

# Nicholas Kern

MIT Pappalardo Fellow

CONTACT INFORMATION	MIT Kavli Institute for Astrophysics & Space Research 77 Massachusetts Ave., Building 37-241 Cambridge, MA, 02139	<i>E-mail:</i> <a href="mailto:nkern@mit.edu">nkern@mit.edu</a> <i>Web:</i> <a href="http://nkern.github.io">nkern.github.io</a>
EMPLOYMENT	<b>Pappalardo Fellow</b> Department of Physics & MIT Kavli Institute for Astrophysics and Space Research Massachusetts Institute of Technology, Cambridge, MA, USA	September 2020 – present
EDUCATION	<b>Ph.D., Astrophysics, University of California, Berkeley</b> Advisor: Aaron R. Parsons	August 2020
	<b>M.A., Astrophysics, University of California, Berkeley</b>	May 2017
	<b>B.S., Physics, Astrophysics, University of Michigan, Ann Arbor</b> Advisor: Christopher Miller	May 2015
RESEARCH INTERESTS	The intersection of cosmological data analysis and machine learning, radio interferometry, star and galaxy formation, large scale structure, astrostatistics	
HONORS & AWARDS	Pappalardo Fellow, MIT, Department of Physics Mary Elizabeth Uhl Dissertation Prize, UC Berkeley, Department of Astronomy Teaching Effectiveness Award, UC Berkeley Outstanding Graduate Student Instructor Award, UC Berkeley Graduated with Highest Honors and Distinction, University of Michigan Excellence in Astrophysics Research Award, University of Michigan International Institute Fellow, University of Michigan Upper-Level Writing Prize in the Natural Sciences, University of Michigan	2020 – 2023 2020 2017 2017 2015 2015 2014 2014
GRANTS AND COMPUTE ALLOCATIONS	<b>Principal Investigator</b> , <i>Bayesian Frameworks for New 21 cm Telescopes</i> 230,000 CPU & 8,000 GPU hours, XSEDE, PSC Bridges2 Cluster	2022
	<b>Principal Investigator</b> , <i>ML Tools for 21 cm Constraints on Fundamental Physics</i> 120,000 CPU & 28,000 GPU hours, NERSC, Perlmutter Cluster	2022
STUDENTS ADVISED	<ul style="list-style-type: none"><li>• Cynthia De Los Santos, San Bernardino Community College <i>Spherical Harmonic Decomposition of HERA's Primary Beam</i></li><li>• Eleanor Rath, MIT PhD student <i>A Bayesian framework for modeling antenna beam perturbations</i></li><li>• Ntsikelelo Charles, U. Rhodes, South Africa, PhD student <i>Mitigating diffuse foregrounds for interferometric calibration</i></li><li>• Duncan Rocha, Harvey Mudd undergrad (→ U. Chicago grad) <i>Detectability of Alcock Paczynski effects for 21 cm intensity mapping</i></li><li>• Timothy Wilson, UCLA undergrad (→ UCLA grad) <i>An MCMC sampler for semi-numerical Cosmic Dawn simulations</i></li></ul>	Summer 2022 Fall 2021 – Fall 2022 Spring 2021 – present Summer 2017 Summer 2016
TEACHING EXPERIENCE	<ul style="list-style-type: none"><li>• Session Instructor for <i>Interferometric Calibration and Imaging</i> - Designed and taught a 3-hour lesson for the HERA summer undergraduate bootcamp</li><li>• Head Instructor for <i>Python Programming in Astronomy</i> at UC Berkeley</li></ul>	Summer 2018 – present Summer 2017

- Developed course material for an intensive 6-week undergraduate summer class
- Lectured daily, held office hours, wrote and graded midterms, oversaw final projects
- Graduate Instructor for *Introduction to Astrophysics* at UC Berkeley Fall 2016
  - Led discussion section, developed interactive worksheets, graded homework & exams
  - Awarded department-wide “Outstanding Graduate Instructor” and university-wide “Teaching Effectiveness Award”
- Graduate Instructor for *Stellar Structure & Evolution* at UC Berkeley Fall 2015
  - Led discussion section, developed interactive worksheets, graded homework & exams
- Undergraduate Instructor for *Introduction to Mechanics* at U. Michigan Spring 2015
  - Taught undergraduates in breakout coding sessions, held office hours

## SERVICE

### To the Astrophysics Community:

- Referee, Radio Science 2020 – present
- Referee, Monthly Notices of the Royal Astronomical Society 2019 – present
- Referee, Astrophysical Journal 2018 – present

### At the Massachusetts Institute of Technology

- Co-Coordinator, HERA Undergraduate Summer Research Bootcamp 2021
- Instructor & Mentor, HERA Undergraduate Summer Research Bootcamp 2020 – 2021

