

Eve M. Vavagiakis

325 Physical Sciences Building
Cornell University
Ithaca, NY, 14853 USA

(607) 255 0474
ev66@cornell.edu
www.evevavagiakis.com

RESEARCH INTERESTS

Cosmology and astrophysics, analyzing maps of the cosmic microwave background (CMB) to study galaxy clusters, galaxy evolution, neutrinos, dark energy, and fundamental physics.

Cryogenic receivers and astronomical instrumentation, designing and developing cryogenic instrumentation for CMB and sub-mm measurements.

Applied superconductivity in cosmology/astronomical survey devices, measuring low-temperature devices including transition edge sensor bolometers and SQUIDs to study device physics and deploy next-generation detector arrays.

EDUCATION

Cornell University, Ithaca, NY

Ph.D., Physics 2021

Thesis: *Measuring the Sunyaev-Zel'dovich Effects with Current and Future Observatories*

M.S., Physics 2017

Cornell University, Ithaca, NY

B.A., Physics with Astronomy Concentration 2014

APPOINTMENTS

Scholar in Residence, Duke University 2023 –

NSF Astronomy and Astrophysics Postdoctoral Fellow, Cornell University 2022 –

Postdoctoral Research Associate, Cornell University, Ithaca, NY 2021 – 2022

Graduate Research Assistant, Cornell University, Ithaca, NY 2019 – 2021

Provost Diversity Fellow, Cornell University, Ithaca, NY Spring 2021

NSF Graduate Research Fellow, Cornell University, Ithaca, NY 2015 – 2019

Advisor: Prof. Michael Niemack. Atacama Cosmology Telescope, CCAT-prime, CMB-S4, and Simons Observatory Collaborations

Research Fellow, Caltech, Pasadena, CA Fall 2014

Advisor: Prof. Jamie Bock. CIBER-2 project

Undergraduate Research Assistant, Cornell University, Ithaca, NY 2011 – 2014

Advisor: Prof. Gordon Stacey. SOFIA and ZEUS-2

HONORS AND AWARDS

National Science Foundation Astronomy and Astrophysics Postdoctoral Fellowship 2022 – 2025

Provost Diversity Fellowship, Cornell University 2021

National Science Foundation Graduate Research Fellowship 2014 – 2019

Stirling A. Colgate Travel Award 2017

Dr. Gerald A. Soffen Memorial Fund Travel Grant 2014

Cranson W. and Edna B. Shelley Award for Undergraduate Research in Astronomy 2013

Tony Alt Memorial Foundation Scholarship 2010 – 2014

RESEARCH COLLABORATIONS

- Advanced ACTPol** (2015 – Present): Analysis of CMB maps for cosmology and astrophysics. Screened TESes and SQUIDs, remotely observed using the Atacama Cosmology Telescope on Cerro Toco in northern Chile.
- CCAT-prime** (2017 – Present): Leading design and development of first light instrumentation for the Fred Young Submillimeter Telescope, a high-throughput 6-meter sub-mm and mm telescope on Cerro Chajnantor being built in northern Chile.
- CMB-S4** (2018 – Present): Superconducting film and detector testing for the next-generation ground-based CMB effort uniting the experimental cosmology community.
- DeepSkies Lab** (2022 – Present): Applying machine learning to astrophysics research.
- Simons Observatory** (2016 – Present): Detector testing, magnetic shielding requirement development, cryogenic testbed development, and SZ analysis pipeline work for an array of CMB telescopes being built on Cerro Toco. Co-lead, Education and Public Engagement Working Group.

PAST RESEARCH COLLABORATIONS

- CIBER-2** (2014): Designing a shielding pop-up baffle for the second generation sounding rocket-borne Cosmic Infrared Background Experiment.
- SOFIA** (2011-2014): Designing and testing prototype Miniature Cryogenic Scanning Fabry-Perot (MCSF) interferometers for the FORCAST instrument on the Stratospheric Observatory for Infrared Astronomy.
- ZEUS-2** (2011): Writing a data reduction program for the second generation sub-mm grating spectrometer for the CSO and APEX.

INVITED TALKS

Seminar, Penn State, State College, PA	2023
Seminar, Kavli Institute for Cosmological Physics, Chicago, IL	2023
Colloquium, Duke University, Durham, NC	2023
Colloquium, Rochester Institute of Technology, Rochester, NY	2023
Colloquium, NASA Goddard Space Flight Center, Greenbelt, MD	2022
Colloquium, UH Manoa Institute for Astronomy, Honolulu, HI	2022
Kavli Institute for Particle Astrophysics & Cosmology Tea (Virtual)	2021
CMB-S4 Collaboration Meeting (Virtual)	2021
UC San Diego Cosmology Journal Club (Virtual)	2021
Max Planck Institute for Astrophysics Seminar, Garching, Germany (Virtual)	2021
CMB-S4 Collaboration Meeting (Virtual)	2021
Colloquium, Wells College, Aurora, NY	2019
Tompkins Cortland Community College, Dryden, NY	2019
St. Xavier's College, Kathmandu, Nepal (Virtual)	2018

CONTRIBUTED PRESENTATIONS

American Astronomical Society 241st Meeting, Seattle, WA	2023
NSF AAPF Symposium, Seattle, WA	2023
SPIE Astronomical Telescopes + Instrumentation Conference, Montreal, CA	2022
SZ Workshop, Flatiron Institute, NY, NY	2022

