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CURRICULUM VITAE

EDUCATION

2011 **Ph.D.**, Astrophysical and Planetary Sciences, University of Colorado at Boulder
Dissertation entitled: *Galaxy Cluster Scaling Relations with APEX-SZ*.
Advisor: Prof. Nils Halverson

2006 **M.S.**, Astrophysical, Planetary and Atmospheric Sciences
University of Colorado at Boulder

2004 **B.S.**, Physics
University of Illinois at Urbana-Champaign

RESEARCH EXPERIENCE

2016 - present **Assistant Physicist**
Argonne National Laboratory

Instrumentation & Operations for the SPT-3G Receiver

- Development, integration, installation, and commissioning of detector and readout systems in SPT-3G receiver
- Optimization of readout electronics performance in the SPT-3G receiver
- Routine monitoring of data quality and receiver performance

CMB-S4 Readout Development

- co-L2 manager for readout subsystem
- Facilitated technology selection and trade studies to inform design decisions
- Guiding system design including setting requirements and defining interfaces with other system
- Peform planning for subsystem production and quality assurance
- Develop subsystem cost estimate, schedule, risk register

Development of Frequency Domain Multiplexing (fMux) Readout Technology

- Development of new cryogenic architecture for fMux system for operation of low resistance ($r < 0.5\,\Omega$) transition-edge sensor bolometers for optimal noise performance

2014 - 2016 **Postdoctoral Researcher**
Argonne National Laboratory with Clarence Chang
Associate Fellow, Kavli Institute for Cosmological Physics, University of Chicago

Instrumentation for the SPT-3G Receiver
SPT-3G contains 16,000 polarization-sensitive transition-edge sensor (TES) bolometers to make multi-wavelength measurements of the Cosmic Microwave Background (CMB) polarization.

- Systematics optimized design of cryogenic readout electronics for SPT-3G.

- Integration and characterization of cryogenic readout components for SPT-3G, including Superconducting Quantum Interference Devices (SQUIDs) and superconducting resonator neworks.
- Integration of readout electronics with SPT-3G detectors for both detector and full system characterization.
- Characterization of superconducting material samples for SPT-3G detectors.
- Coordination of unified detector and readout characterization effort across eight universities/laboratories.

Galaxy Cluster Analysis with South Pole Telescope Data

- Using existing SPT CMB survey data to measure the pressure profile of galaxy clusters.

2011 - 2014 **Postdoctoral Fellow in Astrophysics**
McGill University with Matthew Dobbs

Readout Electronics Development for CMB Telescopes

- Laboratory commissioning of readout electronics for large-format TES bolometer arrays to be deployed on the South Pole Telescope and POLARBEAR2 experiment.
- Characterized instrumental systematics for SPT polarization (SPTpol) receiver.

Millimeter-Wavelength Galaxy Cluster Measurements

- Continued ongoing analysis with Atacama Pathfinder Experiment SZ-receiver (APEX-SZ) data to correlate millimeter and X-ray observations of galaxy clusters.

2007 - 2011 **Graduate Research Assistant**
University of Colorado at Boulder with Nils Halverson

- Deployment and overall characterization of the millimeter-wavelength APEX-SZ experiment, designed to measure secondary anisotropies in the CMB.
- Analyzed observations from APEX-SZ to measure millimeter-wavelength flux from galaxy clusters and correlate with X-ray cluster properties.

2005 - 2007 **Graduate Research Assistant**
University of Colorado at Boulder with Erica Ellingson

Analyzed Hubble Space Telescope Advanced Camera for Surveys data to investigate the influence of the galaxy cluster environment on galaxy evolution

2002 - 2004 **Undergraduate Research Assistant**
University of Illinois at Urbana-Champaign with Robert Brunner

Compared intrinsic properties of Sloan Digital Sky Survey quasars with statistical excesses in the number of galaxies in their local environments.

2003 **Undergraduate Research Assistant**
Kitt Peak National Observatory REU with Richard Green

Analyzed optical spectra to determine the velocity dispersion of the stars surrounding and the mass of the supermassive black hole in NGC 4486B

2002 **Undergraduate Research Assistant**
University of Chicago REU with Donald York

Created a catalogue of quasar - galaxy near neighbors from the Sloan Digital Sky Survey used to map the gaseous galactic halo.

SELECTED PUBLICATIONS

Bender, A.N., et al., 2020, "On-Sky Performance of the SPT-3G Frequency-Domain Multiplexed Readout", *Journal of Low Temperature Physics*, 199, 182

Lowitz, A.E., Bender, A.N., et al., 2020, "Performance of a Low-Parasitic Frequency-Domain Multiplexing Readout", *Journal of Low Temperature Physics*, 199,192

Bender, A.N., et al., 2018, "Year two instrument status of the SPT-3G cosmic microwave background receiver", *Proceedings of the SPIE*,10708, 1070803

Henning, J.W., et al., 2018, "Measurements of the Temperature and E-Mode Polarization of the CMB from 500 Square Degrees of SPTpol Data", *Astrophysical Journal*, 852,97

Bender, A.N., et al., 2016, "Galaxy cluster scaling relations measured with APEX-SZ", *Monthly Notices of the Royal Astronomical Society*, 460, 3432

