around the North West and Gauteng provinces.

This year’s training was the second school hosted at and by HartRAO and plans are underway for hosting it again for the next two years.

Dr. Alet de Witt, Operations Astronomer at HartRAO and coordinator of the training programme, says that African postgraduate students with a degree in science and engineering fields are invited to participate in the training school.

"Some of them are already working and some are still studying, but we train them so that they can go back and build the radio astronomy capacity in their own countries," says De Witt.

Kushatha Kelebeng (27), an MSc student in Computer Science at the Botswana University of Science and Technology says that she finds the course interesting.

"Coming from a computer science background, I don’t know much about radio astronomy, but now with this course I have learned a lot of information about radio astronomy and determining how we can perform data mining, which is an area that I am interested in," she says.

The African VLBI Network (AVN) is a project to build a network by converting redundant satellite Earth-station antennas across Africa to use for radio astronomy.

The AVN will help to develop the skills, regulations and institutional capacity needed in SKA partner countries to optimise African participation in the SKA and enable participation in SKA pathfinder technology development and science.

The AVN programme will transfer skills and knowledge in African partner countries to build, maintain, operate and use radio telescopes.

At the end of the training, the DARA Annual Networking and Steering Committee Meeting was held at the Ekudeni Conference Centre in Gauteng.
From 15 to 19 August 2016, SKA SA’s Outreach Team travelled to Botswana to join the National Science Week activities in Palaype, Botswana.

The official opening of the event by Botswana’s Minister of Infrastructure, Science and Technology, the Honourable Nonofo Molefhi on 15 August 2016, featured the inauguration of a 10-PC astrophysics lab and a demonstration of a two-dish interferometer, both situated at the Botswana International University for Science and Technology (BIUST) and donated by SKA Africa.

The SKA Africa team also conducted outreach programmes at Lotsane Senior Secondary School and Palapye Technical College in Palaype, as well as Mmachibaba Junior Secondary School and Moeng College in the villages of Ratholo and Moeng respectively.

The outreach programme, consisting of three interactive workshop titles and a motivational lecture by African Very Long Baseline Interferometry Network (AVN) electronics technician, Norah Mogakwe, saw the team engage with more than 500 Form 4 and 5 learners in order to raise the awareness of radio astronomy, Botswana’s role in the AVN and SKA-related careers.

Botswana Form 4 learners from Lotsane Senior Secondary School, Palaype, Botswana practice using DIY pinhole projectors. Learners made their projectors during a workshop facilitated by SKA Africa as part of Botswana’s National Science Week, and used their projectors to view the partial solar eclipse which was visible from Southern Africa in September 2016.
The UN Sustainable Development Goals (SDG’s) are a set of 17 Global Goals with 169 targets between them in order to transform human behaviour and appreciation for the world for the better by 2030. These goals range from ending poverty and hunger to improving education, health and well-being, addressing inequalities and protecting the planet. (http://www.un.org/sustainabledevelopment/sustainable-development-goals/)

Achieving the SDG’s requires a massive, widespread effort operating across all levels of society and all geographic regions. Achieving the goals requires a rethink of personal and national economic priorities and a shift in thinking from a “for me and mine” view of the world to a more global appreciation that “what is good for the world and all its people is also good for me and those closest to me”.

Clearly, there are many important contributing factors in achieving the goals, many of them relating to policy, trade deals, funding and implementation priorities for targeted interventions as well as establishing effective systems for monitoring developments and tracking progress. However, we focus here on the research needs of the SDG’s since fundamental and applied research will need to play a strong role not only in leading to better understanding and awareness of the complex distributed global natural and man-made systems, but also in providing the breakthroughs needed in new materials, new drugs, new energy systems, new agricultural, distribution and transport systems, new systems for education, and new economic systems.