APS April Meeting, NY, NY	2022
Cornell University Galaxy Lunch, Ithaca, NY	2022
American Astronomical Society 238th Meeting (Virtual)	2021
Cornell University Astrophysics Lunch, Ithaca, NY (Virtual)	2021
Applied Superconductivity Conference (Virtual)	2020
Low Temperature Detectors Conference (Winner, Best Poster Video), Milan, Italy	2019
CMB-S4 Collaboration Meeting, Fermilab, IL	2019
SPIE Astronomical Telescopes + Instrumentation Conference, Austin, TX	2018
Center for Computational Astrophysics, Flatiron Institute, NY, NY	2018
Cornell University Galaxy Lunch, Ithaca, NY	2018
APS Division of Particles and Fields Conference, Fermilab, IL	2017
Cornell University Summer STEM Colloquium, Ithaca, NY	2017
American Astronomical Society 230th Meeting, Austin, TX	2017
Cornell University Astrophysics Lunch, Ithaca, NY	2016
SPIE Astronomical Telescopes + Instrumentation Conference, Montreal, CA	2014

GRADUATE STUDENT MENTEES

Ema Smith, Cornell Physics PhD student	2023 – Present
Alicia Middleton, Cornell Physics PhD student	2023 – Present
Lawrence Lin, Cornell Physics PhD student	2022 – Present
Rodrigo Freundt, Cornell Astronomy PhD student	2021 – Present
Ben Keller, Cornell Physics PhD student	2021 – Present
Zachary Huber, Cornell Physics PhD student	2020 – Present
Cody Duell, Cornell Physics PhD student	2018 – Present

UNDERGRADUATE STUDENT MENTEES

Kush Banker, University of Chicago '26	2023 – Present
Julia Youssef, University of Chicago '26	2023 – Present
Elaine Ran, Cornell '26	2023 – Present
Colin Murphy, Cornell '25	2022 – Present
Antwine Willis, Washington University '23, Simons-NSBP Program	2023
Hanzhi Tan, University of Chicago '24	2022
Ioana Cristescu, University of Richmond '24	2022
Brian Zhang, University of Chicago '25	2022
Photon Xu, Cornell '22 → Physics PhD student at UCSD	2021
Dontae Milner, Eastern Illinois U., Simons-National Society of Black Physicists Program	2020
Pedro Guicardi, Cornell '22 → Physics PhD student at Caltech	2019 – 2020
Kshama Malavalli, Cornell '21 → Graduate student at the Carl Sagan Institute	2019 – 2020
Willow Martin, Cornell '22 → Physics PhD student at Stanford	2019 – 2020
Dallin Richards, Cornell '23 → Engineering Physics PhD student at Cornell	2018 – 2019
Noah Sailer, Cornell '19 → Physics PhD student at UC Berkeley	2017 – 2019
Kaiwen Zheng, Cornell '18 → Physics PhD student at Princeton University	2016 – 2018
Tracy Paltoo, Adelphi University, LSAMP Program → Civil Engineering Project Analyst	2016
Prabudhya Bhattacharyya, Cornell '16 → Physics PhD student at UC Berkeley	2015 – 2016

SERVICE

Simons Observatory:

Team Lead, SO APS-IDEA Team	2022 – Present
Co-chair, Engagement, Mentorship, and Climate Committee	2020 – Present
Member, Equity, Diversity, and Inclusion group	2016 – 2020
Member, Education and Public Outreach group	2016 – 2020

Member, CCAT-prime Collaboration Publications and Speakers Committee 2022 – Present

Invited Panelist:

Comm 5660, Science Communication Workshop, Cornell University	2022, 2023
APS Conferences for Undergraduate Women in Physics (CUWiP) Cornell	2023
NSF GRFP Information Sessions, Cornell University	2017 – 2018
Physics Graduate School Information Session, Cornell University	2015

Co-organizer, Cornell Laboratory for Elementary-Particle Physics Seminar Series 2021 – 2022

Group Safety Representative, Physical Sciences Building, Cornell University 2019 – 2021

Organizer, Cosmology Journal Club, Cornell University 2017 – 2019

Peer Reviewer, NSF GRFP Fellowship Review Sessions, Cornell University 2015 – 2019

Reviewer:

IEEE Transactions on Applied Superconductivity

MIT Press

Physical Review D

TEACHING EXPERIENCE

Cornell University

Grader, Physics 3318: Analytical Mechanics Spring 2021

Grader, Physics 3317: Applications of Quantum Mechanics Fall 2016 – 2020

Grader, Physics 6562: Statistical Mechanics Spring 2020

Grader, Physics 7645: Particle Physics Spring 2018 – 2019

Teaching Assistant, Physics 3314: Intermediate Mechanics Spring 2016

Private Physics Tutor, Physics 1102: Electricity, Magnetism and Waves Spring 2016

Teaching Assistant, Physics 1101: Mechanics and Thermodynamics Fall 2015

Physics Tutor, Cornell University Learning Strategies Center 2012 – 2014

Undergraduate Teaching Assistant, Physics 1112: Mechanics Spring 2011

California Institute of Technology

Teaching Assistant, Physics 1: Mechanics Fall 2014

TRAINING

Cornell Center for Teaching Innovation Research and Practice of Teaching Symposium 2022

NextGen Professors Program, Cornell University 2019 – 2020

Selective career development program for participants dedicated to advancing EDI

Cornell Center for Teaching Innovation GET SET Workshops:

