



AVN Training HartRAO 2016

Welcome to HartRAO - we hope that you have an enjoyable and interesting visit.

*Radio transmitters may interfere with science operations. All cellular phones must be switched **OFF** inside the security fence. The use of wireless devices are **NOT** permitted. If you do not know how to turn off your Wi-Fi and bluetooth on your laptop please ask.*

Please note:

All the **Lectures** will take place in the [Lecture room](#)
Tea and Coffee will be served in the [Foyer](#)
Lunch and Dinner will be served in the [Visitor Centre](#)

Important dates:

Registration: **22 February 2016**
AVN Training School: **22 February - 08 March 2016**
IVS VLBI School: **09 - 12 March 2016**
IVS General Meeting, Ice breaker: **13 March 2016**
IVS General Meeting: **14 -16 March 2016**
IVS General Meeting, Conference dinner: **16 March 2016**
AVN Networking Meeting: **18 - 19 March 2016**

Programme: AVN Training School

Sunday 21 February: Arrival of Students

- 13:00 - 14:00: Lunch
 - 18:30 - 19:30: Dinner
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Monday 22 February: Welcome and Introduction

- 08:30 - 09:00: **Registration (Foyer)**
 - 09:00 - 10:00: **Welcome and introduction** (the Newton Project) - Ludwig
Logistics (catering and accommodation) - Glenda
Health and Safety - Pieter
Logistics (programme) - Alet
Computers (instructions) - Roelf
 - 10:00 - 11:00: Available projects - Alet
Participants to introduce themselves
 - 11:00 - 11:30: Tea/Coffee
 - 11:30 - 13:00: **Tour of the facility** - Alet & Pieter / Roelf & Ludwig
 - 13:00 - 14:00: Lunch
 - 14:00 - 15:00: **History of radio astronomy I** (L) - Khadija
 - 15:00 - 16:00: **History of radio astronomy II** (L) - Khadija
 - 16:00 - 16:30: Tea/Coffee break
 - 18:30 - 19:30: Dinner (labs will close at 20:00)
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Tuesday 23 February: Introduction to Radio Astronomy

- 09:00 - 10:00: **Radio astronomy basic terms** (L) - Alet
 - 10:00 - 11:00: **Measurement Errors** - Gordon
 - 11:00 - 11:30: Tea/Coffee break
 - 11:30 - 13:00: **Radio antennas** (L+D) - George
 - 13:00 - 14:00: Lunch
 - 14:00 - 16:00: **Hike**
 - 16:00 - 16:30: Tea/Coffee break
 - 18:30 - 19:30: Social Dinner (labs will close at 20:00)
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☑ Wednesday 24 February: History of Radio Astronomy in SA

- 09:00 – 10:00: **History of HartRAO** – George
 - 10:00 – 11:00: **History and status of the AVN (L)** – Gordon
 - 11:00 – 11:30: **Tea/Coffee break**
 - 11:30 – 13:00: **History and status of the SKA, KAT-7, MeerKAT** – Russ
 - 13:00 – 14:00: **Lunch**
 - 14:00 – 16:00: **Half day tour to SANSA** – Eugene
Historical background of SANSA (T)
Industrial applications (T)
 - 16:00 – 16:30: **Tea/Coffee break**
 - 18:30 – 19:30: **Dinner (labs will close at 20:00)**
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☑ Thursday 25 February: Coordinate and Timing Systems

- 09:00 – 10:00: **Overview of coordinate systems (L+D)** – Alet
 - 10:00 – 11:00: **Overview of coordinate systems (E)** – Alet
 - 11:00 – 11:30: **Tea/Coffee break**
 - 11:30 – 13:00: **Climb the dish** – Pieter / Alet
 - 13:00 – 14:00: **Lunch**
 - 14:00 – 15:00: **Timing systems (T)** – Ludwig
 - 15:00 – 16:00: **Pointing (L+D)** – Jonathan
 - 16:00 – 16:30: **Tea/Coffee break**
 - 18:30 – 19:30: **Dinner (labs will close at 20:00)**
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☑ Friday 26 February: Signal Flow and Processing

