Interferometric data analysis pipelines for the Upgraded GMRT: CAPTURE and CAPTURE-POL

Ruta Kale*[1], Manisha Samble[2], Ishwara-Chandra C. H.[1], Preeti Kharb[1], Yogesh Wadadekar[1], Dharam V. Lal[1] and Yashwant Gupta[1]

(1) National Centre for Radio Astrophysics, T. I. F. R. , Pune, India
(2) Giant Metrewave Radio Telescope, National Centre for Radio Astrophysics, T. I. F. R. , Pune, India

1 Extended Abstract

The Upgraded Giant Metrewave Radio Telescope (uGMRT), located near Pune, India is a path-finder telescope for the Square Kilometer Array (SKA) that operates at frequencies in the range 120 - 1450 MHz. It consists of 30 dishes of 45 m diameter each, spread in a "Y" shaped configuration over a region of 25 km. The upgrade has allowed use of instantaneous bandwidths of up to 400 MHz that have resulted in a significant improvement in sensitivity but also an increase in data volumes by factors of about 10 to 100. For obtaining an image useful for scientific studies, the raw data need to be calibrated and imaged. The image is further improved using a self-calibration strategy that needs to be tailored depending on the frequency band used. The NRAO Common Astronomy Software Applications (CASA, [1]) is the package that provides the basic tasks required for processing the uGMRT data. However the tasks need to be run with inputs relevant for the observing frequency. We have developed an automated data analysis pipeline called CAPTURE (CASA Pipeline-cum-Toolkit for uGMRT Data Reduction, [2]) with the idea of providing an automated framework to obtain images from uGMRT data. The first version of CAPTURE was released in late 2020 and has been further improved to have additional features. The salient new features of the pipeline are: i) possibilities of end-to-end and step-by-step data reduction, ii) diagnostic plots from calibration, iii) improved control on imaging parameters and iv) self-calibration on sub-banded data. The sub-banding of data before imaging results in better gain solutions during self-calibration and improves the image. Polarization at sub-GHz frequencies is less explored in general, but holds potential for interesting science. We are developing a version of the pipeline that can carry out polarization calibration called CAPTURE-POL. CAPTURE-POL can carry out polarization calibration for band-4 (550 - 950 MHz) of the uGMRT using the strategy described in [3]. Currently CAPTURE pipelines make use of tools only within CASA for imaging and calibration. In order to improve upon the imaging speed and quality we are testing the use of WSclean [4]. In this work I will describe CAPTURE and present examples of the results obtained using the CAPTURE pipelines. CAPTURE is available for users on `https://github.com/ruta-k/CAPTURE-CASA6` and `https://github.com/ruta-k/CAPTURE-POL`.

References

[1] McMullin, J. P., Waters, B., Schiebel, D., Young, W., and Golap, K., "CASA Architecture and Applications," *Astronomical Data Analysis Software and Systems XVI* , 2007, vol. 376, p. 127.

[2] Kale, R. and Ishwara-Chandra, C. H., "CAPTURE: a continuum imaging pipeline for the uGMRT," *Experimental Astronomy*, vol. 51, no. 1, pp. 95-108, 2021. doi:10.1007/s10686-020-09677-6.

[3] Silpa, S., "Outflows in the radio-intermediate quasar III Zw 2: a polarization study with the EVLA and uGMRT," *Monthly Notices of the Royal Astronomical Society*, vol. 507, no. 1, pp. 991-1001, 2021. doi:10.1093/mnras/stab1870.

[4] Offringa, A. R., "WSCLEAN: an implementation of a fast, generic wide-field imager for radio astronomy," *Monthly Notices of the Royal Astronomical Society*, vol. 444, no. 1, pp. 606?619, 2014. doi:10.1093/mnras/stu1368.