Best Practices for Large Lecture Classes 2020

Enhancing Your Teaching with Research-Based Principles 2020

Writing a Teaching Statement 2019

Grading Effectively 2019

Using a Case-Study Approach to Teaching 2019

Digital Storytelling 2019

Incorporating Experiential Learning in Your Classes	2019
Science Communication Workshop (COMM 5660), Cornell University	2019
ComSciCon-Cornell, Cornell University	2018
<i>Selective science communication workshop</i>	
CMB Data Analysis Summer School, University of Michigan	2016
Teaching and Learning Physics (PHYS 4484), Cornell University	2011

PUBLIC OUTREACH AND ENGAGEMENT

ParticleBites, the high energy physics reader’s digest blog:	
Co-director	2018 – Present
Author	2016 – 2018
Talk at Sustainable HEP: Tanedo, Vavagiakis, <i>Year of ParticleBites</i> :	2022
<i>Re-imagining a reader’s digest of high-energy physics for community building in an ecosystem of remote collaboration</i>	
Social media: ACT, CCAT-prime, Simons Observatory, ParticleBites	2017 – Present
Reaching a global audience of >100,000/month	
Media interviews:	
CBC Radio One’s Ideas Podcast	2023
Twinkl Educational Publishing House Podcast	2022
Into the Impossible Podcast	2022
Cornell Chronicle	2017, 2022
Tidbits of Research Podcast	2020
WHCU 97.7 Ithaca	2019
WPRB 103.3 Princeton	2018
<i>Invited talk</i> , Warrior-Scholar Project STEM Boot Camp, Cornell, Ithaca, NY	2022, 2023
<i>Invited talk</i> , CMB-S4 Saturday Science Series, Virtual	2022, 2023
<i>Invited virtual visit</i> , Chicago Greater Area Girl Scouts Astronomy Club	2023
<i>Invited talk</i> , Cornell Friends of Astronomy Symposium, Ithaca, NY	2019
Science on Tap talk, Organized by Graduate Women in Science, Ithaca, NY, audience of 55	2019
Xraise Cornell High Energy Synchrotron Source (CHESS) Outreach Program:	
Tour Guide, leading public tours of Wilson Synchrotron Lab	2017 – 2019
Video development: An introduction to CHESS for the public	2017 – 2018
Volunteer: Science Cabaret, Coltivare, Ithaca, NY	2017
Panelist, Cosmology and Cocktails, Fleet Science Center, San Diego, CA, audience of >200	2017

K-12 EDUCATION

Creator, Organizer: Cosmology Day, Ithaca, NY	2019 – Present
<i>Annual half-day event for high school students, communicating real step-by-step paths from high school to careers in physics, astronomy & engineering</i>	
Author, children’s book series on particle physics and astronomy, MIT Kids Press	
MIT Open Space event, “I’m a Neutrino” reading, Cambridge, MA, audience of >50	2022
“I’m a Neutrino” included in the UK’s Summer Reading Challenge for ages 4–11	2022
Invited Guest Speaker, Girl Tales Podcast Taleblazer Weekend	2022
Expanding Your Horizons Conference, Cornell University	
<i>One-day conference designed to stimulate 7th-9th grade girls’ interest in STEM</i>	
Lab Tour Leader	2023

Conference Volunteer	2021
Physics Workshop Instructor	2019
Conference Buddy	2015
Volunteer, Cornell Center for Materials Research Educational Programs	2015 – 2020
<i>Educational programs and demonstrations for K-12 students, teachers, and the public</i>	
Laboratory tour for Cornell STEM Teacher Workshop, Ithaca, NY	2018
Cosmology lecture at Ithaca High School, Ithaca, NY, audience of >30	2018
Laboratory tour for New Settlement Housing Fund visiting students	2015
Volunteer, Focus For Teens, Cornell University Department of Astronomy	2011, 2014
<i>4-H STEM career exploration event for high school students</i>	
Physics Instructor, Northern Lights Learning Cooperative, Ithaca, NY	Spring 2011

GROUPS AND ADVOCACY

APS Inclusion, Diversity and Equity Alliance (IDEA) Workshops	2020 – Present
Team Lead, Simons Observatory Institutional Team	
Volunteer, Student Disability Services, Cornell University	2015 – 2021
<i>Advocacy for students with invisible disabilities</i>	
Member, Cornell Allergy and Asthma Awareness Club	2016 – 2017
Member, Caltech Graduate Student Council Advocacy Committee	Fall 2014
Member, Society of Physics Students, Cornell University	2010 – 2014

PUBLICATIONS, MAIN AUTHOR

Google Scholar Profile, h-index 27, 4489 citations 8/2023
Publications with fifteen or more authors have the alphabetized author list shortened to et al.

