Results from the Green Bank Telescope 21 cm intensity survey

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Large galaxy surveys conducted in optical wavelengths have played a central role in the development of our cosmological model. There is substantial interest in the viability of similar surveys that map the diffuse intensity of 21 cm emission from neutral hydrogen. Such methods could push to higher redshifts, larger areas and have complementary systematic errors. The principal challenges for 21 cm experiments are astronomical foregrounds and anthropogenic radio frequency interference. Synchrotron foregrounds are unavoidable and three orders of magnitude brighter than the 21cm signal. Instrumental systematics such as a time or frequency-dependent gain can mix the relatively simple synchrotron emission from extragalactic sources and the Milky Way into a larger number of contaminated modes in the data. We assume that not all of these modes can be known in advance, and so must be determined from the data itself.

I will describe results from an observational campaign with the Green Bank Telescope where we have measured cosmological structure in the redshift range $0.6 < z < 1$ over two fields totaling ~41 deg. sq. and 190 h of radio integration time. We remove several empirically-determined modes to mitigate the foreground contamination. The most robust indication of cosmological structure is provided by the cross-correlation of 21 cm intensity and density inferred from an optical galaxy survey. Here, residual foregrounds boost the errors. We achieve a significant detection of 21 cm structure coincident with the WiggleZ galaxy survey. The cross-correlation is a lower limit because the two fields may not correlate perfectly. Conversely, any residual foregrounds will additively bias the 21 cm auto-correlation, so it can be considered an upper bound. We combine these two bounds to infer $\Omega_{HI}\, b_{HI} = [0.6 \pm 0.2] \times 10^{-3}$ at 68% confidence with 9% systematic calibration uncertainty, where Ω_{HI} is the neutral hydrogen (HI) fraction and b_{HI} is the HI bias parameter.