- 09:00 – 10:00: **Microwave receiver systems (L+D)** – Pieter / George
 - 10:00 – 11:30: **Tour of the workshop** – Pieter / George
 - 11:00 – 11:30: **Tea/Coffee break**
 - 11:30 – 13:00: **Microwave receiver systems (P)** – Pieter / George
 - 13:00 – 14:00: **Lunch**
 - 14:00 – 16:00: **Microwave receiver systems (E)** – Pieter / George
 - 16:00 – 16:30: **Tea/Coffee break**
 - 18:30 – 19:30: **Dinner (labs will close at 20:00)**
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☑ Saturday 27 February: Excursion and Social Event

- 08:30: **Buses depart from HartRAO**
 - 14:00 – 15:00: Lunch at HartRAO (labs open from 14:00 – 18:00)
 - 15:00 – 16:00: **Using your imagination** (T) – Gordon
 - 16:00 – 16:30: Tea/Coffee break
 - 18:30 – 21:00: Braai
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☑ Sunday 28 February: No class, free time

- 11:00 – 11:30: Tea/Coffee break
 - 13:00 – 14:00: Lunch
 - 16:00 – 16:30: Tea/Coffee break
 - 18:30 – 19:30: Dinner (labs open on request and will close at 20:00)
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☑ Monday 29 February: Signal Flow and Processing

- 09:00 – 09:30: **Antenna performance** (L+D) – Alet
 - 10:00 – 11:00: **Calibrating a small radio telescope** (P) – Alet / Sayan
 - 11:00 – 11:30: Tea/Coffee break
 - 11:30 – 13:00: **Measuring the HPBW** (P) – Alet / Sayan
 - 13:00 – 14:00: Lunch
 - 14:00 – 15:00: **Detecting radio emission from space** (L) – Alet
 - 15:00 – 16:00: **Exercises** – Alet / Sayan
 - 16:00 – 16:30: Tea/Coffee break
 - 16:30 – 18:00: **Continue with exercises** – Alet / Sayan
 - 18:30 – 19:30: Dinner (labs will close at 20:00)
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☑ Tuesday 01 March: Single-dish Observations: Drift scans

- 09:00 – 09:30: **Power received from radio emitters** (L) – Alet
 - 09:30 – 10:00: **Single-dish continuum observations of AGN** (L) – Pfsesi
 - 10:00 – 11:00: **Drift scan observations** (D) – Alet / Pfsesi
 - 11:00 – 11:30: **Tea/Coffee break**
 - 11:30 – 13:00: **Drift scan observations and calibration** (E) – Alet
 - 13:00 – 14:00: **Lunch**
 - 14:00 – 15:00: **Radiometer, square law detector** (L+D) – Keith
 - 15:00 – 16:00: **Continue with exercises** – Alet / Pfsesi / Pieter
 - 16:00 – 16:30: **Tea/Coffee break**
 - 16:30 – 18:00: **Continue with exercises** – Alet / Pfsesi / Pieter
 - 18:30 – 19:30: **Dinner (labs will close at 20:00)**
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☑ Wednesday 02 March: Single-dish Observations: Spectral Line

- 09:00 – 11:00: **Spectral line observations** (L) – Gordon
 - 10:00 – 11:00: **Spectral line observations** (D) – Gordon / Sharmila
 - 11:00 – 11:30: **Tea/Coffee break**
 - 11:30 – 13:00: **Spectral line observations** (E) – Gordon / Sharmila
 - 13:00 – 14:00: **Lunch**
 - 14:00 – 16:00: **Spectral line observations** (E) – Gordon / Sharmila
 - 16:00 – 16:30: **Tea/Coffee break**
 - 18:30 – 19:30: **Dinner (labs will close at 20:00)**
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☑ Thursday 03 March: Technical Aspects & Amateur Radio