- 12) **E. M. Vavagiakis**, C. J. Duell et al. 2022. *CCAT-prime: Design of the Mod-Cam receiver and 280 GHz MKID instrument module*, Proc. SPIE 12190:1219004, Millimeter, Submillimeter, and Far-Infrared Detectors and Instrumentation for Astronomy XI, arXiv:2208.05468.
- 11) Z. Huber, Y. Li, **E. M. Vavagiakis** et al. 2022, *The Simons Observatory: Magnetic Shielding Measurements for the Universal Multiplexing Module*, J. Low Temp. Phys. 2022, arXiv:2111.11495.
- 10) **E. M. Vavagiakis**, P. A. Gallardo, V. Calafut, S. Amodeo et al. 2021, *The Atacama Cosmology Telescope: Probing the Baryon Content of SDSS DR15 Galaxies with the Thermal and Kinematic Sunyaev-Zel'dovich Effects*, Phys. Rev. D 104, 043503, arXiv:2101.08373.
- 9) V. Calafut, P. A. Gallardo, **E. M. Vavagiakis** et al. 2021, *The Atacama Cosmology Telescope: Detection of the Pairwise Kinematic Sunyaev-Zel'dovich Effect with SDSS DR15 Galaxies*, Phys. Rev. D 104, 043502, arXiv:2101.08374.
- 8) C. J. Duell, **E. M. Vavagiakis** et al. 2020, *CCAT-prime: Designs and Status of the First Light 280 GHz MKID Array and Mod-Cam Receiver*, Proc. SPIE 11453:114531F, Millimeter, Submillimeter, and Far-Infrared Detectors and Instrumentation for Astronomy X, arXiv:2012.10411.
- 7) **E. M. Vavagiakis** et al. 2020, *The Simons Observatory: Magnetic Sensitivity Measurements of Microwave SQUID Multiplexers*, IEEE Trans. Appl. Supercond., 31, 5, arXiv:2012.04532.

- 6) **E. M. Vavagiakis**, N. F. Cothard, J. R. Stevens, C. L. Chang, M. D. Niemack, G. Wang, V.G. Yefremenko, J. Zhang 2019, *Developing AlMn films for Argonne TES fabrication*, J. Low Temp. Phys. 199, 408–415, arXiv:1910.10199.
- 5) J. R. Stevens, N. F. Cothard, **E. M. Vavagiakis** et al. 2019, *Characterization of Transition Edge Sensors for the Simons Observatory*, J. Low Temp. Phys. 199, 672–680, arXiv:1912.00860.
- 4) **E. M. Vavagiakis** et al. 2018, *Prime-Cam: A first-light instrument for the CCAT-prime telescope*, Proc. SPIE 10708:107081U, Millimeter, Submillimeter, and Far-Infrared Detectors and Instrumentation for Astronomy IX, arXiv:1807.00058.
- 3) **E. M. Vavagiakis**, S. W. Henderson, K. Zheng et al. 2018, *Magnetic Sensitivity of AlMn TESes and Shielding Considerations for Next Generation CMB Surveys*, J. Low Temp. Phys. 193, 288–297, arXiv:1710.08456.
- 2) F. De Bernardis, S. Aiola, **E. M. Vavagiakis**, M. D. Niemack, N. Battaglia et al. 2017, *Detection of the pairwise kinematic Sunyaev-Zel’dovich effect with BOSS DR11 and the Atacama Cosmology Telescope*, JCAP 03, 008, arXiv:1607.02139.
- 1) S. C. Parshley, **E. M. Vavagiakis**, T. Nikola, G. J. Stacey 2014, *A Miniature Cryogenic Scanning Fabry-Perot Interferometer for Mid-IR to Submm Astronomical Observations*, Proc. SPIE 9147:914745, Ground-based and Airborne Instrumentation for Astronomy V.

PUBLICATIONS, COAUTHOR

- 71) M. Mallaby-Kay, S. Amodeo, J. C. Hill et al. 2023, *The Kinematic Sunyaev-Zel’dovich Effect with ACT, DES, and BOSS: a Novel Hybrid Estimator*, Phys. Rev. D 108, 023516, arXiv:2305.06792.
- 70) The CCAT-prime Collaboration 2023, *CCAT-prime Collaboration: Science Goals and Forecasts with Prime-Cam on the Fred Young Submillimeter Telescope*, ApJS 264 7, arXiv:2107.10364.
- 69) Z. B. Huber, S. K. Choi, C. J. Duell, R. G. Freundt, P. A. Gallardo, B. Keller, Y. Li, L. T. Lin, M. D. Niemack, T. Nikola, D. A. Reichers, G. Stacey, **E. M. Vavagiakis**, B. Zou 2022, *CCAT-prime: the optical design for the Epoch of reionization spectrometer*, Proc. SPIE 12190:121902H, Millimeter, Submillimeter, and Far-Infrared Detectors and Instrumentation for Astronomy XI, arXiv:2208.09521.
- 68) S. C. Chapman, Anthony I. Huber, Adrian K. Sinclair, Jordan D. Wheeler et al. 2022, *CCAT-prime: the 850 GHz camera for Prime-Cam on FYST*, Proc. SPIE 12190:1219005, Millimeter, Submillimeter, and Far-Infrared Detectors and Instrumentation for Astronomy XI, arXiv:2208.10634.
- 67) A. I. Huber, S. C. Chapman, A. K. Sinclair, L. D. Spencer et al. 2022, *CCAT-prime: optical and cryogenic design of the 850 GHz module for Prime-Cam*, Proc. SPIE 12190:121901D, Millimeter, Submillimeter, and Far-Infrared Detectors and Instrumentation for Astronomy XI, arXiv:2208.09560.

