# Curriculum Vitae          Michael Wilensky

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## Education:

PhD, Physics, University of Washington, 2015-2021
BS, Physics, University of California Los Angeles, 2011-2015

## References:

Dr. Phil Bull (Most recent manager) - **phil.bull@manchester.ac.uk**
Professor Miguel Morales (PhD Advisor) - **miguelfm@uw.edu**
Professor Adrian Liu - **adrian.liu2@mcgill.ca**

## Appointments:

Visiting Postdoc, University of Cambridge, 2022 - 2023
Postdoctoral Research Assosciate, University of Manchester, 2022 - now (transfer from QMUL)
Postdoctoral Research Assistant, Queen Mary University of London, 2021 - 2022
ASTRO3D Science Visitor, Oct 2019
Research Assistant, University of Washington, 2017-2021
Teaching Assistant, University of Washington, 2015-2017

## Publications:

[1] **Wilensky, Michael J.** et al., "High-dimensional inference of radio interferometer beam patterns I: Parametric model of the HERA beams," *Submitted*, **https://arxiv.org/abs/2403.13769**

[2] Burba, Jacob; Bull, Philip; **Wilensky, Michael J.** et al., "Sensitivity of Bayesian 21 cm power spectrum estimation to foreground model errors," *Submitted*, **https://arxiv.org/abs/2403.13767**

[3] Glasscock, Katrine A. et al., "Statistical estimation of full-sky radio maps from 21cm array visibility data using Gaussian Constrained Realisations," *Submitted*, **https://arxiv.org/abs/2403.13766**

[4] Garsden, Hugh; Bull, Philip; **Wilensky, Michael J.** et al., "A demonstration of the effect of fringe-rate filtering in the Hydrogen Epoch of Reionization Array delay power spectrum pipeline," *Submitted*, **https://arxiv.org/abs/2402.08659**

[5] **Wilensky, Michael J.** et al., "Evidence of Ultrafaint Radio Frequency Interference in Deep 21 cm Epoch of Reionization Power Spectra with the Murchison Wide-field Array," *The Astrophysical Journal*, vol. 957, no. 2, 2023. doi:10.3847/1538-4357/acffbd.

[6] **Wilensky, Michael J.** et al., "Why and when to expect Gaussian error distributions in epoch of reionization 21-cm power spectrum measurements," *Monthly Notices of the Royal Astronomical Society*, Volume 521, Issue 4, pp. 5191-5206, doi: 10.1093/mnras/stad863

[7] Kennedy, Fraser; Bull, Philip; **Wilensky, Michael J**; Burba, Jacob; Choudhuri, Samir; "Statistical Recovery of 21 cm Visibilities and Their Power Spectra with Gaussian-constrained Realizations and Gibbs Sampling," The Astrophysical Journal Supplement Series, Volume 266, Issue 2, id.23, 17 pp. doi: 10.3847/1538-4365/acc324

[8] HERA Collaboration et al., "Improved Constraints on the 21 cm EoR Power Spectrum and the X-Ray Heating of the IGM with HERA Phase I Observations", *The Astrophysical Journal*, vol. 945, no. 2, 2023. doi:10.3847/1538-4357/acaf50.

[9] **Wilensky, Michael J.** et al., "Bayesian jackknife tests with a small number of subsets: application to HERA 21 cm power spectrum upper limits", *Monthly Notices of the Royal Astronomical Society*, Volume 518, Issue 4, pp. 6041-6058, doi: 10.1093/mnras/stac3484

[10] **Wilensky, Michael J.**, Hazelton, Bryna J., Morales, Miguel F., "Exploring the consequences of chromatic data excision in 21-cm epoch of reionization power spectrum observations", *Monthly Notices of the Royal Astronomical Society*, Volume 510, Issue 4, pp.5023-5034, doi: 10.1093/mnras/stab3456

[11] Rahimi, M. et al., "Epoch of reionization power spectrum limits from Murchison Widefield Array data targeted at EoR1 field", *Monthly Notices of the Royal Astronomical Society,* vol. 508, no. 4, pp. 5954–5971, 2021. doi:10.1093/mnras/stab2918.

[12] Trott, C. M et al., "Constraining the 21 cm brightness temperature of the IGM at z = 6.6 around LAEs with the murchison widefield array", *Monthly Notices of the Royal Astronomical Society*, vol. 507, no. 1, pp. 772–780, 2021. doi:10.1093/mnras/stab2235.

[13] Yoshiura, S et al., "A new MWA limit on the 21 cm power spectrum at redshifts 13-17", *Monthly Notices of the Royal Astronomical Society*, vol. 505, no. 4, pp. 4775–4790, 2021. doi:10.1093/mnras/stab1560.

