Radio astronomy and Remote sensing: A journey in Geoinformatics

A concise walk through my background at DARA, how astronomy and remote sensing interact and the transferable skills that bridge both fields

DEVELOPMENT IN AFRICA WITH RADIO ASTRONOMY

Key Aspects of the DARA Mission:

- **Capacity Building**: Training in radio astronomy, space technologies, and data science for science and engineering graduates.
- **Target Countries**: The program operates in the eight SKA partner countries in Africa.
- **Skill Transfer**: Focuses on developing STEM skills that are transferable to sectors like telecommunications, computing, and agriculture.
- **Strategic Collaboration**: A partnership involving UK and South African institutions, including the South African Radio Astronomy Observatory (SARAO).
- **Impact**: Aims to create a sustainable, knowledge-based economy and foster innovation in Africa.

contents

1. **Introducing myself** :
   - brief background, research focus

2. **My journey with DARA**:
   - Internship, collaborations and projects

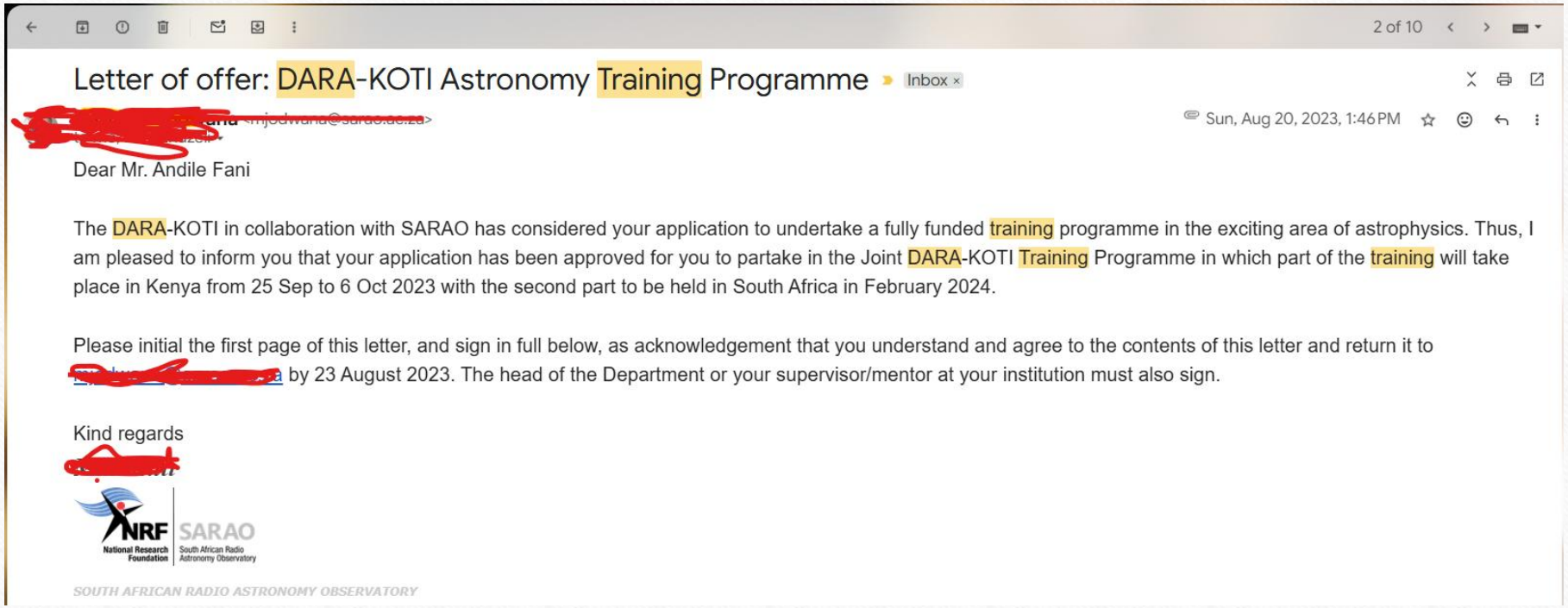
3. **Remote sensing meets astronomy**

   i)Shared instruments, signal ii). Technology iii) transferability of skills Vi)statistics V)data science

   Vi)AI and ML

4. **Opportunities out there**
   - Motivation

Did anyone get it ?



