THE MAURITIUS RADIOTELESCOPE

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Abstract

The Mauritius Radiotelescope (MRT) is a T-shaped array of helical antennas with a 2048 m EW arm and a 890 m South arm. The primary objective of the telescope is to produce a sky survey in the declination zone -15^o to -65^o with a point source sensitivity of ≈200 mJy and an angular resolution of 4'×4.6'cosec(z) at 151.6 MHz, z being the zenith angle . This paper describes the telescope and the present status

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1 Introduction

The Mauritius Radiotelescope (MRT) is an aperture synthesis instrument built and run collaboratively by the Raman Research Institute (India), the Indian Institute of Astrophysics and the University of Mauritius. It is situated in Mauritius, a small island in the Indian Ocean (Latitude $20^o.31$ South, Longitude $57^o.74$ East). It is a T-shaped array with 1024 helices in a 2048 m EW arm and 16 trolleys with 4 helices each in a 890 m South arm.

The design of the telescope has been partly influenced by the 6th Cambridge Survey. This survey provides a moderately deep radio catalogue reaching a source density of about 2×10^4 sources/sr$^-1$ (i.e.$\approx$200 mJy at 150MHz), covering most of the sky north of dec $+30^o$ (Baldwin et al. 1985). MRT has been built mainly to fill the lacuna which exists in the low frequency surveys of the Southern sky with high resolution and sensitivity. It will produce a 151 MHz sky survey covering a large part of the Southern sky (Dec. -15^o to -65^o).

2 Description of the array

The primary element of the array is a peripherally fed monofilar axial mode helix. It has a collecting area of about λ^2 (4 m^2 at 150 MHz) with a HPBW about $50^o \times 50^o$ (Kraus 1988). The helices are mounted with a tilt of 20^o towards the South. This tilt allows a better coverage of the Southern sky (-15^o to -65^o dec) including the Southern-most part of the galactic plane. This region is largely unexplored at meter wavelengths.

In the EW arm 1024 helices are mounted on a 2 m wide ground plane with an inter-element spacing of 2 m (λ at 150 MHz) and is divided into 32 groups of 32 helices each. The HPBW of the Primary Beam of each EW group is $2^o \times 50^o$ and allows observation of a source for roughly $8\times$ cosec(δ) minutes of time. In each group four helices are combined using hybrids and the output is preamplified in a low noise amplifier. Eight amplifier outputs are further combined and amplified to form a group in the EW array. Due to the uneven terrain all the EW groups are not at the same height. Four helices mounted on a trolley with a 4 m wide ground plane constitutes a group in the S array. The HPBW of the primary beam of each S group is $15^o \times 50^o$. Both EW and S group outputs are heterodyned to an IF of 30 MHz, a frequency more appropriate for transmission. After further amplification the 32 EW and 16 S group outputs are carried using coaxial cables to the observatory situated close to the center of the array.

In the observatory building the 48 group outputs are further amplified and downconverted to 10 MHz (second IF). Four IF bandwidths, ranging from 3 to 0.15 MHz are selectable. The outputs of the 32 EW and 16 S groups are fed into a 32×16 complex, 2 bit-3 level, digital correlator sampling at 12 MHz. To check the repeatability of the data and also help in phase calibration, one of the EW arm outputs is also multiplied with the EW group outputs. This reduces the number of usable trolleys to 15.

