Comparing Redundant and Sky Model Based Interferometric Calibration: A First Look with Phase II of the MWA

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21 cm observations of the Epoch of Reionization (EoR) have the potential to reveal a wealth of information about the formation of the first stars and galaxies. However, these observations are technically very challenging due to bright astrophysical foregrounds and the chromatic nature of radio interferometers. It has become apparent that precision instrument calibration is crucial for disentangling the faint cosmological signal from the bright foregrounds. Current precision calibration efforts for EoR observations fall into two camps: sky based calibration using deep foreground catalogs and forward modelling of the instrument visibilities, and redundant calibration that foregoes a sky model but requires the tiles be placed on a precise grid.

Using new observations with the MWA~II we report on the first direct comparison of sky and redundant calibration with an Epoch of Reionization instrument. In this work, we present the first results of redundant calibration on MWA Phase II observations, as well as sky model based calibration. In Phase II, the MWA installed 72 tiles in two highly redundant hexagonal layouts. In this work, we apply the publicly available package OMNICAL, developed for instrument calibration using redundant baselines, on data from the two hexagons. The sky-based calibration uses publicly available analysis package Fast Holographic Deconvolution (FHD).

The principal results will consist of three sections. (1) We report the success of OMNICAL on observations of ORBCOMM satellites, showing substantial agreement between redundant visibility measurements after calibration. (2) We further compare OMNICAL results with FHD sky model calibration on observations of the EoR0 field, and we find the evidence that these two different calibration schemes give consistent results. (3) We explore improved calibration by combining OMNICAL and FHD together. We evaluate our calibrations by looking at visibility redundancy and power spectra, and suggest future directions for combining these two calibration schemes.