### At the University of California, Berkeley

- Graduate Representative, UC Berkeley Faculty Search Committee 2020
- Instructor & Mentor, HERA Undergraduate Summer Research Bootcamp 2017 – 2019
- Organizer, Astronomy Career Development Seminar 2016 – 2017
- Organizer, Graduate Student Colloquium Speaker Seminar 2015 – 2016

## PUBLICATIONS LED OR COLLABORATION EQUIVALENT

- Barry, N., Bernardi, G., Greig, B., **Kern, N.** (lead author) and Mertens, F. 2021, *SKA-Low Intensity Mapping Pathfinder Updates: Deeper 21 cm Power Spectrum Limits from Improved Analysis Frameworks*, [JATIS 8\(1\) 011007](#)
- HERA Collaboration 2022, including **Kern, N.** (lead author), *First Results from HERA Phase I: Upper Limits on the Epoch of Reionization 21 cm Power Spectrum*, [ApJ 925 221A](#)
- Kern, N.** & Liu, A. 2021, *Gaussian Process Foreground Subtraction and Power Spectrum Estimation for 21 cm Cosmology*, [MNRAS 501 1463K](#)
- Kern, N.**, Dillon, J. S., Parsons, A. R., Carilli, C., Bernardi, G. et al. 2020, *Absolute Calibration Strategies for the Hydrogen Epoch of Reionization Array and Their Impact on the 21 cm Power Spectrum*, [ApJ 890 122](#)
- Kern, N.**, Parsons, A. R., Dillon, J. S., Lanman, A. E., et al. 2020, *Mitigating Internal Instrument Coupling for 21cm Cosmology. II. A Method Demonstration with the Hydrogen Epoch of Reionization Array*, [ApJ 888 70](#)
- Kern, N.**, Parsons, A. R., Dillon, J. S., Lanman, A. E., Fagnoni, N. and de Lera Acedo, E. 2019, *Mitigating Internal Instrument Coupling for 21cm Cosmology. I. Temporal and Spectral Modeling in Simulations*, [ApJ 884 105](#)
- Kern, N.**, Liu, A., Parsons, A. R., Mesinger, A., & Greig, B. 2017, *Emulating Simulations of Cosmic Dawn for 21 cm Power Spectrum Constraints on Cosmology, Reionization and X-ray Heating*, [ApJ 848 23](#)
- Kern, N. S.**, Keown, J. A., Tobin, J. J., Mead, A., & Gutermuth, R. 2016, *Radio Properties of Young Stellar Objects in the Serpens South Infrared Dark Cloud*, [AJ 151 42](#)

19. Xu, Z., Hewitt, J., ..., **Kern, N.** et al. 2022, *Direct Optimal Mapping for 21cm Cosmology: A Demonstration with the Hydrogen Epoch of Reionization Array*, [Submitted to ApJ](#)
18. HERA Collaboration 2022, including **Kern, N.**, *HERA Phase I Limits on the Cosmic 21-cm Signal: Constraints on Astrophysics and Cosmology During the Epoch of Reionization*, [ApJ 924 51A](#)
17. Aguirre, J., Murray, S., ..., **Kern, N.**, et al. 2021, *Validation of the HERA Phase I Epoch of Reionization 21 cm Power Spectrum Software Pipeline*, [ApJ 924 85A](#)
16. LaPlante, P., Williams, P. K. G., ..., **Kern, N.**, et al. 2021, *A Real Time Processing System for Big Data in Astronomy: Applications to HERA*, [A&C 3600489L](#)
15. Tan, J., Liu, A., **Kern, N.**, et al. 2021, *Methods of Error Estimation for Delay Power Spectra in 21cm Cosmology*, [ApJS 255 26T](#)
14. Ewall-Wice, A., **Kern, N.**, Dillon, J. S., et al. 2021, *DAYENU: A Simple Filter of Smooth Foregrounds for Intensity Mapping Power Spectra*, [MNRAS 500 5195E](#)
13. Nunhokee, C. D., Parsons, A. R., **Kern, N.**, et al. 2020, *Measuring HERA’s primary beam in-situ: methodology and first results*, [ApJ 897 5N](#)
12. Thyagarajan, N., Carilli, C., Nikolic, B., ..., **Kern, N.**, et al. 2020, *Detection of Cosmic Structures using the Bispectrum Phase. II. First Results from Application to Cosmic Reionization Using the Hydrogen Epoch of Reionization Array*, [Phys. Rev. D 102, 022002](#)
11. Dillon, J. S., Lee, M., Ali, Z. S., ..., **Kern, N.**, et al. 2020, *Redundant-Baseline Calibration of the Hydrogen Epoch of Reionization Array*, [MNRAS 499 5840D](#)
10. Ghosh, A., Mertens, F., Bernardi, G., ..., **Kern, N.**, et al. 2020, *Foreground modelling via Gaussian process regression: an application to HERA data*, [MNRAS 495 2813G](#)
9. Carilli, C., Thyagarajan, N., Kent, J., ..., **Kern, N.**, et al. 2020, *Imaging and Modeling Data from the Hydrogen Epoch of Reionization Array*, [ApJS 247 67](#)
8. Lanman, A. E., Pober, J. C., **Kern, N.**, et al. 2020, *Quantifying EoR delay spectrum contamination from diffuse radio emission*, [MNRAS 494 3712L](#)
7. Monsalve, R. A., Greig, B., Bowman, J. D., ..., **Kern, N.**, et al. 2018, *Results from EDGES High-Band: II. Constraints on Parameters of Early Galaxies*, [ApJ 863 11](#)
6. Kohn, S. A., Aguirre, J. E., La Plante, P., ..., **Kern, N.**, et al. 2018, *The HERA-19 Commissioning Array: Direction Dependent Effects*, [ApJ 882 58K](#)
5. Dillon, J. S., Kohn, S. A., Parsons, A. R., ..., **Kern, N.**, et al. 2017, *Polarized redundant-baseline calibration for 21 cm cosmology without adding spectral structure*, [MNRAS 477 5670](#)
4. Miller, C. J., Stark, A., Gifford D., & **Kern, N.** 2016, *Inferring Gravitational Potentials from Mass Densities in Cluster-Sized Halos*, [ApJ 822 41](#)
3. Stark, A., Miller, C. J., **Kern, N.**, Gifford, D., et al. 2016, *Probing Theories of Gravity with Phase Space-Inferred Potentials of Galaxy Clusters*, [Phys. Rev. D 93, 084036](#)
2. Gifford, D., **Kern, N.**, & Miller, C. 2016, *Stacking Caustic Masses from Galaxy Clusters*, [ApJ 834 204](#)
1. Gifford, D., Miller, C. J., & **Kern, N.** 2013, *A Systematic Analysis of Caustic Methods for Galaxy Cluster Masses*, [ApJ 773 116](#)