- 09:00 – 10:00: **Radio telescopes: technical aspects** (L+D) – Pieter
 - 10:00 – 11:00: **RFI** (L+D) – George
 - 11:00 – 11:30: **Tea/Coffee break**
 - 11:30 – 13:00: **Antenna conversion** (T) – Anita
 - 13:00 – 14:00: **Lunch**
 - 14:00 – 15:00: **Amateur radio astronomy** (D) – Alet / Pieter
 - 14:00 – 15:00: **Amateur radio** (T) – Tony
 - 16:00 – 16:30: **Tea/Coffee break**
 - 18:30 – 19:30: **Dinner (labs will close at 20:00)**
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☑ Friday 04 March: Radio Surveys and Data Mining

- 09:00 – 10:00: **Radio surveys** (L+D) – Khadija / Nadeem
 - 10:00 – 11:00: **Data mining** (L+D) – Khadija
 - 11:00 – 11:30: **Tea/Coffee break**
 - 11:30 – 13:00: **Virtual Observatory tools** (L+D) – Khadija
 - 13:00 – 14:00: **Lunch**
 - 14:00 – 16:00: **Virtual Observatory tools** (P) – Khadija
TOPCAT
Aladin
 - 16:00 – 16:30: **Tea/Coffee break**
 - 18:30 – 19:30: **Dinner** (labs will close at 20:00)
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☑ Saturday 05 March: Outreach and Education

- 09:00 – 10:00: **Astronomy outreach and education** (T) – Nadeem
 - 10:00 – 11:00: **Astronomy outreach and education** (T) – Nadeem
 - 11:00 – 11:30: **Tea/Coffee break**
 - 11:30 – 13:00: **Talk from the Office of Astronomy Development** – Ram
 - 13:00 – 14:00: **Lunch**
 - 14:00 – 16:00: **Astronomy outreach and education** (P+E) – Marion
 - 16:00 – 16:30: **Tea/Coffee break**
 - 18:30 – 19:30: **Dinner special event** (labs will close at 20:00)
 - 19:30 – 21:30: **Sky viewing evening** – Marion
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☑ Sunday 06 March: Fourier Transforms

- 10:00 – 11:00: **Fourier transforms** (L) – Michael
 - 11:00 – 11:30: **Tea/Coffee break**
 - 11:30 – 13:00: **Fourier transforms** (E) – Michael
 - 13:00 – 14:00: **Lunch**
 - 16:00 – 16:30: **Tea/Coffee break**
 - 18:30 – 19:30: **Dinner** (labs will close at 20:00)
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☑ Monday 07 March: Radio Interferometry and VLBI

- 09:00 – 10:00: **Introduction to interferometry and VLBI** (T) – Alet
 - 10:00 – 11:00: **Interferometry theory and VLBI I** (L) – Michael
 - 11:00 – 11:30: **Tea/Coffee break**
 - 11:30 – 13:00: **Interferometry theory and VLBI II** (L+D) – Michael
 - 13:00 – 14:00: **Lunch**
 - 14:00 – 15:00: **VLBI techniques** (L+D) – Jon
 - 15:00 – 16:00: **Introduction to astrometric VLBI** (L) – Chris
 - 16:00 – 16:30: **Tea/Coffee break**
 - 16:30 – 17:00: **Introduction to geodetic VLBI** (L) – David / Andy
 - 17:00 – 18:00: **Introduction to VieVs** (L) – David / Andy
 - 18:30 – 19:30: **Dinner (labs will close at 20:00)**
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☑ Tuesday 08 March: Radio Interferometry and VLBI

- 09:00 – 11:00: **VieVs exercises** (E) – David / Andy
 - 11:00 – 11:30: **Tea/Coffee break**
 - 11:30 – 13:00: **UCT interferometer** (D+P) – Yannick
 - 13:00 – 14:00: **Lunch**
 - 14:00 – 16:00: **Stellar GPS: navigation** (Invited Talk) – Chris
 - 16:00 – 16:30: **Tea/Coffee break**
 - 16:30 – 18:00: **Feedback and evaluation session**
 - 18:30 – 19:30: **Dinner (labs will close at 20:00)**
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Day-1, Wednesday, 9 March 2016