- 66) A. Sinclair, R. C. Stephenson, C. A. Roberson, E. L. Weeks, J. Burgoyne, A. I. Huber, P. M. Mauskopf, S. C. Chapman et al. 2022, *CCAT-prime: RFSoc Based Readout for Frequency Multiplexed Kinetic Inductance Detectors*, Proc. SPIE 12190:121900W, Millimeter, Submillimeter, and Far-Infrared Detectors and Instrumentation for Astronomy XI, arXiv:2208.07465.
- 65) B. Zou, S. K. Choi, N. F. Cothard, R. Freundt, Z. B. Huber, Y. Li, M. D. Niemack, T. Nikola, D. A. Riechers, K. M. Rossi, G. J. Stacey, **E. M. Vavagiakis** 2022, *CCAT-prime: the design and characterization of the silicon mirrors for the Fabry-Perot interferometer in the Epoch of reionization spectrometer*, Proc. SPIE 12190:121902B, Millimeter, Submillimeter, and Far-Infrared Detectors and Instrumentation for Astronomy XI, arXiv:2207.08318.
- 64) E. Healy, D. Dutcher et al. 2022, *The Simons Observatory 220 and 280 GHz Focal-Plane Module: Design and Initial Characterization*, J. Low Temp Phys 2022, arXiv:2201.04507.
- 63) J. Connors et al. 2022, *Magnetic Field Sensitivity of Microwave SQUID Multiplexers*, J. Low Temp Phys 2022.
- 62) S. K. Choi, C. J. Duell et al. 2022, *CCAT-prime: Characterization of the First 280 GHz MKID Array for Prime-Cam*, J. Low Temp. Phys. 2022, arXiv:2111.01055.
- 61) The CMB-S4 Collaboration 2021, *Snowmass 2021 CMB-S4 White Paper*, arXiv:2112.01458.
- 60) J. C. Hill, E. Calabrese et al. 2021, *The Atacama Cosmology Telescope: Constraints on Pre-Recombination Early Dark Energy*, Phys. Rev. D 105, 123536, arXiv:2109.04451.
- 59) H. McCarrick, E. Healy et al. 2021, *The Simons Observatory microwave SQUID multiplexing detector module design*, ApJ 922 38, arXiv:2106.14797.
- 58) T. Shin, B. Jain et al. 2021, *The mass and galaxy distribution around SZ-selected clusters*, MNRAS, 507, 4, arXiv:2105.05914.
- 57) J. Orłowski-Scherer, L. Di Mascolo, T. Bhandarkar, A. Manduca, T. Mroczkowski et al. 2021, *Atacama Cosmology Telescope: Measurements of a large sample of candidates from the Massive and Distant Clusters of WISE Survey: Sunyaev-Zeldovich effect confirmation of MaDCoWS candidates using ACT*, A&A 653, A135, arXiv:2105.00068.
- 56) Y. Guan, S. E. Clark, B. S. Hensley, P. A. Gallardo, S. Naess, C. J. Duell et al. 2021, *The Atacama Cosmology Telescope: Microwave Intensity and Polarization Maps of the Galactic Center*, ApJ, 920, 6, arXiv:2105.05267.
- 55) Z. Xu et al. 2021, *The Simons Observatory: the Large Aperture Telescope (LAT)*, Res. Notes AAS 5 100, arXiv:2104.09511.
- 54) N. Zhu et al. 2021, *The Simons Observatory Large Aperture Telescope Receiver*, ApJS 256, 23, arXiv:2103.02747.
- 53) S. Amodeo, N. Battaglia, E. Schaan, S. Ferraro, E. Moser et al. 2021, *The Atacama Cosmology Telescope: Modelling the Gas Thermodynamics in BOSS CMASS galaxies from Kinematic and Thermal Sunyaev-Zel'dovich Measurements*, Phys. Rev. D 103, 063514, arXiv:2009.05558.

- 52) E. Schaan, S. Ferraro, S. Amodeo, N. Battaglia et al. 2021, *The Atacama Cosmology Telescope: Combined kinematic and thermal Sunyaev-Zel'dovich measurements from BOSS CMASS and LOWZ halo*, Phys. Rev. D 103, 063513, arXiv:2009.05557.
- 51) Y. Li et al. 2021, *In situ Performance of the Low Frequency Array for Advanced ACTPol*, IEEE Trans. Appl. Supercond., 31 (5), arXiv:2101.02658.
- 50) Y. Wang, K. Zheng et al. 2021, *Simons Observatory Focal-Plane Modules: In-lab Testing and Characterization Program*, J. Low Temp. Phys. 209, 944-952, arXiv:2111.11301.
- 49) M. Hilton, C. Sifón, S. Naess, M. Madhavacheril, M. Oguri, E. Rozo, E. Rykoff et al. 2021, *The Atacama Cosmology Telescope: A Catalog of >4000 Sunyaev-Zel'dovich Galaxy Clusters*, ApJS 253 (1), arXiv:2009.11043.
- 48) H. McCarrick et al. 2021, *The 90 and 150 GHz universal focal-plane modules for the Simons Observatory*, arXiv:2112.01458.
- 47) Z. Xu et al. 2020, *The Simons Observatory: the Large Aperture Telescope Receiver (LATR) integration and validation results*, Proc. SPIE. 11453:1145315, Millimeter, Submillimeter, and Far-Infrared Detectors and Instrumentation for Astronomy X, arXiv:2012.07862.
- 46) J. Seibert et al. 2020, *Development of an optical detector testbed for the Simons Observatory*, Proc. SPIE 11453:114532C, Millimeter, Submillimeter, and Far-Infrared Detectors and Instrumentation for Astronomy X.
- 45) K. Harrington, C. Sierra, G. Chesmore, S. Sutariya et al. 2020, *The integration and testing program for the Simons Observatory Large Aperture Telescope optics tubes*, Proc. SPIE 11453:1145318, Millimeter, Submillimeter, and Far-Infrared Detectors and Instrumentation for Astronomy X, arXiv:2102.02129.
- 44) D. Henke, D. Johnstone, L. B. G. Knee, S. Chapman, C. Ross, M. Fich, T. Nikola, S. K. Choi, M. D. Niemack, S. C. Parshley, G. J. Stacey, **E. M. Vavagiakis** 2020, *Optical design study for the 860 GHz first-light camera module of CCAT-p*, Proc. SPIE 11453:114532K, Millimeter, Submillimeter, and Far-Infrared Detectors and Instrumentation for Astronomy X.
- 43) N. F. Cothard et al. 2020, *Comparing complex impedance and bias step measurements of Simons Observatory transition edge sensors*, Proc. SPIE 11453:1145325, Millimeter, Submillimeter, and Far-Infrared Detectors and Instrumentation for Astronomy X, arXiv:2012.08547.
- 42) M. S. Madhavacheril, C. Sifón, N Battaglia et al. 2020, *The Atacama Cosmology Telescope: Weighing distant clusters with the most ancient light*, ApJL 903, L13, arXiv:2009.07772.
- 41) The CMB-S4 Collaboration 2020, *CMB-S4: Forecasting Constraints on Primordial Gravitational Waves*, arXiv:2008.12619.
- 40) S. Naess et al. 2020, *The Atacama Cosmology Telescope: arcminute-resolution maps of 18,000 square degrees of the microwave sky from ACT 2008-2018 data combined with Planck*, JCAP 2020, 046, arXiv:2007.07290.

