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Full resolution deconvolved images from the Mauritius Radio Telescope

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The first set of full resolution ($4' \times 4.6' \sec(\delta + 20.14^{\circ})$) deconvolved images have been made using the Mauritius Radio Telescope (MRT) for the Right Ascension (RA) range 18:00 to 19:00 hours and the declination range -70° to -10°. This is a part of the MRT southern sky survey at 151.5 MHz which is expected to have a point source sensitivity of 200 mJy/beam (3σ).

During the period May 1994 to March 1999, more than 20,000 hours of astronomical observations have been carried out for the survey. A simple statistical analysis shows that we have good data, sufficient for the entire survey. The visibilities measured are processed offline using MARMOSAT (MAuRitius Minimum Operating System for Array Telescopes). This has been designed in-house by the MRT team to transfer the measured visibilities to images which can be further processed using the standard image processing packages such as Astronomical Image Processing Software (AIPS). The steps involved in imaging are: detection of interference, selection of good data to be used for the survey, determination of complex gain of antennae, transforming the calibrated visibilities to get brightness distribution of the sky and combining data of different days.

Due to non-coplanarity of MRT, wide-field imaging and its deconvolution are challenging problems. We have investigated the usefulness and limitations of the Tangent Plane Approximation (TPA) in transforming the measured visibilities to wide field images. To avoid the problems due to the grating response of the East West array, presently the imaging is done on the meridian only. The two-dimensional image is the time stack of one-dimensional image on the meridian. We considered tangents on the meridian, at various declinations and corrected for phases on the tangent due to heights as seen by a source at the tangent point. By examining the source response on the tangent we calculated the effect of TPA on the sources away from the tangent point. At $\delta = -70^{\circ}$ the TPA for a zone of $\pm 5^{\circ}$ leads to a shift of almost $9'$ away from the meridian for a source at the edges of the zone. The loss of amplitude and the shift in the positions of the sources clearly show that the TPA is not desirable for the inversion of

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visibilities at MRT. Hence the Direct Fourier Transform method which compensates for heights at each point on the meridian is used. This causes the sidelobes to shift away from the meridian in the dirty image and needs a position dependent PSF for deconvolution. Our simulations indicate that such a dirty image can be deconvolved with a dynamic range ≈ 200 by using 6-7 PSFs for the entire declination range of the MRT. Deconvolution was done using the task APCLN in AIPS which uses Clark CLEAN. Sub-images of 256 x 256 pixels were made and then padded with zeros to a size of 512 x 512 pixels. A single PSF appropriate for a source at the centre of the sub-image was used for deconvolution. The CLEANing process was stopped when the rms flux density reached a level of 3 times the rms of the dirty image. All the 213 sources in the Molongolo Radio Catalogue having flux densities above 0.6 Jy at 408 MHz have been identified in the deconvolved map (> 3σ detection). As a sample the dirty and the deconvolved images are shown in Fig. 1 and Fig. 2 respectively. This is a very small portion of the entire image. We have been able to identify all the 25 MRC sources in this field. The strongest being MRC1827-360, having a flux density of 51.66 Jy at 151.5 MHz, assuming a spectral index of –0.7. Detailed analysis of the CLEANed images to estimate the dynamic range achieved, the noise in the deconvolved map, positional accuracy of the point sources detected are under progress.

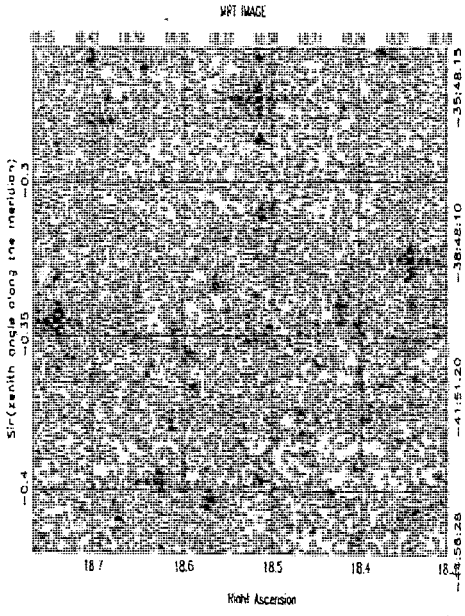

Figure 1. A "Dirty" image (J2000) in the right ascension range 18h18m to 18h45m and declination range –45° to –35°. The contour levels are : -2, 0.1, 2, 3, 4, 5, 7, 10, 14, 24, 33, 42, 55 Jy/beam.

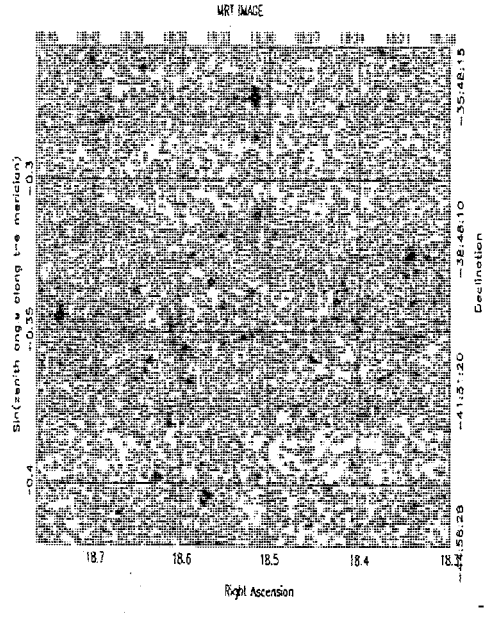

Figure 2. A CLEANed image (J2000) obtained after the deconvolution of the dirty image seen in Fig. 1, by a PSF appropriate to the centre of the image. The contour levels are: -2, 0.1, 2, 3, 4, 5, 7, 10, 14, 24, 33, 42, 55 Jy/beam.