For example, as a non-definitive and non-exhaustive list of research areas mapping to SDG’s:

A. Research into climate change
   - affecting many SDG’s such as: Climate Action; No Poverty; Zero Hunger; Clean Water and Sanitation; Affordable and Clean Energy; Life Below Water; Life on Land

B. Research into food security
   - affecting: No Poverty; Zero Hunger; Good Health and Well-being

C. Research into epidemiology
   - affecting Good Health and Well-being

D. Research into drug design
   - affecting Good Health and Well-being

E. Research into genomics
   - affecting Good Health and Well-being

F. Research into materials science
   - affecting: Affordable and Clean Energy; Industry, Innovation and Infrastructure; Sustainable Cities and Communities; Responsible Consumption and Production

In this data rich era, computing infrastructures play a huge role in supporting research by enabling efficient data collection, analysis, simulation, and most importantly, collaboration. Research in the modern era is fundamentally a global endeavour. High performance computing combined with federated cloud infrastructures play a very strong enabling role.

An example of an undersea optic fibre cable.
The African Data Intensive Research Cloud (ADIRC) is an initiative born of the Square Kilometre Array (SKA) radio astronomy activities in Africa in which a research cloud infrastructure is being developed which will link African partner countries with the African SKA host country, South Africa, in order to meet the scientific computing and research collaboration needs of the telescope. This will be a powerful distributed IT infrastructure, providing ready access to high performance computing, large dataset visualisation, and high performance, high volume storage facilities for collaborating research groups across Africa. Although originating in radio astronomy, the ADIRC will from the start also service the bioinformatics and geosciences domains, both highly relevant to the achievement of the SDG’s.

There are clear scientific benefits in the global collaboration and organisation of countries that is the SKA. However, the geopolitical and IT structures being established to deliver the fundamental science of this global endeavour can be effectively used to also drive forward the global endeavour that is the SDG’s.

The African Data Intensive Research Cloud could and should be used to drive the broader agenda of the SDG’s by supporting relevant research into these broader domains, many of which are in the applied sciences. The big data, high performance computing skills and infrastructures and leadership in global organisation developed through radio astronomy activities are directly relevant to other global concerns. The ADIRC and other emerging research clouds like it should be supported and leveraged in driving towards the global SDG agendas.

The ADIRC is a tool for making fundamental discoveries and will also help re-establish a responsible and sustainable acting out of mankind’s proper place in the Universe.
Agenda 2063 lays out a vision for the future Africa, a continent in which the past has been fully embraced and reconciled, a united continent in which there are much higher levels of prosperity and well-being across the whole population, a continent in which there has been economic, technical and social transformation and a free continent in which the dreams and aspirations of Africans can be fully realised.

Agenda 2063 lays out seven Aspirations for the Africa that is desired. Of these, the first is “A prosperous Africa based on inclusive growth and sustainable development”. This includes the “eradication of poverty”, “sustainable and long-term stewardship of its resources”, “educated and skilled citizens, underpinned by science, technology and innovation”, “modern agriculture”, “valued and protected wildlife and wild lands”, “climate resilient economies and communities”, “the valuing Africa’s human capital as its most precious resource”, “a strong and unified approach to the global problem of climate change”. The other six Aspirations are equally transformative.

Agenda 2063 is ambitious, as it should be, and includes a “Call to Action”, one part of which is to “Catalyse education and skills revolution and actively promote science, technology, research and innovation, to build knowledge, human capital, capabilities and skills to drive innovations”. A key aspect in achieving the ambitions of Agenda 2063 is to build a strong culture and ecosystem of connected research across the continent, both fundamental research and also applied research, directly tackling and helping to overcome many of the continent’s challenges.

Building a connected research culture and capability drives skills development, drives technological adoption and allows for much more rapid and efficient transformation.

A powerful component of the transformation required by Africa will be its rapid and coordinated adoption of digital technology. This will most likely prove to be the dominant factor in whether it is able to achieve many of its aspirations. "Data is the new oil", as the saying goes, and the ability to collect, process and analyse huge amounts of data will directly affect the ability to make new discoveries and the ability to play a leading role in overcoming existing challenges and in the future world economies. Access to data is not enough in itself. To really make use of it, connected data infrastructures spanning the continent and linking globally are needed, high performance computing is needed, developments in artificial intelligence, machine learning and general analytics are needed and, most importantly, skilled people are needed in these areas.