- 39) S. K. Choi, M. Hasselfield, S. P. Ho, B. Koopman, M. Lunguet et al. 2020, *The Atacama Cosmology Telescope: A Measurement of the Cosmic Microwave Background Power Spectra at 98 and 150 GHz*. JCAP 2020, 045, arXiv:2007.07289.
- 38) S. Aiola, E. Calabrese, L. Maurin, S. Naess, B. L. Schmitt et al. 2020, *The Atacama Cosmology Telescope: DR4 Maps and Cosmological Parameters*, JCAP 2020, 047, arXiv:2007.07288.
- 37) A. Suzuki, N. Cothard, A. T. Lee, M. D. Niemack, C. Raum, M. Renzullo, T. Sasse, J. Stevens, P. Truitt, **E. M. Vavagiakis**, J. Vivalda, B. Westrook, D. Yohannes 2020, *Commercially Fabricated Antenna-Coupled Transition Edge Sensor Bolometer Detectors for Next-Generation Cosmic Microwave Background Polarimetry Experiment*, J. Low Temp. Phys. 199, 1158–1166, arXiv:1912.12782.
- 36) M. S. Madhavacheril, J. C. Hill, S. Naess et al. 2019, *The Atacama Cosmology Telescope: Component-separated maps of CMB temperature and the thermal Sunyaev-Zel’dovich effect*, Phys. Rev. D 102 2, 023534, arXiv:1911.05717.
- 35) S. Choi et al. 2019, *Sensitivity of the Prime-Cam Instrument on the CCAT-prime Telescope*, J. Low Temp. Phys. 199, 1089–1097, arXiv:1908.10451.
- 34) N. F. Cothard, S. K. Choi, C. J. Duell, T. Herter, J. Hubmayr, J. McMahon, M. D Niemack, T. Nikola, C. Sierra, G. J. Stacey, **E. M. Vavagiakis**, E. J Wollack, B. Zou 2019, *The Design of The CCAT-Prime Epoch of Reionization Spectrometer Instrument*, J. Low Temp. Phys. 199, 898–907, arXiv:1911.11687.
- 33) M. S. Rao, M. Silva-Feaver et al. 2019, *Simons Observatory Microwave SQUID Multiplexing Readout - Cryogenic RF Amplifier and Coax Chain Design*, J. Low Temp. Phys. 199, 807-816, arXiv:2003.08949.
- 32) Y. Li et al. 2019, *Assembly and Integration Process for the High-Density Detector Array Readout Modules for the Simons Observatory*, J. Low Temp. Phys. 199, 985-993.
- 31) The Simons Observatory Collaboration 2019, *The Simons Observatory: Astro2020 Decadal Project Whitepaper*, Astro2020 Decadal Project White Paper, Bull. Am. Astron. Soc. 51 147, arXiv:1907.08284.
- 30) K. Basu et al. 2019, *“SZ spectroscopy” in the coming decade: Galaxy cluster cosmology and astrophysics in the submillimeter*, Astro2020 Decadal Project White Paper, arXiv:1903.04944.
- 29) The CCAT-prime Collaboration 2019, *The CCAT-Prime Submillimeter Observatory*, Astro2020 APC White Paper, arXiv:1909.02587.
- 28) The Simons Observatory Collaboration 2018, *The Simons Observatory: Science goals and forecasts*, JCAP 1902, 056, arXiv:1808.07445.
- 27) G. Coppi, Z. Xu, et al. 2018, *Cooldown strategies and transient thermal simulations for the Simons Observatory*, Proc. SPIE 10708:1070827, Millimeter, Submillimeter, and Far-Infrared Detectors and Instrumentation for Astronomy IX, arXiv:1808.07896.

