

WIDE-FIELD EFFECTS IN REDSHIFTED 21 CM POWER SPECTRA

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ABSTRACT

Foreground emission is currently the primary limitation to detection of redshifted H I emission from the epoch of reionization. Modern radio telescopes that target this cosmological signal are typically wide-field instruments. Through modeling of delay spectra measured between antenna pairs, it has recently emerged that wide-field measurements imprint a characteristic *pitchfork*-shaped signature in this Fourier domain. It is characterized by enhanced power from foreground emission mapped to regions near the horizon and plays a significant role in determining the contamination of the cosmological H I signal. With MWA data sensitivity improved by coherently averaging snapshots aligned in local sidereal time across different observing nights, we confirm the prediction from modeling at $> 5\sigma$ level.

Subject headings: cosmology: observations — dark ages, reionization, first stars — large-scale structure of universe — methods: statistical — radio continuum: galaxies — techniques: interferometric

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1. INTRODUCTION

2. WIDE-FIELD EFFECTS IN DELAY SPECTRUM

Thyagarajan et al. (2015) have described in detail the effects wide-field measurements have on the delay spectrum.

Throughout the paper, we follow the conventions used in Thyagarajan et al. (2015).

3. THE MURCHISON WIDEFIELD ARRAY OBSERVATIONS

4. RESULTS

5. SUMMARY

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REFERENCES

Thyagarajan, N., Jacobs, D. C., Bowman, J. D., et al. 2015, ArXiv e-prints, arXiv:1502.07596