In this data rich era, computing infrastructures play a huge role in supporting research by enabling efficient data collection, analysis, simulation, and most importantly, collaboration. Research in the modern era is fundamentally a global endeavour. High performance computing combined with federated cloud infrastructures play a very strong enabling role.

The African Data Intensive Research Cloud (ADIRC) is an initiative born of the Square Kilometre Array (SKA) radio astronomy activities in Africa in which a research cloud infrastructure is being developed which will link.

The Global Goals for Sustainable Development.
WITH THE ADIRC

African partner countries with the African SKA host country, South Africa, in order to meet the scientific computing and research collaboration needs of the telescope. This will be a powerful distributed IT infrastructure, helping to ready Africa, and providing access to high performance computing, large dataset visualisation, and high performance, high volume storage facilities for collaborating research groups across Africa. Although originating in radio astronomy, the ADIRC will from the start also service the bioinformatics and geosciences domains, both highly relevant to achieving the Agenda 2063 Aspirations.

There are clear scientific benefits in the global collaboration and organisation of countries that is the SKA. However, the geopolitical and IT structures being established to deliver the fundamental science of this global endeavour can be effectively used to also drive forward the African agenda. The African Data Intensive Research Cloud could and should be used to as part of the Agenda 2063 Call to Action by supporting relevant research into these broader domains, many of which are in the applied sciences. The big data, high performance computing skills and infrastructures and leadership in continental and global organisation developed through radio astronomy activities are directly relevant to Agenda 2063. The ADIRC and other emerging research clouds like it should be supported and leveraged in pursuit of these broader aims.

What better way to both enable fundamental discoveries about the Universe and also to drive towards the Africa we want, the Africa of Agenda 2063, an Africa that is educated, prosperous, sustainable and takes its proper place in the world.

References

The Big Data Revolution for Sustainable Development:

- Where are the funds going (geographic visualisations)?
- Is funding going to the right places (overlay scientific criteria)?
- What changes occurred over time?
- Did the intervention cause the change?
- Identify the drivers.
- What other factors might have influenced the outcome?

Reflections on Big Data and the Sustainable Development Goals:
https://unstats.un.org/bigdata/taskteams/sdgs/
A one-day work session was held on 11 July 2017 at the Ministry of Environment, Science, Technology and Innovation (MESTI) in Ghana to kick off the High Performance Computing (HPC) training programme in Ghana.

The training programme, named the Big Data Project, includes the donation of HPC equipment to Ghana.

The main objective of the meeting was to identify potential users for the joint research and teaching project. The sub-objectives are to identify the host site, develop a strategy for setup and operationalising of the facility; and identifying flagship projects that could be piloted on the computing equipment donated to Ghana.

The meeting included participants from the Ghana Space Science and Technology Institute, the University of Ghana, the Centre for Scientific and Industrial Research; and the Kofi Annan ICT Centre.

During phase 1 of the project HPC was installed in five SKA African partner countries, namely Botswana, Zambia, Namibia, Madagascar and Mauritius, an initiative being led by the Centre for High Performance Computing (CHPC) in Ghana.

The CHPC is one of three primary pillars of the national cyber-infrastructure interventions in South Africa supported by the Department of Science and Technology (DST). The South African National Research Network (SANReN) and the Data Intensive Research Infrastructure of South Africa (DIRISA) complement the CHPC through the provision of high-speed, high-bandwidth connectivity, and the effective curation of a variety of notably large and critical databases.

MESTI Minister Professor Kwabena Frimpong-Boateng chaired the meeting and announced that the HPC equipment will be placed at the CSIR Institute for Scientific and Technological Information (CSIR-INSTI) site.

A meeting to agree on the strategy for setup and operationalisation of the HPC facility was developed during a visit to the Kutunse site on 13 July 2017.
USING ASTRONOMY AS A TOOL IN THE PATH TOWARDS SUSTAINABLE DEVELOPMENT

The Office of Astronomy for Development (OAD), hosted at the South African Astronomical Observatory in Cape Town, South Africa, is a joint partnership of the International Astronomical Union (IAU) and the National Research Foundation (NRF) South Africa.

