Mitigating Spectral Leakage in Delay Filtered PAPER-64 Visibilities using Foreground Subtraction

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Detecting the statistical footprints of the Epoch of Reionization is made difficult by galactic and extragalactic foregrounds present in all radio observations. These foregrounds being approximately 5 orders of magnitude brighter than the EoR signal, rely on new foreground removal techniques with the possibility of a hybrid approach combining foreground avoidance and subtraction. The PAPER-64 power spectrum pipeline uses the foreground avoidance technique which involves adapting a modified CLEAN algorithm to remove bright sources that reside between certain delays in Delay space. We investigate the hybrid approach of foreground subtraction applied to PAPER-64 visibilities prior to using the foreground avoidance delay filtering technique. In adapting the foreground subtraction technique, we use the GLEAM source catalog, with 20K sources with the primary concern that Fornax A and Pictor A are properly modeled and subtracted as they are the brightest sources in the PAPER field of view for our observation window of 0-8.5 hours LST. The removal of excess power within the wedge should reduce the amount of power spread into higher delay k-modes due to spectral leakage. This technique is tested using both a naive approach to filtering with a traditional notch filter in Delay space and using the WideBand CLEAN delay filtering technique. The WideBand CLEAN in conjunction with the subtracted foregrounds affords no additional increase in power removal, compared to just the WideBand CLEAN by itself. The naive approach to filtering in delay space with foreground subtraction reaches to the same level of power removed as the WideBand CLEAN, with the potential of increasing the power being removed provided a better source catalog is used or a complete deconvolution of the visibilities.