A Report from the Mauritius Radio Telescope

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Abstract

The Mauritius Radio Telescope (MRT) was built with an objective of imaging the southern sky at 150 MHz. The main objective of the telescope has been achieved and a survey covering the declination range -10° < δ < -70° and 24 hours in RA with a resolution of $4' \times 4'.6$ sec ($\delta + 20°.14$) has been completed. The detection limit (5 σ) of the survey is ∼1 Jy/beam. We present some interesting images chosen from the survey covering 4 steradians and highlights of imaging with this non-coplanar array.

1 Introduction

The MRT is a T-shaped array consisting of 2048 metre long East-West (EW) arm and a 880 metre long South arm. In the EW arm 1024 helices are arranged in 32 groups and in the south arm 16 trolleys, with 4 helices on each, which move on a rail are used for synthesis. Due to the uneven nature of the local terrain antenna groups in the EW arm are at different heights making MRT array a non-coplanar array. A 512 channel, 2-bit, 3-level complex correlation receiver is used to measure the visibilities. At least 60 days of observations are required for obtaining the visibilities up to 880 metre spacing, sampling every metre. After calibration the visibilities are transformed taking care of the non-coplanarity of the array to produce an image of the area of the sky under observation.

Imaging with the MRT is challenging because of the non-coplanarity of the array, its wide field of view and the effect of bandwidth decorrelation. This is further complicated by the long observing time for the survey which spanned from July 1994 to March 1999. Modifications to the receiver system which demanded changes in data recording formats adds another level of complexity to the MRT data reduction.

Approximately 20,000 hours of observations have been carried out for the survey during the time interval 1994 to 1999. Using this data deconvolved images covering one steradian of the sky ($18^h \leq \alpha \leq 24^h 30^m, -70° \leq \delta \leq -10°$) and a source catalogue containing around 2,800 sources have already been made in a previous work in 2006.

2 A southern sky survey at 151.5 MHz

In this report we describe the completion of the MRT survey. Presently the whole sky observable from the MRT has been imaged (declination range -70° $\leq \delta \leq -10°$ and 24 hours in RA). To cope with the large number of observations an automatic RFI detection and mitigation technique was developed. In addition an automatic method for classification of data quality has also been developed. Due to the non-coplanar nature of the array, the PSF of the array is declination dependent. The problems of deconvolving wide-field images with a varying PSF have also been addressed. We have tackled the problems of automating the reduction of large number of hours of observations. Analysis of 1 steradian of the sky previously imaged showed systematic errors in the position of sources. We developed a method based on Homography to correct for positional systematics in the images in order to avoid the long task of correcting for such errors in the uv domain. Analysis of the Homography matrix cued towards errors in the array geometry. These errors

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were estimated and corrected for by setting up and solving a set of linear equations based on observations of 3 strong calibrators widely separated in declination. We further developed a field of view based calibration technique to overcome the limitations of our earlier calibration scheme which is based on of observations of a few strong calibrators. From the images we generated a catalogue consisting of ∼13,000 sources. A detailed analysis of these images which include estimation of rms noise, positional and flux density errors has been carried out. We have identified ∼ 300 extended sources in the images.

3 Conclusion

We have completed a southern sky survey at a low frequency of 151.5 MHz using the MRT and generated a source catalogue of ∼13,000 sources and have thus achieved the main objective behind the building of MRT.

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