[14] La Plante, P. et al., "A Real Time Processing system for big data in astronomy: Applications to HERA", *Astronomy and Computing*, Volume 36, article id. 100489, doi: 10.1016/j.ascom.2021.100489

[15] Byrne, R., Morales, M. F., Hazelton, B., and **Wilensky, M.**, "A Unified Calibration Framework for 21 cm Cosmology", *Monthly Notices of the Royal Astronomical Society*, Volume 503, Issue 2, pp.2457-2477, doi: 10.1093/mnras/stab647

[16] **Wilensky, Michael J.**, "Improving 21-cm Epoch of Reionization Power Spectrum Limits by Characterizing and Mitigating Radio Frequency Interference", PhD Thesis, University of Washington, 2021

[17] Zhang, Z. et al., "The impact of tandem redundant/sky-based calibration in MWA Phase II data analysis", *Publications of the Astronomical Society of Australia*, vol. 37, 2020. doi:10.1017/pasa.2020.37.

[18] **Wilensky, M. J.**, Barry, N., Morales, M. F., Hazelton, B. J., and Byrne, R., "Quantifying excess power from radio frequency interference in Epoch of Reionization measurements", *Monthly Notices of the Royal Astronomical Society*, vol. 498, no. 1. pp. 265–275, 2020. doi: 10.1093/mnras/staa2442.

[19] Trott, C. M et al., "Deep multiredshift limits on Epoch of Reionization 21 cm power spectra from four seasons of Murchison Widefield Array observations", *Monthly Notices of the Royal Astronomical Society*, vol. 493, no. 4, pp. 4711–4727, 2020. doi:10.1093/mnras/staa414.

[20] Li, W et al., "First Season MWA Phase II Epoch of Reionization Power Spectrum Results at Redshift 7", *The Astrophysical Journal*, vol. 887, no. 2, 2019. doi:10.3847/1538-4357/ab55e4.

[21] **Wilensky, M. J.**, Morales, M. F., Hazelton, B. J., Barry, N., Byrne, R., and Roy, S., "Absolving the SSINS of Precision Interferometric Radio Data: A New Technique for Mitigating Faint Radio Frequency Interference", *Publications of the Astronomical Society of the Pacific*, vol. 131, no. 1005. p. 114507, 2019. doi: 10.1088/1538-3873/ab3cad.

[22] Barry, N., **Wilensky, Michael J.**, et al. "Improving the Epoch of Reionization Power Spectrum Results from Murchison Widefield Array Season 1 Observations", *The Astrophysical Journal,* vol. 884, no. 1. 2019. doi: 10.3847/1538-4357/ab40a8.

[23] Trott, C. M et al., "Gridded and direct Epoch of Reionisation bispectrum estimates using the Murchison Widefield Array", *Publications of the Astronomical Society of Australia*, vol. 36, 2019. doi:10.1017/pasa.2019.15.

[24] Trott, C. M et al., "Robust statistics towards detection of the 21 cm signal from the Epoch of Reionization", *Monthly Notices of the Royal Astronomical Society*, vol. 486, no. 4, pp. 5766–5784, 2019. doi:10.1093/mnras/stz1207.

## Talks:

[1] SALF IX, 2023, "Evidence of Ultra-faint RFI in Deep 21-cm Power Spectra," ASTRON

[2] *Invited Seminar Talk*, Trottier Space Institute Cosmo-ph discussion, 2023, "Evidence of Ultra-faint RFI in Deep 21-cm Power Spectra with the Murchison Widefield Array," McGill University

[3] *Invited Seminar Talk*, 2023, "Chiborg: a Bayesian jackknife framework for testing consistency of multiple measurements," Center for Computational Astrophysics

[4] *Invited Seminar Talk*, Yale Wright Lab Seminar, 2023, "Addressing the Challenges in 21-cm Cosmology using Bayesian Inference and other Data Analysis Techniques," Yale University

[5] YERAC, 2023, "*Chiborg*: a Bayesian jackknife framework for testing consistency of multiple measurements," University of Manchester

[6] URSI GASS, 2023, "*Chiborg*: a Bayesian jackknife framework for testing consistency of multiple measurements," Sapporo, Japan

[7] MWA Project Meeting, 2023, "Evidence of Ultra-Faint RFI in Deep 21-cm Power Spectra," 2023, Curtin University, **won best talk**

[8] *Invited Seminar Talk*, Cambridge Summer Intern Seminar, 2023, "Mapping out the Early Universe by Observing Cosmic Radio Waves," University of Cambridge

[9] SKA Cosmology Science Working Group Meeting, 2023, "*Chiborg*, a Bayesian jackknife framework for testing consistency of multiple measurements," University of Manchester