The OAD, together with its network of nine regional offices around the world and its vast network of collaborators, coordinates projects and activities globally, using astronomy as a tool in the path towards sustainable development.

Every year, the OAD funds projects through an open call for proposals, inviting people and organisations from any country to submit ideas that use astronomy to address an issue related to development.

One of the projects funded in 2017 is a teacher training initiative in Nigeria. The West African Regional Office conducted a hands-on training program for primary and secondary school teachers. About 80 educators were trained to use low-cost and locally available materials to create teaching aids and also provided the tools and methods to use space sciences to engage children in the classroom.

The West African International Summer School for Young Astronomers (WAISSYA) is another effort to build astronomy capacity in West Africa targeted at university students. WAISSYA aims to empower West African students to pursue science and to build a critical mass of astronomers in the region.

The school is informed by research in science education and focuses on developing instructors’ teaching practices and on inquiry-based methods. The 2017 edition of WAISSYA, hosted by the Ghana Space Science and Technology Institute (GSSTI) and supported by the OAD, included topics such as radio astronomy, cosmology and advanced data analysis.

Students from African countries benefit from the astronomy-studies related training supported by the Office of Astronomy for Development, hosted at the South African Astronomical Observatory in Cape Town, South Africa.
The Southern African Regional Office is hosting an AstroLab workshop from 6-11 November, 2017 at the National University of Science and Technology in Bulawayo, Zimbabwe. AstroLab is a low-cost research tutorial developed for universities with little or no astronomy infrastructure.

The program uses remote telescopes (accessible over the internet) to teach students the primary steps involved in astronomy research and the scientific method - observation, image acquisition, processing, data analysis. Previous Astrolab projects have been successfully conducted in Nigeria, Rwanda and Zambia with the support of the OAD.

The OAD supports and funds the AstroVarsity program that aims to use astronomy to enhance science teaching, as well as potentially start astronomy modules, in physics departments of historically black universities in South Africa. An ongoing partnership, led by the University of Zululand, and supported by the University of KwaZulu-Natal, the OAD, the Department of Science and Technology and the National Research Foundation, is working towards the establishment of a teaching observatory for students from the University of Zululand.

In May 2017, the OAD participated in the Fourth Middle East and Africa Regional IAU Meeting (MEARIM), co-hosted in Addis Ababa by the East African Regional Office.

The MEARIM conference brings together astronomers and students to exchange ideas and pursue collaborations while providing a forum to consolidate and strengthen scientific capacity in the region.

Dr. Vanessa McBride from the OAD delivered a keynote presentation at the opening session which was attended by His Excellency Dr. Ing. Getahun Mekuria, the Ethiopian Minister of Science and Technology. The conference included sessions on Astronomy for Development, where participants discussed various ways in which astronomy can serve the needs of society.

UPCOMING EVENTS:

Regional AstroLab Workshop
6-11 November 2017
Bulawayo, Zimbabwe
http://southernafrica.astro4dev.org/

Astronomy (Dot Astronomy) 9
14-17 November 2017
Cape Town, South Africa
http://dotastronomy9.sao.ac.za/

The historic main building of the South African Astronomical Observatory (SAAO) in Cape Town, built in 1820. The SAAO hosts the Office of Astronomy for Development, which is a joint partnership of the International Astronomical Union and the National Research Foundation in South Africa.
THE KUTUNSE RADIO TELESCOPE IN NUMBERS

The project to refurbish the radio telescope at Kutunse, Ghana has been in progress since 2011.

- **2700** litres of paint used to repaint the antenna
- **450** metres of weld seals
- **200** X-rays taken
- **240** weight of antenna in tonnes
- **192** bolts replaced on main reflector
- **32** diameter of antenna in metres
- **15** life expectancy of antenna in years
- **2019** telescope will be ready to do science