Investigation on improvement of radio interferometry calibration using redundant calibration along with sky model calibration

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Detection of highly faint 21 cm signal to help us understand the Epoch of Reionization (EoR) relies on instrument with high precision and powerful calibration techniques. The cosmological signal we aim to detect is so weak that it could be easily obscured by even small error in amplitude and phase calibration on visibility data, which could scatter power and eventually introduce artifacts to the sky image we aim to obtain, thus antenna based gain calibration plays an important role in getting an optimal quality of sky image.

The most common techniques we use on calibration are redundant calibration and sky model based calibration. We mainly present the basic idea of redundant calibration, as well as two important algorithms we use to do redundant calibration, i.e., logarithmic calibration and linearized calibration. The most attractive aspect of redundant calibration is that it is independent of sky model, while sky based calibration requires some priori knowledge about the sky, which is always not perfect to some level. However, redundant calibration requires redundant calibratability of the antenna array. MWA (Murchison Widefield Array) Phase II array includes 72 tiles forming into two hexagons with instantaneous redundancy. This configuration provides us with a good redundant calibratability. We further show how much improvement we could obtain by applying redundant calibration, along with FHD (Fast Holographic Deconvolution) based sky model calibration on MWA Phase II data. We compare the performance of calibration with redundant calibration first and sky calibration afterwards and the other way round.

We further investigate how redundancy deviation (i.e., the position deviations of the antennas from ideal redundancy) and primary beam deviation of antennas would affect the 21 cm power spectrum.