- 26) N. F. Cothard, M. Abe, T. Nikola, G. J. Stacey, G. Cortes-Medellin, P. A. Gallardo, B. J. Koopman, M. D. Niemack, S. C. Parshley, **E. M. Vavagiakis**, K. J. Vetter 2018, *Optimizing the efficiency of Fabry-Perot interferometers with silicon-substrate mirrors*, Proc. SPIE 10706:107065B, Advances in Optical and Mechanical Technologies for Telescopes and Instrumentation III, arXiv:1807.06019.
- 25) S. R. Dicker, P. A. Gallardo, P. D. Mauskopf, J. E. Gudmundsson, et al. 2018, *Cold optical design for the large aperture Simons' Observatory telescope*, Proc. SPIE 10700:107003E, Ground-based and Airborne Telescopes VII, arXiv:1808.05058.
- 24) P. A. Gallardo, J. Gudmundsson, B. J. Koopman, F. T. Matsuda, S. M. Simon, et al. 2018, *Systematic uncertainties in the Simons Observatory: optical effects and sensitivity considerations*, Proc. SPIE 10708:107083Y, Millimeter, Submillimeter, and Far-Infrared Detectors and Instrumentation for Astronomy IX, arXiv:1808.05152.
- 23) J. L. Orlowski-Scherer, N. Zhu, Z. Xu et al. 2018, *Simons Observatory large aperture receiver simulation overview*, Proc. SPIE 10708:107083X, Millimeter, Submillimeter, and Far-Infrared Detectors and Instrumentation for Astronomy IX, arXiv:1808.06648.
- 22) S. C. Parshley, M. D. Niemack, R. Hills, S. R. Dicker et al. 2018, *The optical design of the six-meter CCAT-prime and Simons Observatory telescopes*, Proc. SPIE 10700:1070041, Ground-based and Airborne Telescopes VII, arXiv:1807.06678.
- 21) S. C. Parshley, J. Kronshage, et al. 2018, *CCAT-prime: a novel telescope for sub-millimeter astronomy*, Proc. SPIE 10700:107005X, Ground-based and Airborne Telescopes VII, arXiv:1807.06675.
- 20) G. J. Stacey et al. 2018, *CCAT-Prime: science with an ultra-widfield submillimeter observatory on Cerro Chajnantor*, Proc. SPIE 10700:107001M, Ground-based and Airborne Telescopes VII, arXiv:1807.04354.
- 19) J. R. Stevens, N. Goeckner-Wald, R. Keskitalo, N. McCallum, et al. 2018, *Designs for next generation CMB survey strategies from Chile*, Proc. SPIE 10708:1070841, Millimeter, Submillimeter, and Far-Infrared Detectors and Instrumentation for Astronomy IX, arXiv:1808.05131.
- 18) N. Zhu, J. L. Orlowski-Scherer, Z. Xu, et al. 2018, *Simons Observatory large aperture telescope receiver design overview*, Proc. SPIE 10708:1070829, Millimeter, Submillimeter, and Far-Infrared Detectors and Instrumentation for Astronomy IX, arXiv:1808.10037.
- 17) K. T. Crowley et al. 2018, *Advanced ACTPol TES Device Parameters and Noise Performance in Fielded Arrays*, J. Low Temp. Phys. 193, 328-336, arXiv:1807.07496.
- 16) B. Koopman et al. 2018, *Advanced ACTPol Low Frequency Array: Readout and Characterization of Prototype 27 and 39 GHz Transition Edge Sensors*, J. Low Temp. Phys. 193, 1103–1111, arXiv:1711.02594.
- 15) S. M. Simon et al. 2018, *The Advanced ACTPol 27/39 GHz Array*, J. Low Temp. Phys. 193, 1041–1047.

- 14) M. Hilton, M. Hasselfield, C. Sifon, N. Battaglia, et al. 2018, *The Atacama Cosmology Telescope: The Two-Season ACTPol Sunyaev-Zel'Dovich Effect Selected Cluster Catalog*, ApJS, 235, 1. arXiv:1709.05600.
- 13) B. D. Sherwin, A. van Engelen, N. Sehgal, M. Madhavacheril et al. 2017, *The Atacama Cosmology Telescope: Two-Season ACTPol Lensing Power Spectrum*, Phys. Rev. D 95, 123529, arXiv:1611.09753.
- 12) S. P. Ho et al. 2017, *Highly uniform 150 mm diameter multichroic polarimeter array deployed for CMB detection*, Proc. SPIE 9914:991418, Millimeter, Submillimeter, and Far-Infrared Detectors and Instrumentation for Astronomy VIII.
- 11) Y. Li, S. Choi, S. P. Ho, et al. 2016, *Assembly and integration process of the first high density detector array for the Atacama Cosmology Telescope*, Proc. SPIE 9914:991435, Millimeter, Submillimeter, and Far-Infrared Detectors and Instrumentation for Astronomy VIII.
- 10) S. M. Simon et al. 2016, *The design and characterization of wideband spline-profiled feedhorns for Advanced ACTPol*, Proc. SPIE 9914:991416, Millimeter, Submillimeter, and Far-Infrared Detectors and Instrumentation for Astronomy VIII.
- 9) F. De Bernardis, J. R. Stevens, M. Hasselfield, et al. 2016, *Survey strategy optimization for the Atacama Cosmology Telescope*, Proc. SPIE 9910:991014, Observatory Operations: Strategies, Processes, and Systems VI, arXiv:1607.02120.
- 8) J. Ward et al. 2016, *Mechanical design and development of TES bolometer detector arrays for the Advanced ACTPol experiment*, Proc. SPIE 9914:991437, Millimeter, Submillimeter, and Far-Infrared Detectors and Instrumentation for Astronomy VIII, arXiv:1607.05754.
- 7) S. W. Henderson, J. R. Stevens et al. 2016, *Readout of two-kilopixel transition-edge sensor arrays for Advanced ACTPol*, Proc. SPIE 9914:99141G, Millimeter, Submillimeter, and Far-Infrared Detectors and Instrumentation for Astronomy VIII, arXiv:1607.06064.
- 6) B. Koopman, J. Austermann, H.-M. Cho, et al. 2016, *Optical modeling and polarization calibration for CMB measurements with ACTPol and Advanced ACTPol*, Proc. SPIE 9914:99142T, Millimeter, Submillimeter, and Far-Infrared Detectors and Instrumentation for Astronomy VIII, arXiv:1607.01825.
- 5) S. P. Ho, C. G. Pappas et al. 2016, *The First Multichroic Polarimeter Array on the Atacama Cosmology Telescope: Characterization and Performance*, J. Low Temp. Phys. 184:3, 559-567.
- 4) S. W. Henderson et al. 2016, *Advanced ACTPol Cryogenic Detector Arrays and Readout*, J. Low Temp. Phys. 10909:1575-z, arXiv:1510.02809.
- 3) S. M. Duff et al. 2016, *Advanced ACTPol Multichroic Polarimeter Array Fabrication Process for 150 mm Wafers*, J. Low Temp. Phys. 10909:1576-y.
- 2) R. Datta et al. 2016, *Design and Deployment of a Multichroic Polarimeter Array on the Atacama Cosmology Telescope*, J. Low Temp. Phys. 10909:1553-5, arXiv:1510.07797.
- 1) C. G. Pappas et al. 2016, *High-Density Superconducting Cables for Advanced ACTPol*, J. Low Temp. Phys. 10909:1454-z.