09:00-09:15 Welcome (**Rüdiger Haas + Alet de Witt**)
09:15-10:00 **L01**: Introductory lecture, (**Axel Nothnagel**)
10:00-10:30 -- Coffee break --
10:30-12:00 **L02**: Technical equipment at stations (**Bill Petrachenko**)
12:00-13:00 -- Lunch break --
13:00-14:00 **L03**: Digital backends, DBBC, Fila10G (**Gino Tuccari**)
14:00-14:30 -- Coffee break --
14:30-15:30 **L04**: Data acquisition, Mark5/Flexbuff... (**Harro Verkouter**)
15:30-16:00 -- Coffee break --
16:00-17:00 **L05**: Data acquisition, RDBE, Mark6... (**Chet Ruszczyk**)
17:00-17:15 Stretch your legs break --
17:15-19:15 **EX1**: Exercises on technical aspects (**Bill, Gino, Harro, Chet**)
19:00-20:00 Dinner (labs will close at 20:00)

Day-2, Thursday, 10 March 2016

08:30-10:00 **L06**: Experiment scheduling (**John Gipson**)
10:00-10:30 -- Coffee break --
10:30-12:00 **L07**: Observing an experiment (**Alexander Neidhardt**)
12:00-13:00 -- Lunch break --
13:00-14:30 **EX2**: Exercises on scheduling (**John + tbd**)
14:30-15:00 -- Coffee break --
15:00-16:30 **L08**: Correlators for geodesy and astrometry (**Walter Brisken**)
16:30-17:00 -- Stretch your legs break --
17:00-18:30 **EX3**: Exercises on running an experiment (**Alexander + tbd**)
19:00-20:00 Dinner (labs will close at 20:00)

Day-3, Friday, 11 March 2016

08:30-10:00 **L09**: Post-correlation anal., fringe-fitting (**Roger Cappallo**)
10:00-10:30 -- Coffee break --
10:30-12:00 **EX4**: Exercise-4 on correlation (**Walter + Roger + tbd**)
12:00-13:00 -- Lunch break --
13:00-14:30 **L10**: Geophysical modelling (**Thomas Hobiger**)
14:30-15:00 -- Coffee break --
15:00-16:30 **L11**: Signal propagation (**Johannes Böhm**)
16:30-17:00 -- Stretch your legs break --
17:00-18:30 **EX5**: Exercises on modelling (**Thomas H. + Johannes + tbd**)
19:00-20:00 Dinner (labs will close at 20:00)

Day-4, Saturday, 12 March 2016

08:30-10:00 **L12**: Radio sources (**Patrick Charlot**)
10:00-10:30 -- Coffee break --
10:30-12:00 **L13**: Data analysis for geodesy (**Thomas Artz**)
12:00-13:00 -- Lunch break --
13:00-14:30 **L14**: Data analysis for astrometry (**Chris Jacobs**)
14:30-15:00 -- Coffee break --
15:00-18:00 **EX6**: Exercises on data analysis (**Thomas A. + Chris**)
19:00-22:00 -- VLBI school dinner (labs will close at 19:00)

Content: AVN Training School

☑ Monday 22 February: Welcome and Introduction

- **History of radio astronomy**
 - Pre-history of radio astronomy
 - History of radio astronomy
 - Major discoveries
 - History of interferometry and VLBI
 - Current radio telescope facilities

☑ Tuesday 23 February: Introduction to Radio Astronomy

- **Radio astronomy basic terms**
 - Electromagnetic spectrum
 - Radio waves
 - Radio emission processes
 - Interference
 - Importance of multi-wavelength analysis
 - Gain of a parabolic reflector antenna
- **Radio antennas**
 - Types of antennas
 - Parabolic dishes: types of mounts, reflector types...
 - Antenna beam patterns
 - Apertures and diffraction pattern

☑ Wednesday 24 February: History of Radio Astronomy in SA

- **History of radio astronomy in South Africa**
 - * Hartrao history since the NASA days
 - * Astronomy, astrometry and geodesy at Hartrao
- **History of the AVN and current status**
- **History of the SKA, KAT-7, MeerKAT and status**
- **Historical background of SANSa and status**
 - * Industrial Applications

