Nicholas Kern

NASA Hubble Fellow

Contact Information

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Employment

NASA Hubble Fellow — September 2023 – present
Department of Physics & MIT Kavli Institute for Astrophysics and Space Research
Massachusetts Institute of Technology, Cambridge, MA, USA

Pappalardo Fellow — September 2020 – September 2023
Department of Physics & MIT Kavli Institute for Astrophysics and Space Research
Massachusetts Institute of Technology, Cambridge, MA, USA

Education

Ph.D., Astrophysics, University of California, Berkeley — August 2020
Advisor: Aaron R. Parsons

M.A., Astrophysics, University of California, Berkeley — May 2017

B.S., Physics, Astrophysics, University of Michigan, Ann Arbor — May 2015
Advisor: Christopher Miller

Research Interests

cosmological data analysis, machine learning, radio interferometry, star and galaxy formation, large scale structure, astrostatistics

Honors & Awards

Hubble Fellow, NASA	2023
Pappalardo Fellow, MIT, Department of Physics	2020
Mary Elizabeth Uhl Dissertation Prize, UC Berkeley, Department of Astronomy	2020
Teaching Effectiveness Award, UC Berkeley	2017
Outstanding Graduate Student Instructor Award, UC Berkeley	2017
Graduated with Highest Honors and Distinction, University of Michigan	2015
Excellence in Astrophysics Research Award, University of Michigan	2015
International Institute Fellow, University of Michigan	2014
Upper-Level Writing Prize in the Natural Sciences, University of Michigan	2014

Grants and Compute Allocations

Principal Investigator, *Bayesian Frameworks for New 21 cm Telescopes* — 2022
230,000 CPU & 8,000 GPU hours, XSEDE, PSC Bridges2 Cluster

Principal Investigator, *ML Tools for 21 cm Constraints on Fundamental Physics* — 2022
120,000 CPU & 28,000 GPU hours, NERSC, Perlmutter Cluster

Students Advised

- Honggeun Kim, MIT PhD Student — Fall 2021 – present
  Detecting ionized bubbles at the EoR with HERA using matched filters
  Mitigating the impact of antenna feed deviations for 21 cm cosmology
- Ntsikelelo Charles, Rhodes U., South Africa, PhD student — Spring 2021 – present
  Inteferometric gain calibration in the presence of mutual coupling
  Mitigating diffuse foregrounds for interferometric calibration
- Cynthia De Los Santos, San Bernardino Community College — Summer 2022
  Spherical Harmonic Decomposition of HERA's Primary Beam

- Eleanor Rath, MIT PhD student — Fall 2021 – Fall 2022
  A Bayesian framework for modeling antenna beam perturbations
- Duncan Rocha, Harvey Mudd undergrad (→ U. Chicago grad) — Summer 2017
  Detectability of Alcock Paczynski effects for 21 cm intensity mapping
- Timothy Wilson, UCLA undergrad (→ UCLA grad) — Summer 2016
  An MCMC sampler for semi-numerical Cosmic Dawn simulations

Teaching Experience

- Session Instructor for *Interferometric Calibration and Imaging* — 2018 – 2021
  - Designed and taught a 3-hour lesson for the HERA summer undergraduate bootcamp
- Head Instructor for *Python Programming in Astronomy* at UC Berkeley — 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

- Lead 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

8. Barry, N., Bernardi, G., Greig, B., **Kern, N.** (lead author) and Mertens, F. 2022, *SKA-Low Intensity Mapping Pathfinder Updates: Deeper 21 cm Power Spectrum Limits from Improved Analysis Frameworks*, JATIS 8(1) 011007
7. 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
6. **Kern, N.** & Liu, A. 2021, *Gaussian Process Foreground Subtraction and Power Spectrum Estimation for 21 cm Cosmology*, MNRAS 501 1463K
5. **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
4. **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

3. **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

2. **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

1. **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

Publications Led by a Supervised Student

2. Kim, H., **Kern, N.**, Hewitt, J., et al. 2023, *The Impact of Beam Variations on Power Spectrum Estimation for 21 cm Cosmology. II. Mitigation of Foreground Systematics for HERA*, ApJ 953 136

1. Charles, N., **Kern, N.**, Bernardi, G. et al. 2023, *On the use of temporal filtering for mitigating galactic synchrotron calibration bias in 21 cm reionization observations*, MNRAS 522 1009C

Other Publications as a Contributing Author

23. Keller, P., Nikolic, B., Thyagarajan, N., ..., **Kern, N.**, et al. 2023, *Search for the Epoch of Reionisation with HERA: Upper Limits on the Closure Phase Delay Power Spectrum*, MNRAS 524 583K

22. HERA Collaboration 2023, including **Kern, N.**, *Improved Constraints on the 21 cm EoR Power Spectrum and the X-Ray Heating of the IGM with HERA Phase I Observations*, ApJ 945 124

21. Pagano, M., Liu, J., Liu, A., **Kern, N.** et al. 2022, *Characterization Of Inpaint Residuals In Interferometric Measurements of the Epoch Of Reionization*, MNRAS 520 5552P

20. Kim, H., Nhan, B., Hewitt, J., **Kern, N.** et al. 2022, *The Impact of Beam Variations on Power Spectrum Estimation for 21-cm Cosmology I: Simulations of Foreground Contamination for HERA*, ApJ 941 207

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*, ApJ 938 128

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

5. Gorce, A., Ganjam, S., Liu, A., ..., **Kern, N.**, et al. 2022, *Impact of instrument and data characteristics in the interferometric reconstruction of the 21?cm power spectrum*, MNRAS 520 375G

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

Johns Hopkins Theoretical Cosmology Seminar Baltimore, MD	December, 2023
NASA Hubble Symposium Cambridge, MA	September, 2023
Wisconsin 21 cm Workshop Madison, Wisconsin	August, 2022

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