SEARCH FOR ULTRA STEEP SPECTRUM SOURCES USING GMRT 150 MHZ BAND

***C. H. Ishwara-Chandra*[1], *S. K. Sirothia*[1] *and Radhika Marathe*[2]**

[1] National Center for Radio Astrophysics, Pune University Campus, Pune, India

[2] Department of Electrical Engineering, California Institute of Technology, USA

We have carried out deep radio imaging of selected regions of sky at 150 MHz using the GMRT to detect ultra-steep spectrum radio sources. It has been known that the high redshift radio sources exhibits steep radio spectra, hence ultra-steep spectrum sources are efficient tracers of high-redshift sources. The GMRT 150 MHz images with rms noise of about 1 to 1.5 mJy/beam and resolution of $\sim 20''$ is ideally placed for detecting ultra-steep spectrum sources. In this paper, we report the discovery of several ultra-steep spectrum radio sources from our observations, which needs to be followed up with multi-wavelength observations.

1 Summary

The Giant Metrewave Radio Telescope (GMRT) in India, currently operates at five frequency bands from 150 MHz to L-band, is the largest telescope in the world at metrewavelength. At 150 MHz, which is of prime interest for this work, the field of view (half power width) is about 7 square degrees. From about five to six hours of integration on source, GMRT is capable of producing images at 150 MHz with rms noise of 1 to 1.5 mJy/beam and resolution of $20''$. We have been able to produce some of the best images at 150 MHz using the GMRT with rms noise of ~ 1 mJy. One of the aim is to search for steep spectrum radio sources by matching the sources from higher frequency radio sources such as NVSS and WENSS.

High-redshift radio galaxies (HzRGs) are an important probe of galaxy formation. Recent studies have shown that the HzRGs which are typically at z > 1 are indeed massive galaxies in early phases of formation (De Breuck et al. 2002a; van Breugel et al. 1998; Lacy, Bunker, & Ridgway 2000). HzRGs are usually identified as Ultra Steep Spectrum (USS) sources in radio surveys, with spectral index $\alpha > 1$ ($S_\nu \propto \nu^{-\alpha}$). Since steep spectrum radio sources will be easily detected at low radio frequencies, GMRT 150 MHz band is well placed for this work.

From the GMRT 150 MHz images of field of Abell 764 and UPSILON Andromeade, we have generated the sources list both using source detection algorithms within AIPS and also by visual inspection of images for ensuring that no spurious source is cataloged and no genuine source is missed out. We then compare the positions of a few bright sources to check if there any overall shift in the positions due to self-cal, ionospheric refraction, etc. The catalogue generated this way is then compared with higher frequency radio cataloges such as WENSS at 325 MHz and NVSS at 1400 MHz. Considering the large beam of NVSS (which is more than twice that of GMRT 150 MHz), we have taken $15''$ radius for searching counterparts for GMRT sources in NVSS and WENSS catalogues. For a source detected at GMRT 150 MHz, if there is no counterpart is found at higher radio frequencies, spectral index was put using the value of 3 mJy at 1400 MHz, which is close to reliable detection in NVSS.

The preliminary analysis indicate that about 8% of the sources tend to exhibit spectra steeper than 1.25 and about 2% of them flatter (spectral index flatter than 0.5). The most interesting result is the discovery of a few **ultra steep spectrum** sources, having flux densities close to 100 mJy at 150 MHz and having extremely faint match or no detection at 1400 MHz. Multiwavelenth studies of these sources are needed to understand the nature of these sources.