☑ Thursday 25 February: Coordinate and Timing Systems

- **Overview of coordinates systems**
 - * The celestial sphere
 - * Celestial coordinates
 - * Precession, nutation and rotation
 - * The International Celestial Reference Frame (ICRF)
- **Climb the dish**
- **Timing systems**
- **Pointing**
 - * Pointing and pointing models for radio telescopes

☑ Friday 26 February: Signal Flow and Processing

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- **Microwave receiver systems**
 - * Main components of a typical receiver
 - * Power ratios to quantify changes in signal level
 - * Measure signal level through receiver in workshop
 - **Tour of the workshop**
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[Monday 29 February: Signal Flow and Processing](#)

- **Detecting radio emission from space**
 - * System temperature
 - * Integration time
 - * Radiometer sensitivity equation
 - * RMS noise and minimum detectable flux
 - **Antenna performance**
 - * Gain of a parabolic reflector antenna
 - * Aperture efficiency
 - * Surface efficiency
 - * Pointing errors
 - * Servo performance
 - **Calibrating a small radio telescope**
 - **Measuring the brightness temperature of the sun and the HPBW**
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[Tuesday 01 March: Single-Dish Observations: Drift scans](#)

- **Power Received from radio emitters in the sky**
 - * Measure source electric field
 - * Power, brightness, flux density
 - * Antenna temperature and PSS
 - **Continuum observations**
 - * Drift scan observations
 - * Measure the PSS and source flux density
 - **Single-dish continuum observations of AGN**
 - **Drift scan observations and calibration**
 - **Radiometer, square law detector**
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[Wednesday 02 March: Single Dish Observations: Spectral Lines](#)

- **Spectral line observations**
 - * Theory of spectral line observations
 - * Position and frequency switching
 - * Monitoring observations: Masers
 - * Spectral line observations of a maser source and calibrator
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[Thursday 03 March: Technical Aspects & Amateur Radio](#)

- **Radio telescopes**
 - * Astronomical drive and tracking systems...
 - * Maintenance, health and safety procedures
- **RFI**
 - * Radio frequency interference and mitigation procedures
- **Antenna conversion**
 - * Update and overview of the AVN engineering project
- **Amateur radio astronomy**
 - * How to build your own radio telescope

Friday 04 March: Radio Surveys and Data Mining

- **Radio surveys**
 - * Types and goals of sky surveys at different wavelengths
 - * Brief history of sky surveys
 - * Surveys and catalogues in the radio
 - * Cross-matching catalogues
 - **Data mining**
 - * Various data archives, surveys, data products
 - **Virtual Observatory tools**
 - * Data discovery and visualisation, spectral analysis...
 - * Aladin, TOPCAT, VO Spec, SPLAT, VOPlot...
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Saturday 05 March: Outreach and Education

- **Astronomy outreach and education**
 - * The importance of Astronomy Outreach and Education
 - * Current programmes in South Africa and elsewhere
 - * Tips for Outreach and Science Centres
 - **Talk from the Office of Astronomy Development (OAD)**
 - **Sky viewing evening**
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Sunday 06 March: Fourier Transforms

- **Fourier transforms**
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Monday 07 March: Radio Interferometry and VLBI

- **Introduction to interferometry theory and VLBI**
 - * The basics of interferometry and VLBI
 - * Overview of astrometry, astronomy and geodesy with VLBI
 - **Interferometry theory and VLBI**
 - * Aperture synthesis
 - * Synthesised beam
 - * Complex visibility
 - * Projected baseline
 - * How to use FFT, dirty image, CLEAN algorithm
 - **VLBI techniques in control room**
 - * Field System
 - * Backends and recording systems
 - * e-VLBI, timing, hydrogen masers and GPS
 - **Introduction to astrometric VLBI**
 - **Introduction to geodetic VLBI**
 - **Introduction to VieVS**
 - * Matlab software for geodetic VLBI data analysis
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Tuesday 08 March: Radio Interferometry and VLBI

