Radioastronomy in Mauritius - Past, Present and Future Outlook

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Fundamental Physics with the SKA
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Aerial view, Mauritius Radio Telescope (MRT) in the forest reserve of Bras-D'Eau

- The Mauritius Radio Telescope in Retrospect
- MRT output & MRT people now
- Current Work at MRT site.
- Future Outlook in the context of the SKA
MRT - an Indo-Mauritian venture (between IIA, RRI and UoM) initiated by Prof Ch V Sastry (IIA) - 1987

Three Mauritians from UoM (NH Issur, R Somanah & K Golap) involved in all aspects of its construction, along with the Indian Team.

Marked the beginning of Radioastronomy in Mauritius.
(sensitivity 200 mJy, resolution ~4")

2 km EW arm:
1024 helical antennas divided in 32 groups.

About 1 km South arm:
16 movable groups (on trolleys) with 4 helical antennas each.
The Great Wall of Mauritius
MRT Specifications for continuum

- Location: 20°.14 S; 57°.73 E
  - Observing frequency: 151.5 MHz
  - Telescope configuration: T-shaped array

- Basic element: Helical Antenna
  - Polarization: Right Circular
  - Collecting area of a helix: 4 m$^2$ at 150 MHz
  - FWHM of helix: 56°
  - Declination coverage: -70° to -10°

- East-west arm: Length: 2048 m
  - Composition: 32 groups with 32 helices each
  - Collecting area: 4096 m$^2$

- North-south arm: Length: 880 m
  - Composition: 16 trolleys, each with 4 helices
  - Collecting area: 256 m$^2$

- 1st IF frequency: 30 MHz
- 2nd IF frequency: 10.1 MHz

- Instrumental bandwidths (available): 0.15 MHz, 1.0 MHz, 1.5 MHz, 3.0 MHz

- Digitization before correlation: 2-bit 3-level, 1-bit 2-level
  - Correlation receiver: 32 X 16 complex correlators

- Number of baselines measured per day: 32 X 16
  - Collecting area per baseline (1 EW X 1 NS): 90 m$^2$

- Sensitivity per baseline: 26 Jy (integration time = 1 s, BW = 1 MHz)
  - Minimum and maximum baselines: 0, 661 lamda
  - Self correlations: 64

- Minimum time required to get full resolution image: 60 days

- Synthesized beam-width: 4'X4'.6 sec (delta+20°.14)

- Expected RMS noise: 110 mJy (1-sigma; for Tsys = 700 K; integration time = 4 s)
Above: Our Galactic Plane (K Golap)

Left: Our Galactic Centre (R Somanah)
Pulsar observing system installed in 1996. The new hardware consisted of a tracking system (limited to the 2 deg beam of an EW group) and a Fast Data Acquisition System for direct recording and offline dedispersion.
High time-resolution MRT 150MHz Observation of MSP J0437-4715
(NH Issur & A.A. Deshpande)
MRT operating structure & timeline

- Conception (1987) before creation of School of Science (1988) at UoM
- Initially involvement of the School of Industrial Technology + Science
- Inauguration (1992) after 5 years sustained efforts from Indo-Mauritian tea, and progress monitored by a National Monitoring Committee.

- Data Processing & Astrophysical Analysis of MRT data (1992-now)

- MRT under Department of Physics, Faculty of Science, UoM.
- MRT 1hr drive from UoM, Reduit but MRT Head, based at Reduit + Reduced technical staff based at MRT (UoM financial constraints)
- System Degradation and Cable Thefts (after 2006)
- Helical Antennas removed 2011

- Since 2006-2007, a partner country in the SA SKA project
  Several activities geared towards preparing for the SKA
MRT Output

- Valuable Astronomical Data & Software Development.
- Training of a large no of students: B.Sc and B.Tech level (Physics & Engineering)
- 11 completed Theses excluding our students who became SA SKA PG Bursars or got other scholarships. All did extremely well for their Masters & a few completing their PhDs now (Brain Drain?)
- Some MRT people now: K. Golap (CASA developer, NRAO), S. Sachdev (Software for speech problems, N Zealand), N. Oozeer (Commissioning Scientist, SA SKA)
- Over 100 Publications from MRT work and MRT people in Nasa ADS
- Several International meetings organised. (since LFM, 1997)


Visitors during the LFM 1997
Current Work at MRT site
(using infrastructure initially developed for MRT)

• New Antennas Fabrication and Testing.
• Solar Activity monitoring with the CALLISTO.
• Ionospheric Scintillation Monitor (SANSA)
• Solar Radiation Measurements
• Occasional Optical Observations & P.O. (e.g 1\textsuperscript{st} Sept 2016 Solar eclipse)
• Communication with CUBESATs initiated.
• Several Activities in line with the upcoming SKA from B.Sc students & 2 PhD students.
1\textsuperscript{st} Sept 2016 solar eclipse
Viewing at MRT site
1st Sept 2016 Solar eclipse
Viewing on UoM Campus, Reduit
Future Outlook: New structure desirable given present

- **Strength**: Availability of site. Dark Skies & low RFI. Students & staff trained in Astronomy.
- **Weakness**: Insufficient HR at higher levels (sp. Scientific & engineering) at the observatory.
- **Opportunities**: Future Challenges with the upcoming AVN and the SKA.
- **Threats**: Structure of operation not efficient to tap our talented people + possible RFI degradation (wind farm & nearby smart city)
Suggested Conversion to MAO (Mauritius Astronomical Observatory)

- To host a variety of installations for astronomical observations (Radio, preparing for the AVN & SKA + optical). To attract attention of relevant authorities to preserve the site for same.
- To be used for training (B.Sc, Masters & PhD) & research (with international collaborations & hopefully funding)
- Also Public Outreach and possibly a revenue generating paid access for tourists.
**Possible Projects in line with MAO**

- Development of Capacity building for SKA mid-freq. (GKB) + to observe at higher frequencies with dish antennas for upcoming AVN and SKA
- The Deuterium Array at 327.4 MHz (V. Prayag)
- Exploring novel techniques to process data in real time using open source hardware (N. Rughoomundun)
- For the AVN, if funding & help is obtained, installation of a 25 class parabolic dish that can also be used on its own to observe upto 10 GHz (deep sky, transients & pulsar observations).
- As a 1\textsuperscript{st} step: An interferometer with 2 small (3m) dish antennas to observe neutral Hydrogen – initiated in part.
- For training purposes, re-installation of part of MRT array.