2 References

De Breuck, C., et al. 2002, AJ, 123, 637

Lacy, M., Bunker, A.J., Ridgway, S.E. 2000, AJ, 120, 68

van Breugel, W. J. M, 1998, ApJ, 502, 614

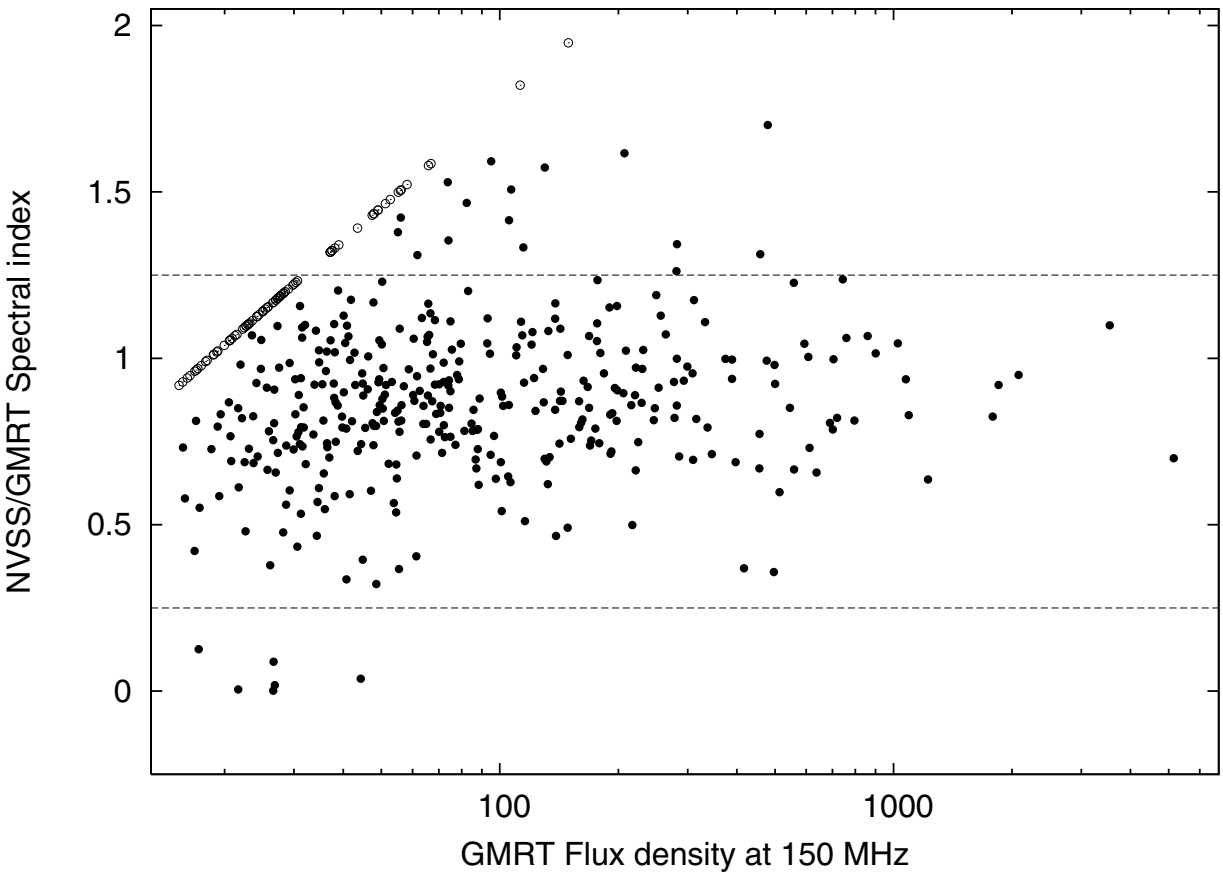

Figure 1: The spectral index distribution of sources from both the fields (Abell 764 and Upsilon Andromade). The spectral index was calculated between the GMRT 150 MHz measurements and NVSS catalogue. For the sources where the counterparts are not found at 1400 MHz, the spectral index is steeper than the limit and are marked by open circles. The sources with identified counterparts in NVSS are indicated by filled circles. We consider the sources with spectral index steeper than 1.25 as **ultra steep spectrum** sources and flatter than 0.25 as **flat spectrum** sources.