- **VieVS exercise**
- **UCT interferometer**
- **Stellar GPS: navigation (invited talk)**
- **Complete evaluation forms**

Staff Contact Details:

| Name | Office Number | EXT | Cellphone |
|-------------------------|----------------------|------------|------------------|
| Dr Alet de Witt | 16 | 222 | 072 784 3988 |
| Dr Khadija EL Bouchefry | 17A | 202 | 076 514 7982 |
| Dr Gordon MacLeod | 17A | 202 | 072 144 6088 |
| Mrs Glenda Coetzer | Library | 218 | 072 147 4654 |
| Mrs Marion West | 4 | 227 | 082 350 7686 |
| Mrs Marisa Nickola | 16 | 222 | 072 403 2853 |
| Mr Pieter Stronkhorst | Workshop | 252 | 072 600 7449 |
| Ms Sharon Rakgalakane | Geodesy Lab | 241 | 072 824 6319 |

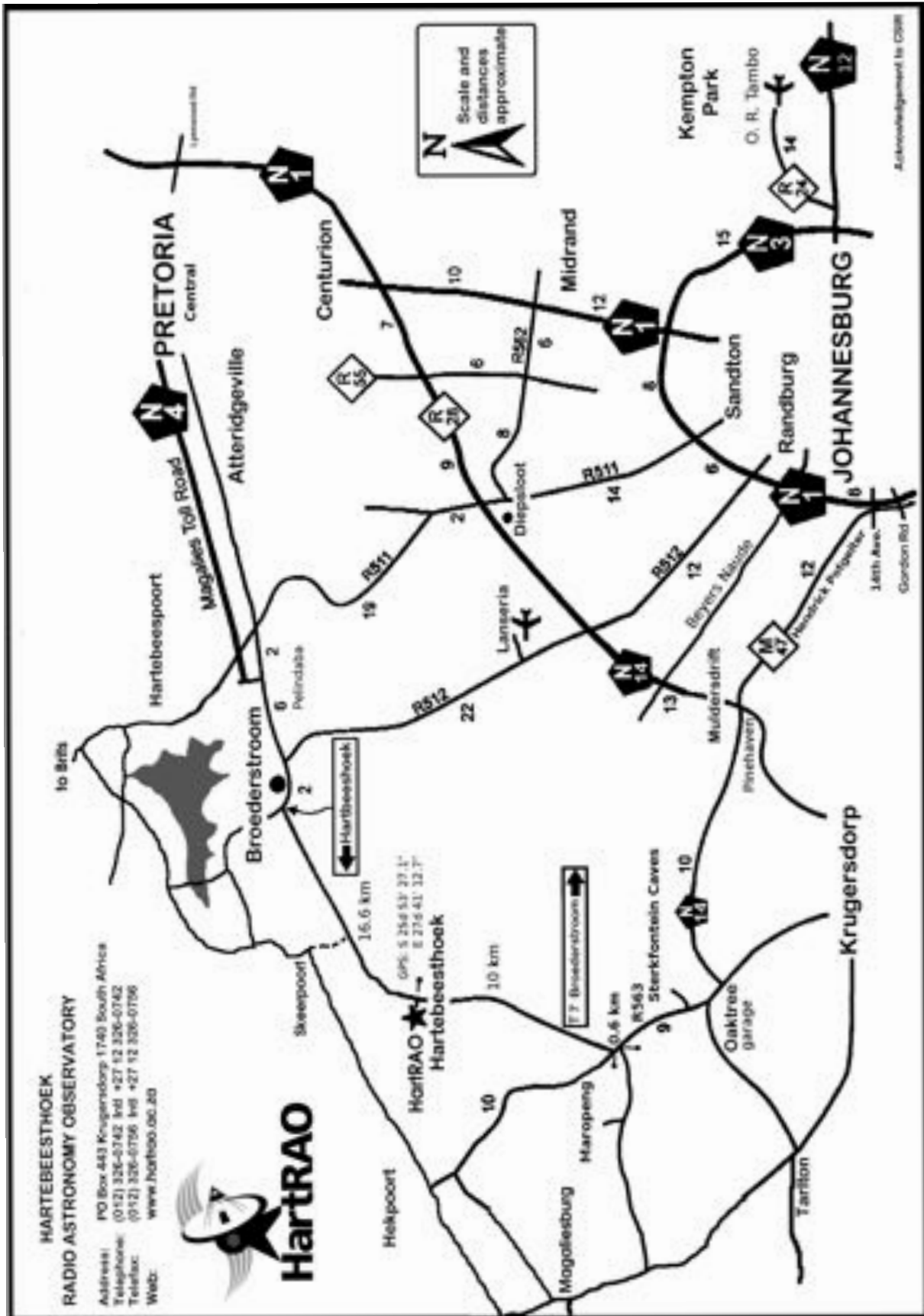
Emergency Contact Numbers:

