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Detection of Cosmological 21 cm Emission with CHIME

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The Canadian Hydrogen Intensity Mapping Experiment (CHIME) is a radio interferometer designed to measure the power spectrum of 21 cm emission from neutral hydrogen (HI) between redshifts 0.8 and 2.5 [1]. The imprint of the Baryon Acoustic Oscillations (BAO) on the power spectrum will enable a precise characterization of the expansion history of the Universe over this poorly probed epoch. These measurements will be combined with measurements from the cosmic microwave background (CMB) at higher redshifts and measurements from spectroscopic galaxy surveys at lower redshifts to yield tight constraints on an evolving dark energy equation of state.

CHIME is located at the Dominion Radio Astrophysical Observatory (DRAO) near Penticton, British Columbia. It consists of four 100×20 meter cylindrical dishes oriented in the north-south direction. The focal line of each dish is populated with 256 dual-polarization antenna feeds that are sensitive to frequencies between 400-800 MHz and have a system temperature of approximately 50 K. CHIME maps the northern half of the sky each day with a synthesized beam resolution of 20-40 arcminutes and a frequency resolution of 0.39 MHz. CHIME has been acquiring data since October 2018.

The CHIME collaboration recently reported the detection of 21 cm emission from large-scale structure between redshifts 0.8 and 1.4 [2]. This was achieved by stacking maps of the radio sky, constructed from 102 nights of CHIME data, on the angular and spectral locations of luminous red galaxies (LRG), emission line galaxies (ELG), and quasars (QSO) from the extended Baryon Oscillation Spectroscopic Survey (eBOSS) clustering catalogs. I will provide an overview of this detection and the resulting constraints on the effective clustering amplitude of neutral hydrogen, defined as $\mathcal{A}_{\mathrm{HI}} \equiv \Omega_{\mathrm{HI}}(b_{\mathrm{HI}} + \langle f\mu^2 \rangle)$, where Ω_{HI} is the cosmic abundance of HI, b_{HI} is the linear bias of HI, and $\langle f\mu^2 \rangle = 0.552$ encodes the effect of redshift-space distortions at linear order. As part of the stacking analysis, a high-pass filter is applied to the frequency axis of each map pixel to remove foregrounds. Alas, this filter also removes the large-scale cosmological modes along the line-of-sight, resulting in a measurement that is primarily sensitive to non-linear scales. The resulting constraints on $\mathcal{A}_{\mathrm{HI}}$ are limited by modeling uncertainty at these scales. I will describe the dominant systematic errors at the linear scales relevant for the BAO analysis and discuss our prospects for accessing this regime through new calibration strategies and foreground removal techniques.

References

[1] CHIME Collaboration, M. Amiri, K. Bandura, A. Boskovic, T. Chen, J.-F. Cliche, M. Deng, N. Denman, M. Dobbs, M. Fandino, S. Foreman, M. Halpern, D. Hanna, A. S. Hill, G. Hinshaw, C. Höfer, J. Kania, P. Klages, T. L. Landecker, J. MacEachern, K. Masui, J. Mena-Parra, N. Milutinovic, A. Mirhosseini, L. Newburgh, R. Nitsche, A. Ordog, U.-L. Pen, T. Pinsonneault-Marotte, A. Polzin, A. Reda, A. Renard, J. R. Shaw, S. R. Siegel, S. Singh, R. Smegal, I. Tretyakov, K. Van Gassen, K. Vanderlinde, H. Wang, D. V. Wiebe, J. S. Willis, and D. Wulf, "An Overview of CHIME, the Canadian Hydrogen Intensity Mapping Experiment," *arXiv:2201.07869*, Jan. 2022.

[2] CHIME Collaboration, M. Amiri, K. Bandura, T. Chen, M. Deng, M. Dobbs, M. Fandino, S. Foreman, M. Halpern, A. S. Hill, G. Hinshaw, C. Höfer, J. Kania, T. L. Landecker, K. Masui, J. Mena-Parra, N. Milutinovic, A. Mirhosseini, L. Newburgh, A. Ordog, U.-L. Pen, T. Pinsonneault-Marotte, A. Polzin, A. Reda, J. R. Shaw, S. R. Siegel, S. Singh, K. Vanderlinde, H. Wang, D. V. Wiebe, and D. Wulf, "Detection of Cosmological 21 cm Emission with the Canadian Hydrogen Intensity Mapping Experiment," *In Prep.*