What Will the Next Generation of 21cm Experiments Teach Us About the Epoch of Reionization?

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In the next several years, the first generation of experiments targeting a detection of the highly-redshifted 21cm signal from the Epoch of Reionization (EoR) will come to fruition. In particular, the LOw Frequency ARray (LOFAR), the Murchison Widefield Array (MWA), and the Donald C. Backer Precision Array for Probing the Epoch of Reionization (PAPER) have all begun long, dedicated campaigns with the goal of detecting the 21cm power spectrum. Ultimately, the success or failure of these campaigns will depend on the feasibility of controlling both instrumental systematics and foreground emission at a heretofore unachieved level for radio astronomy. However, all of these experiments will be sensitivity limited, placing detailed power spectrum characterization in the realm of a next generation of larger 21cm experiments.

The goal of this work is to explore the range of constraints that will be achievable with larger 21cm experiments, and, in particular, focus on new scientific lessons regarding the EoR. Many groups have already analyzed the observable effects of different reionization models on the 21cm power spectrum. In general, however, these works do not include the more sophisticated understanding of foreground emission that has arisen in the last few years, i.e., the division of 2D k-space into the foreground-contaminated "wedge" and the relatively clean "EoR window." The principal contribution of this present work to the field is to reconcile these two literatures, exploring the effects of both different EoR histories and foreground removal models on the recovery of scientific information from the 21cm power spectrum. The end result is a set of generic conclusions which motivates the need for a large collecting area next generation experiment while also laying out the potential limitations given the current uncertainties in a number of factors.

In order to accomplish these goals, this work will employ simple models designed to encompass a wide range of possible scenarios. We explore a wide variety of scenarios related to instrument sensitivity, foregrounds (and foreground removal techniques), and EoR histories. We conclude with several generic messages about the kind of science the community can expect from 21cm experiments in the next ~ 5 years.