COLLABORATION  
PUBLICATIONS

4. Storer, D., Dillon, J., Jacobs, D., ..., **Kern, N.**, et al. 2021, *Automated Detection of Antenna Malfunctions in Large-N Interferometers: A Case Study with the Hydrogen Epoch of Reionization Array*, [RaSc 5707376S](#)
3. Gehlot, B., Jacobs, D., ..., **Kern, N.**, et al. 2021, *Effects of model incompleteness on the drift-scan calibration of radio telescopes*, [MNRAS 506 4578G](#)
2. Fagnoni, N., de Lera Acedo, E., ..., **Kern, N.**, et al. 2021, *Understanding the HERA Phase I receiver system with simulations and its impact on the detectability of the EoR delay power spectrum*, [MNRAS 500 1232F](#)
1. Kerrigan, J., La Plante, P., ..., **Kern, N.**, et al. 2019, *Optimizing sparse RFI prediction using deep learning*, [MNRAS 488 2605](#)

INVITED TALKS  
AND  
PRESENTATIONS

3rd URSI Atlantic Radio Science Meeting, Invited Presentation Gran Canaria, Spain	June 2022
ASTRON/JIVE Colloquium, Invited Talk ASTRON, Dwingeloo, Netherlands	March 2022
Royal Astronomical Society Specialist Discussion, Invited Talk Virtual	December 2021
Science at Low Frequencies VIII, Invited Presentation Virtual	December 2021
Astrophysics Seminar, Invited Talk John Hopkins University, Baltimore, MA	November 2021
INAF Joint Astrophysical Colloquium, Invited Talk INAF, Bologna, Italy	November 2021
Pappalardo Research Symposium, Invited Talk MIT, Cambridge, MA, USA	May 2021
A Precursor View of the SKA Sky, Invited Presentation Virtual	March 2021
Observing the First Billion Years, Invited Presentation IIT Indore, Indore, India	January 2020
Observational Cosmology Seminar, Invited Talk California Institute of Technology, Pasadena, CA, USA	December 2019
Center for Astrophysics SMA Seminar, Invited Talk Center for Astrophysics, Cambridge, MA, USA	November 2019
MIT Kavli Institute Brown Bag Lunch Talks, Invited Talk MIT, Cambridge, MA, USA	November 2019
BCCP Cosmology Workshop, Invited Presentation University of California, Berkeley, CA, USA	January 2018
JILA Astrophysics Seminar, Invited Talk University of Colorado, Boulder, CO, USA	October 2017
NASA Machine Learning Workshop, Invited Presentation NASA Ames, Mountain View, CA, USA	August 2017