The Metrewavelength Sky
ASI Conference Series, 2014, Vol. 13, pp 395 – 396
Edited by J. N. Chengalur & Y. Gupta

The MWA, the RTS and Shapelets: Real time calibration of extended sources

J. L. Riding[1,2*], D. A. Mitchell[1,2] and R. L. Webster[1,2]
[1]*School of Physics, The University of Melbourne, Parkville, VIC 3010, Australia*
[2]*ARC Centre of Excellence for All-sky Astrophysics (CAASTRO)*

Abstract. The Murchison Widefield Array (MWA), like most low frequency arrays, has a large field of view which requires multisource calibration to account for direction dependent effects (DDEs). Often these fields contain sidelobes from extended sources which obscure weaker sources. This can limit the number of calibrators that can be reliably used to solve for array parameters and DDEs. Sources such as Fornax A are so bright they can critically limit the number of usable calibrators. One solution is to subtract out these sources before or during calibration using a model, in this case a shapelet model.

Keywords : techniques - image processing, interferometric

1. Introduction

Low frequency radio astronomy can reveal much about the Universe but analysing observations is challenging. The Real Time System (RTS, Mitchell et al. 2008) is a GPU-based pipeline developed to process data from the MWA (Tingay et al. 2013). It implements a peeling technique to solve for DDEs, whereby strong sources are sequentially calibrated towards and subtracted from the visibility data. The ability to accurately peel extended sources from the field or primary-beam sidelobes can increase the number of reliable calibrators. Shapelets (Refregier, 2013) can model these sources accurately and compactly. They are an orthonormal set of basis functions such that an object can be reduced to a set of moments. The moments calculated for a deconvolved image can be easily applied to visibility data (see Chang & Refregier, 2002).

*email: j.thompson10@student.unimelb.edu.au

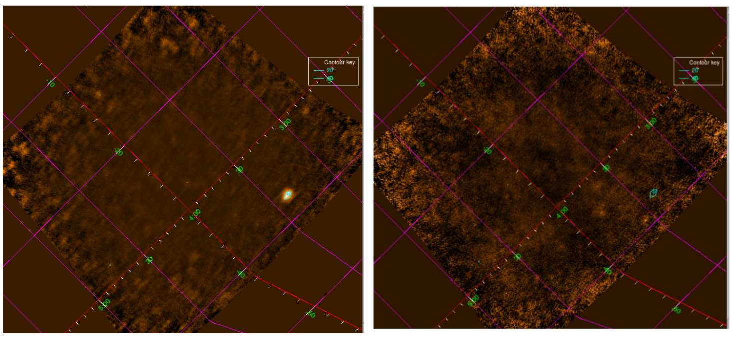

Figure 1: A MWA snapshot at 150MHz as processed by the RTS. Left: The raw data with calibration using three sources. Right: The data after 100 sources and Fornax A subtracted (10 source calibration).

2. The RTS and Fornax A

Fornax A is a nearby radio bright galaxy featuring radio lobes. It is located on the edge of one of the MWA's epoch of reionisation fields. On the left hand side of Figure 1 it is the bright object on the right. With Fornax A in the field only three calibrators provide reliable calibration solutions. On the right hand side of Figure 1 is the same dataset but using a shapelet model of 50 moments (compression factor of 1:69). Fornax A was subtracted from the visibility data (contours where it used to be). Ten sources were used to calibrate the field and a further 90 were subtracted. The result shows no residuals or artifacts from the shapelet model.

3. Conclusion

Shapelets can model and subtract bright extended sources within the RTS. For the case of Fornax A, the model compression is good, implementation with the RTS did not noticeable increase processing time and even after 100 sources subtracted from the field, no residuals or artifacts are apparent. The result also demonstrates the ability of the MWA and RTS to recover the diffuse background emission in this field.

References

Chang T-C., Refregier A., 2002, ApJ, 570, 447

Mitchell D. A., Greenhill L. J., Wayth R. B., Sault R. J., Lonsdale C. J., Cappallo R. J., Morales M. F., Ord S. M., 2008, IEEE Journal of Sel. Topics in Sig. Proc., 2, 5

Refregier A., 2003, MNRAS, 338, 35

Tingay S. J et al., 2013, PASA, 30