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Letter of offer: DARA-KOTI Astronomy Training Programme Inbox ×

[redacted] <mjodwana@sarao.ac.za>

Sun, Aug 20, 2023, 1:46 PM

Dear Mr. Andile Fani

The DARA-KOTI in collaboration with SARAO has considered your application to undertake a fully funded training programme in the exciting area of astrophysics. Thus, I am pleased to inform you that your application has been approved for you to partake in the Joint DARA-KOTI Training Programme in which part of the training will take place in Kenya from 25 Sep to 6 Oct 2023 with the second part to be held in South Africa in February 2024.

Please initial the first page of this letter, and sign in full below, as acknowledgement that you understand and agree to the contents of this letter and return it to [redacted] by 23 August 2023. The head of the Department or your supervisor/mentor at your institution must also sign.

Kind regards

[redacted]

NRF National Research Foundation | SARAO South African Radio Astronomy Observatory

SOUTH AFRICAN RADIO ASTRONOMY OBSERVATORY

1. Get to know me

- Andile H Fani
- PhD student (2nd year)
- Geoinformatics (UP)

Remote sensing, Spatial analysis

PhD topic: Use of drones, AI, and ML in precision Agriculture (yield prediction, irrigation scheduling, crop monitoring).

- DARA Intern

Where it all started

Remote Sensing

- Remote sensing is the technique of observing and measuring Earth's surface and atmosphere from a distance using satellites, aircraft, or drones.

How ?

- A source of energy (usually the Sun or an active sensor like radar) sends electromagnetic waves.
- These waves interact with the Earth's surface (land, water, vegetation, buildings).
- Sensors record the reflected or emitted energy.
- Data is processed into images and maps.

Most basic

☀ Sunlight

↓

🌍 Earth Surface

↑ reflected light

Satellite Sensor

↓

Images & Maps

🌌 Distant Galaxy

)))) Radio Waves))))