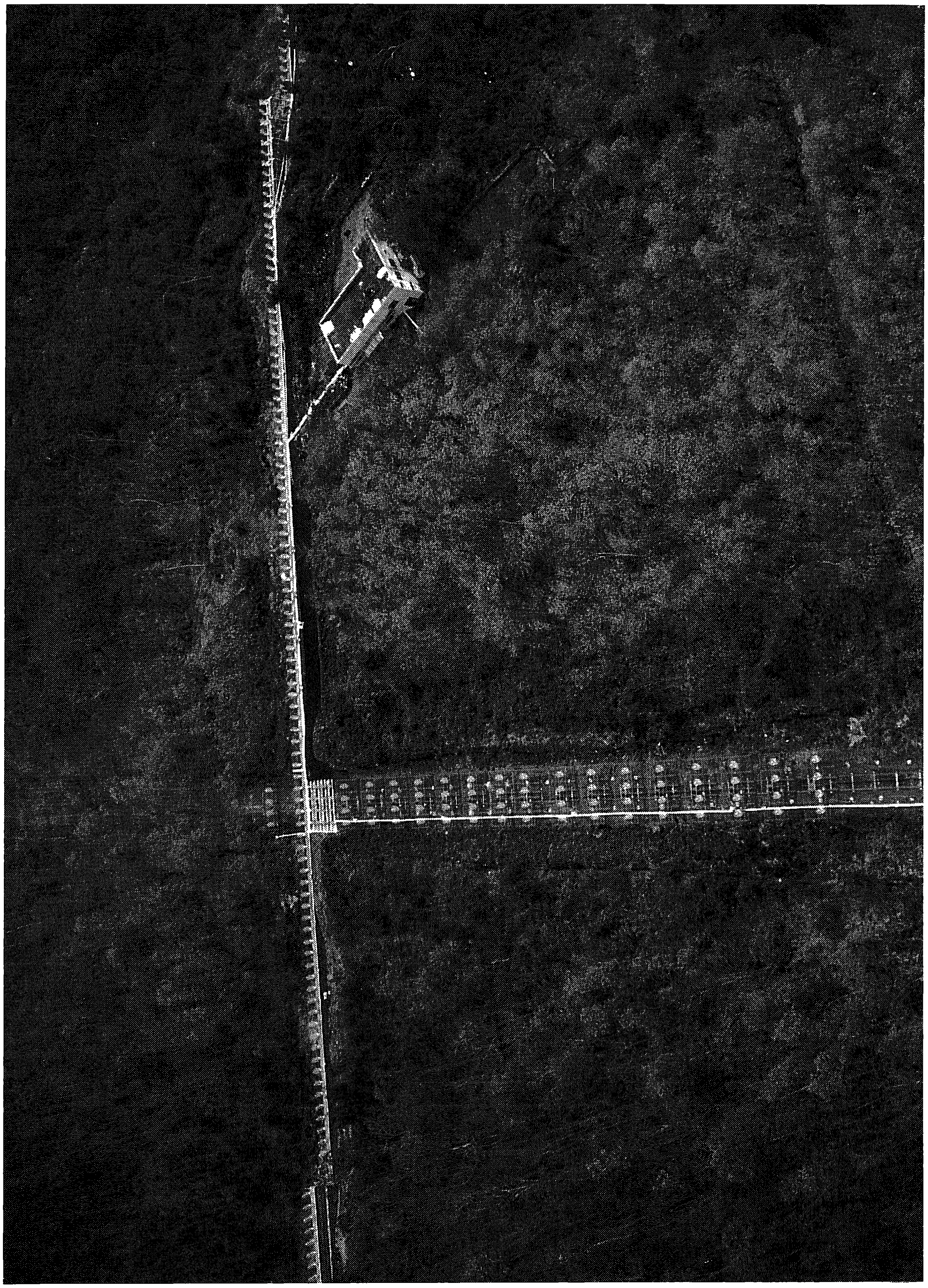
The correlation receiver measures 512 complex visibilities using 32 EW groups, 15 S trolleys and an E group. These are recorded with one second of integration on the disk of a Sun Spark 1 work station. At the end of 24 hours of observing the trolleys are moved to different positions and new visibilities are recorded. It is proposed to sample the visibilities in the S direction at intervals of $\lambda/2$ to ensure that there are no grating responses in declination.

This sampling needs a minimum of 60 days of observing to obtain the visibilities up to 890 m spacing . Experience so far shows that 3 days of observing are required with one set of trolley positions to obtain repeatable and interference free data.

Fourier transform of the phase corrected visibilities obtained after the complete observing schedule (32×890 visibilities per second) produces a map of the area of the sky under observation with a synthesised beam width of 4'×4'.6cosec(z). The phase corrections mentioned above take into consideration the non-coplanarity of the baselines. The expected rms values of the background in the synthesised images arising from system noise with 1 MHz bandwidth and an integration time of 8 sec and from confusion are expected to be around 60 mJy and 10 mJy respectively.

3 Present Status

The telescope is now fully operational. Observations have been carried out to calibrate the system, study its amplitude and phase stability and assess ionospheric effects. A survey comparable in resolution and sensitivity ($\approx 1/2^o \times 1/2^o$ and 1 Jy) to the all sky survey at 408 MHz (Haslam et al.) is now being carried out using part of the south array.



AERIAL VIEW OF THE MAURITIUS RADIO TELESCOPE

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