

# Improved 21cm Epoch of Reionization Power Spectrum Measurements with a Hybrid Foreground Subtraction and Avoidance Technique

Joshua R. Kerrigan

Department of Physics, Brown University, Providence, Rhode Island

Observations of the 21cm Epoch of Reionization (EoR) signal are dominated by Galactic and extragalactic foregrounds. The need for foreground removal has led to the development of two main techniques, foreground avoidance and foreground subtraction. Avoidance is typically achieved by filtering foregrounds in Fourier space and subtraction uses an explicit foreground model that is removed. Each of these techniques were purpose built for use on arrays with antenna configurations that were extremized for either maximum redundancy or maximum sampling of the (u,v)-plane. We demonstrate that both methods can be applied more generally to arrays that exist at both extremes and achieve a result that is an improvement over either method independently. Foregrounds present in PAPER-64 observational data over the period of approximately 128 days (1088 hrs) are subtracted using the Fast Holographic Deconvolution radio interferometry package. These foregrounds are modeled as point sources using the MWA GLEAM catalog with the addition of Fornax A and Pictor A. The foreground subtracted and filtered visibilities are compared with visibilities processed through the standard PAPER-64 power spectrum pipeline (*filtering only*). This combined approach when compared to using any single foreground removal method is shown to decrease the amount of foreground contamination in EoR power spectrum k-modes of interest for all redshifts, with a 6% sensitivity improvement for  $k = 0.1 \text{ hMpc}^{-1}$  at redshift  $z = 8.4$  (middle of observing band) and 33% for  $k = 0.1 \text{ hMpc}^{-1}$  at  $z = 7.4, 10.4$  (band edges). We additionally show that this same technique can be an optimal strategy for improving EoR power spectrum measurements for arrays with high (u,v) coverage (MWA) and that with increasing signal-to-noise the effectiveness of this technique becomes more apparent.