↓

📡 Radio Dish

↓

💻 Computer Data

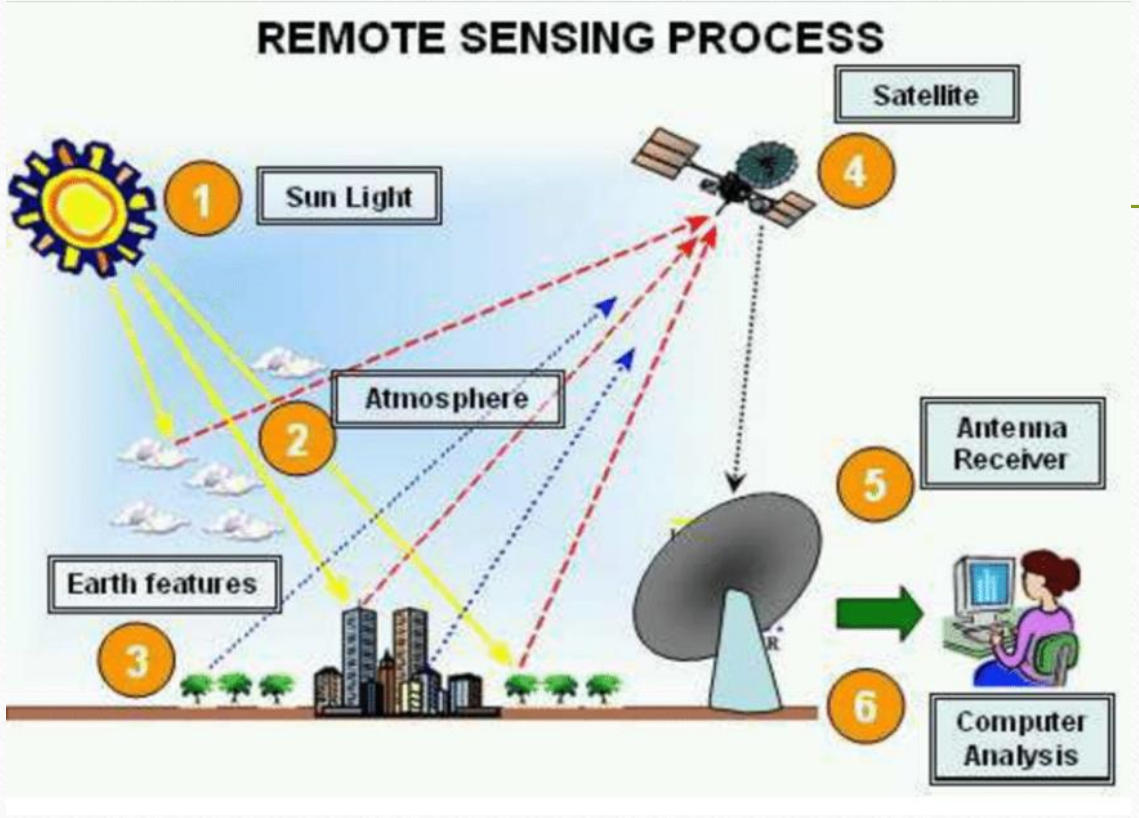
↓

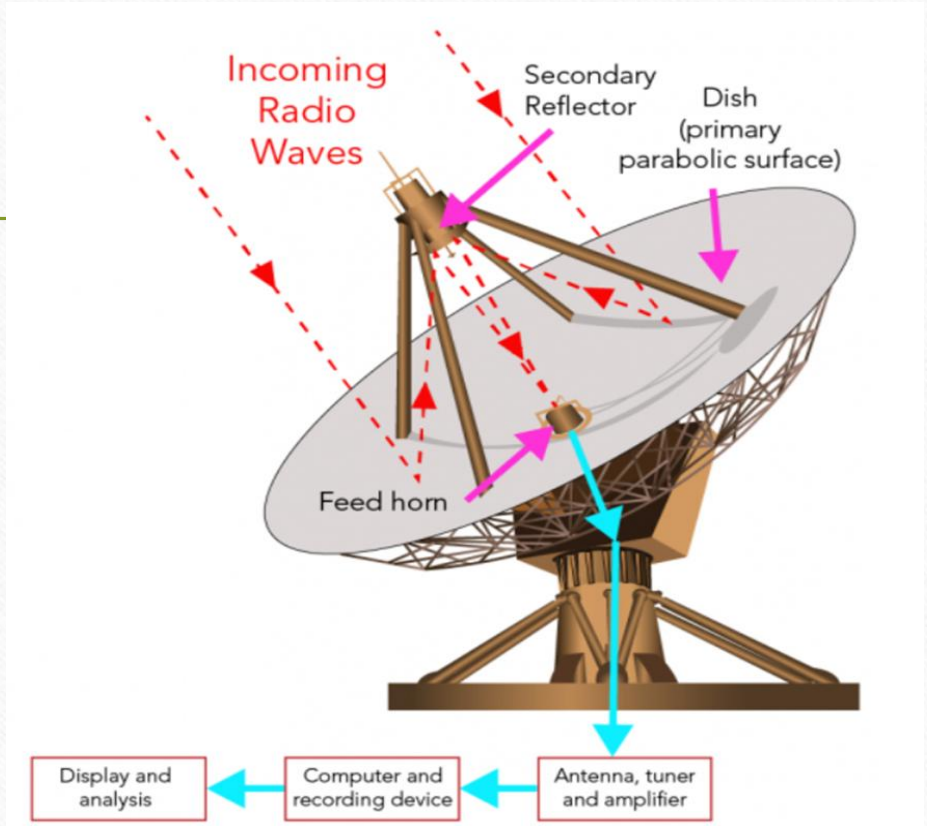
 Radio Image Map

What are the relationships? You get it.

If you don't get it, then ……

Remote sensing process and Radio astronomy





These images illustrate instrument setups and intermediate products. Note how calibration, noise mitigation, and imaging algorithms are shared concerns. Visual pipelines inform both scientific interpretation and downstream ML models.

Connecting Earth Observation and Space Observation

Common hardware

Antennae, receivers, spectrometers, and imaging arrays — design and signal-conditioning principles overlap.

Data characteristics

Spectral, spatial, radiometric, and temporal resolution are central to analysis and model design.

Practical takeaway: techniques developed in one domain (e.g., deconvolution, denoising) can accelerate progress in the other.

Connecting Earth Observation and Space Observation

Shared physics

- Both study electromagnetic radiation—different bands but same fundamental laws (propagation, scattering, absorption).