- 8) Y. Gong, R. Bean, P. A. Gallardo, **E. M. Vavagiakis**, N. Battaglia, M. Niemack 2023, *Pairwise kSZ signal extraction efficacy and optical depth estimation*, in submission, arXiv:2307.11894.
- 7) W. R. Coulton, M. S. Madhavacheril, A. J. Duivenvoorden, J. C. Hill et al. 2023, *The Atacama Cosmology Telescope: High-resolution component-separated maps across one-third of the sky*, in submission, arXiv:2307.01258.
- 6) J. Orłowski-Scherer, R. Venterea, N. Battaglia, S. Naess et al. 2023, *The Atacama Cosmology Telescope: Millimeter Observations of a Population of Asteroids or: ACTeroids*, in submission, arXiv:2306.05468.
- 5) M. S. Madhavacheril, F. J. Qu, B. D. Sherwin, N. MacCrann, Y. Li et al. 2023, *The Atacama Cosmology Telescope: DR6 Gravitational Lensing Map and Cosmological Parameters*, Submitted to ApJ, arXiv:2304.05203.
- 4) F. J. Qu, B. D. Sherwin, M. S. Madhavacheril, D. Han, K. T. Crowley et al. 2023, *The Atacama Cosmology Telescope: A Measurement of the DR6 CMB Lensing Power Spectrum and its Implications for Structure Growth*, Submitted to ApJ, arXiv:2304.05202.
- 3) Y. Li, E. Biermann, S. Naess et al. 2023, *The Atacama Cosmology Telescope: Systematic Transient Search of 3-Day Maps*, Submitted to ApJ, arXiv:2303.04767.
- 2) Z. Atkins, A. J. Duivenvoorden, W. R. Coulton, F. J. Qu et al. 2023, *The Atacama Cosmology Telescope: Map-Based Noise Simulations for DR6*, Submitted to JCAP, arXiv:2303.04180.
- 1) C. Hervías-Caimapo, S. Naess, A. D. Hincks et al. 2023, *The Atacama Cosmology Telescope: Flux Upper Limits from a Targeted Search for Extragalactic Transients*, Submitted to MNRAS, arXiv:2301.07651.

BOOKS AND MAGAZINES

- E. M. Vavagiakis**, *I'm a Neutrino* (I. Lemesis, Illus.), MIT Kids Press, March 2022.
- E. M. Vavagiakis**, T. C. Bachlechner, M. Kleban 2021, *Is the electric potential physical?*, Physics Today 74 (8), 62.
- Forthcoming series of illustrated children's books highlighting modern experiments:
- E. M. Vavagiakis**, *I'm a Photon* (M. Malbrough, Illus.), MIT Kids Press, Spring 2025.
- E. M. Vavagiakis**, *I'm a Black Hole* (J. Lanan, Illus.), MIT Kids Press, March 2024.

REFERENCES

- Michael Niemack** Associate Professor of Physics and Astronomy, Cornell University
niemack@cornell.edu, (607) 255-0391
- Rachel Bean** Professor of Astronomy, Cornell University
Senior Associate Dean for Math and Science, College of Arts & Sciences
rachel.bean@cornell.edu, (607) 254-4920
- Gordon Stacey** Professor of Astronomy, Cornell University
stacey@cornell.edu, (607) 255-5900
- Brian Nord** Associate Scientist, Fermi National Accelerator Laboratory
CASE Scientist, University of Chicago Astronomy & Astrophysics
Senior Member, Kavli Institute for Cosmological Physics
Visiting Professor, MIT Laboratory for Nuclear Sciences, NSF IAIFI
nord@fnal.gov, (630) 840-8337