[10] RFI2022, 2022, "Predicting and Measuring the Effect of RFI on 21-cm Epoch of Reionization Power Spectrum Measurements," Virtual

[11] *Invited Seminar Talk*, 2021,"Improving 21-cm Epoch of Reionization Power Spectrum Limits by Characterizing and Mitigating Radio Frequency Interference," Queen Mary University of London

[12] URSI, "Consequences of RFI and RFI Excision for 21-cm EoR Science," 2020, Virtual

[13] SALF VI, 2019, "Characterizing RFI Contamination in Epoch of Reionization Power Spectra," Arizona State University

[14] ASTRO3D Visitor Colloquium, 2019, “Characterizing and Mitigating Radio Frequency Interference in Reionization Cosmology,” University of Melbourne

[15] MWA Project Meeting, 2019, “The SSINS of the MWA EoR Highband,” Brown University

[16] URSI, 2019, “A New Technique for Ultra-Faint RFI Contamination,” University of Colorado at Boulder

[17] MWA Project Meeting, 2018, “A New Technique for Ultra-Faint RFI Contamination,” Nagoya University

## Software:

[1] Sky-Subtracted Incoherent Noise Spectra (SSINS): https://github.com/mwilensky768/SSINS

[2] Chiborg: https://github.com/mwilensky768/Chiborg

## Outreach/Mentorship/Teaching:

[1] Guided an investigation into using gaussian constrained realizations for inpainting flagged data in 21-cm power spectrum estimates. Consists mainly of informal discussions on the topic, usually in the form of providing technical feedback for problem-solving obstacles. **See Publication [7].**

[2] Designed and guided a mathematical investigation into precise propagation of error bars through 21-cm power spectrum estimation pipeline. Consisted of weekly meetings to discuss mathematical concepts, software debugging, and general research techniques. **See publication [6]**.

[3] Taught a statistics module for PhD level students. Duties mainly consisted of constructing guided tutorials through various statistical concepts using Python. Course material spanned basic Bernoulli urn style problems all the way to generalized linear regression/Wiener filtering.

[4] Advised a student through analysis and identification of subtle instrumental effects through sensitive quality metrics. Also advising them through enhancement of RFI filtering algorithm in SSINS software (software [1]).

[5] Introduced CHAMP student to fundamental radio astronomy concepts, python programming, and high performance computation. Advised student through analysis of HERA radio frequency interference environment using SSINS software (software [1]).

[6] Similar to previous entry, but not through CHAMP program.

[7] Hosted one student through University of Washington Out in STEM (OSTEM) shadowing program.

## Skills:

Problem Design (Translating questions into solvable problems)
Data reduction and analysis
Bayesian inference
Python programming
Analytic derivation of mathematical statements ("pen and paper" math)
Writing up work in concise documents
Presenting work verbally in formal/informal settings
Creative problem solving

## Research Description:

**Bayesian Methods in 21-cm Power Spectrum Measurements:**

Latest research has been in applying various Bayesian techniques in different stages of the HERA power spectrum pipeline. This includes designing a null test for jackknifing data to separate large sections of biased data from unbiased data using a highly compressed data product from each section, implementing a Gibbs sampler (special exact Markov chain monte carlo sampler) for parameters that describe the beams of the HERA receiving elements, as well as a Gibbs sampler for clustering data into contaminated/uncontaminated subsets and simultaneously constraining the contamination.

**Radio Frequency Interference:**

PhD research was mainly understanding the effect of non-astrophysical radio signals, such as digital television and FM radio broadcasts, contaminating 21-cm Epoch of Reionization cosmology experiments. Major results from this study consist of developing sensitive detection algorithms to detect faintly observed contaminants (publication [21]), subsequent improvement of 21-cm power spectrum upper limits by removal of faint contaminants (publications [16, 22]), and theoretical quantification of the effect of these contaminants on a 21-cm power spectrum in terms of useful observational quantities (publications [10, 18]).

**Error Analysis:**

Understanding thermal uncertainty propagation in power spectrum measurement pipelines, such as the one used in publications [16, 22]. My end of this is providing analytic computations of resulting error distributions starting from the initial distribution in the measurement going all the way to the final power spectrum measurement, as well as mentoring a student through computational verification of the analytic results. See publication [6].

**Telescope Commissioning:**

Went to the Hydrogen Epoch of Reionization Array (HERA) in the Karoo, South Africa to perform commissioning tasks, such as ensuring proper hardware setup and functioning.

**General Collaboration:**

Using radio telescope data generally means being regularly involved in large collaborations, providing expertise where needed, usually during weekly meetings with multiple subgroups of the larger collaborations. Also involves minor contributions to problems of interest outside of the main scope of my research.