Shared challenges

Interference, calibration drift, and limited SNR (signal to noise ratio) require robust

preprocessing and statistical rigor.

Transferable skills between of skills RA and RS (think about your field)

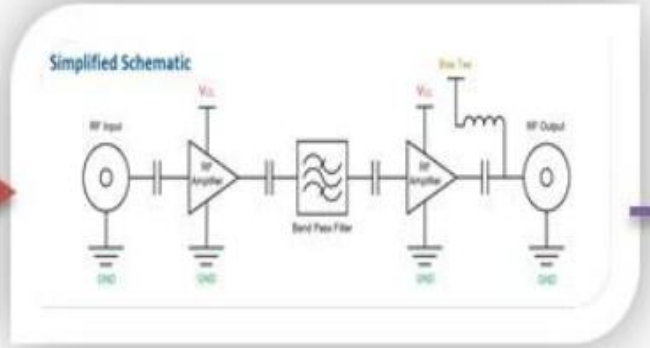
- EMS - Understanding bands (visible, IR, microwave, radio) and their interactions with targets is foundational.
- RS – visible, infrared, micro wave to study Earth
- RA - radio waves, to study space
- measure radiation without physical contact with the phenomenon.
- similar instruments used (Antennas, sensors, receivers, and signal chains, hardware).
- Imaging & signal processing

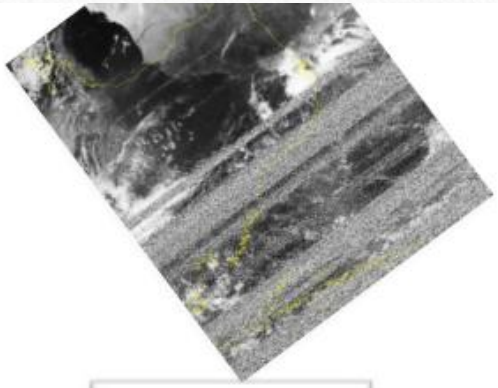
Transferable skills between of skills RA and RS (think about your field)

- processing (Calibration, filtering, Fourier methods, and image reconstruction apply to both radio and optical datasets
- Statistics/math
- Imaging techniques,
- Data analysis techniques

The Helicon Antenna Project

- **THE HCRA SYSTEM OVERVIEW**





RF tuner R820T2 | ADC RTL2832U | USI

RTL-SDR Receiver

Local Laptop (software supplied)

Helicon Antenna

Low Noise Amplifier (LNA)

Digital Back -end

HCRA Specifications

- HCRA diameter: 60cm
- Operating Frequency: 1.4 - 1.7GHz
- Hand tracking
- Type of Satellites: Weather
- Name of Satellites:
- NOAA 15,18,&19,
- Meteo MN2-3 & MN2-4

Application of radio astronomy in your field

- Radio astronomy is not a foreign field
- Telecommunications
- Weather forecasting
- Seismology
- LiDAR(point cloud, 3D)
- Radar
- Geodesy
- ISPs
- Agriculture
- Entertainment.
- Multispectral application
- Hyperspectral imaging

2. Opportunities

Further training, skills, mentorship.

Open Data for Social Impact Challenge

Twenty-five postgraduate students from the University of Fort Hare participated in the first Open Data for Social Impact Challenge, which was hosted close to SARAO's Hartebeesthoek Radio Astronomy Observatory (HartRAO) in Muldersdrift, Gauteng

https://www.sarao.ac.za/news/innovating-for-impact-fort-hare-students-harness-open-data-and-ai-to-uplift-communities-in-the-eastern-cape/

Big Data Africa Schools

- https://www.sarao.ac.za/news/saraos-big-data-africa-school/
- https://scm.sarao.ac.za/researchandstudy/5th-big-data-africa-school/

- Cloud computing
- AWS

Reflection

- Change of environment
- Discovering yourself
- Personal results (distress, motivation).
- Internal fulfilment
- Walking away better
- Long-term friendships, network,
- Realising this field is not for you
- Realising some of the aspects of this are for you.

3. Motivation

- As the year starts.
- New Habits (mental and physical wellbeing)
- New routines
- Lose bad routines and habits
- Be productive
- Account for your time
- Be consistent
- Go out there and win
- I wish you well.

Go out there and win advise to your fellow colleauge