| Name | EXT | Number |
|---------------------------------------|------------|-------------------------------|
| HartRAO Security | 235 | |
| Flying Squad | | 10111 |
| Fire Brigade (Krugersdorp) | | 011 951 3000 |
| Police Station (Magaliesburg) | | 014 577 1316 |
| Police Station (Krugersdorp) | | 011 951 1111 |
| Police Station (Hekpoort) | | 014 576 1122 |
| SAP Reaction Unit | | 011 762 5592 |
| Ambulance | | 011 951 3000 |
| Yusuf Dadoo Hospital (Krugersdorp) | | 011 951 6000 |
| SANSA Security | | 012 334 5014 |
| Medics (Krugersdorp) | | 011 950 9000/ 011 953 1700 |
| Krugersdorp Private Hospital | | 011 951 0299 |
| Netcare 911 (Ambulance) | | 082911 |

Contact Details: Lecturers

- Prof Ludwig Combrinck - HartRAO, South Africa
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- Mr Ramasamy Venugopal - IAU-OAD Visiting Fellow, India
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- Mr Christopher Jacobs - NASA, JPL, United States
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- Mrs Anita Loots - SKA-SA, South Africa
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- Dr Russ Taylor - Univ. of Cape Town, South Africa
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How to get to Hartrao



Hartebeesthoek Radio Astronomy Observatory (HartRAO) facility map [credit: Google Earth, Google Image]



- 01 - HartRAO 26 m dish
- 02 - 15 m dish
- 03 - SLR/LLR facility
- 04 - C-BASS dish

- Reception
- Control Room
- Toilet
- Accommodation
- Eng. Workshop
- Dining (Lunch/Dinner)
- No Access
- Lecture Room/lab
- Kitchen
- Foyer (Regn., tea/coffee)
- Entrance to facility

Student Groups:

| Name | Group # | Country |
|---------------------------|---------|----------|
| Nchimunya Mwiinga | group 1 | Zambia |
| Felix Omonya Wanjala | group 1 | Kenya |
| Calvince Otieno Juma | group 1 | Kenya |
| Mwiya Namakau | group 1 | Zambia |
| Ann Njeri Ng'endo | group 1 | Kenya |
| | | |
| Mhlambululi Mafu | group 2 | Botswana |
| Banda Peter | group 2 | Zambia |
| Jephter Ondieki | group 2 | Kenya |
| Mutembo Careen | group 2 | Zambia |
| Antone Orege Ochieng | group 2 | Kenya |
| Simumba Naomi | group 2 | Zambia |
| | | |
| Sinyangwe Misheck | group 3 | Zambia |
| Amos Kipkosgei Chepkwonyo | group 3 | Kenya |
| Samson Mukandi Mutunga | group 3 | Kenya |
| Chanka Noah | group 3 | Zambia |
| Mutale Mubela | group 3 | Zambia |
| | | |
| Kunaka Esther | group 4 | Zambia |
| Moonga Kando | group 4 | Zambia |
| Willice Odhiambo Obonyo | group 4 | Kenya |
| Nancy Atieno Omolo | group 4 | Kenya |
| Martin Mule Mutie | group 4 | Kenya |