Bender, A.N., et al., 2014, "Digital frequency domain multiplexing readout electronics for the next generation of millimeter telescopes", *Proceedings of the SPIE*, 9153, 91531A

REFEREED PUBLICATIONS

Sayre, J.T., et al., 2020, "Measurements of B-mode polarization of the cosmic microwave background from 500 square degrees of SPTpol data", *Physical Review D*, 101, 122003

Bianchini, F., et al., 2020, "Searching for Anisotropic Cosmic Biregringence with Polarization Data for SPTpol", accepte to *Physical Review D*

Nadolski, A., et al., 2020, "Broadband, millimeter-wave antireflection coatings for large-format, cryogenice aluminum oxide optics", *Applied Optics*, 59, 3285

Bleem, L.E., et al., 2020, "The SPTpol Extended Cluster Survey",*The Astrophysical Journal Supplement Series*, 241, 25

Huang, N., et al., 2020, "Galaxy Clusters Selected via the Sunyaev-Zel'dovich Effect in the SPTpol 100-square-degree Survey", *The Astronomical Journal*, 159, 110

Reichardt C.L., et al., 2020, "An Improved Measurement of the Secondary Cosmic Microwave Background Anisotropies from the SPT-SZ + SPTpol Surveys", *submitted to the Astrophysical Journal*

Anderson, A.J., et al., 2020, "Performance of Al–Mn Transition-Edge Sensor Bolometers in SPT-3G ", *Journal of Low Temperature Physics*, 199, 320

Bianchini, F., et al, 2020, "Constraints on Cosmological Parameters from the 500 deg^2 SPTPOL Lensing Power Spectrum", *The Astrophysical Journal*, 888, 119

Gupta, N., et al., 2019, "Fractional polarization of extragalactic sources in the 500 deg^2 SPTpol survey", *Monthly Notices of the Royal Astronomical Society*, 490, 5712

Raghunathan, S., et al., 2019, "Detection of CMB-Cluster Lensing using Polariation Data from SPTpol", *Physical Review Letters*, 123, 181301

Avva, J.S., et al., 2019, "Particle Physics with the Cosmic Microwave Background with SPT-3G", *Proceedings of TAUP 2019*

Wu, W.L.K., et al., 2019, "A Measurement of the Cosmic Microwave Background Lensing Potential and Power Spectrum from 500 deg^2 of SPTpol Temperature and Polarization Data", *The Astrophysical Journal*, 884, 70

Nagarajan, A., et al., 2019, "Weak-lensing mass calibration of the Sunyaev-Zel'dovich effect using APEX-SZ galaxy clusters", *Monthly Notices of the Royal Astronomical Society*, 488, 1728

Raghunathan, S., et al., 2018, "Mass Calibration of Optically Selected DES clusters using a Measurement of CMB-Cluster Lensing with SPTpol Data", *Astrophysical Journal*, 872, 170

Anderson, A.J., et al., 2018, "SPT-3G: A Multichroic Receiver for the South Pole Telescope ", *Journal of Low Temperature Physics*, 193, 1057

Avva, J.S., et al., 2018, "Design and Assembly of SPT-3G Cold Readout Hardware", *Journal of Low Temperature Physics*, 193, 547

Carter, F.W., et al., 2018, "Tuning SPT-3G Transition-Edge-Sensor Electrical Properties with a Four-Layer Ti-Au-Ti-Au Thin-Film Stack ", *Journal of Low Temperature Physics*, 193, 695

Ding, J., et al., 2018, " Thermal Links and Microstrip Transmission Lines in SPT-3G Bolometers", *Journal of Low Temperature Physics*, 193, 712

Everett, W., et al., 2018, "Design and Bolometer Characterization of the SPT-3G First-Year Focal Plane", *Journal of Low Temperature Physics*, 193, 1085

Pan, Z., et al., 2018, "Optical Characterization of the SPT-3G Camera ", *Journal of Low Temperature Physics*, 193, 305

Posada, C.M., et al., 2018, "Fabrication of Detector Arrays for the SPT-3G Receiver ", *Journal of Low Temperature Physics*, 193, 703

Yefremenko, V., et al., 2018, "Impact of Electrical Contacts Design and Materials on the Stability of Ti Superconducting Transition Shape", *Journal of Low Temperature Physics*, 193, 732

Elleflot, T., et al., 2018, "Detector and Readout Assembly and Characterization for the Simons Array", *Journal of Low Temperature Physics*, 193, 1094

Westbrook, B., et al., 2018, "The POLARBEAR-2 and Simons Array Focal Plane Fabrication Status", *Journal of Low Temperature Physics*, 193, 758

Manzotti, A., et al., 2017, "CMB Polarization B-mode Delensing with SPTpol and Herschel", *Astrophysical Journal*, 846, 45

Bandura, K., et al., 2016, "ICE: a scalable, low-cost FPGA-based telescope signal processing and networking system", *Journal of Astronomical Instrumentation* , 5, 1641005

Whitehorn, N., et al., 2016, "Millimeter Transient Point Sources in the SPTpol 100 Square Degree Survey", *Astrophysical Journal*, 830, 143

Suzuki, A., et al., 2016,"The POLARBEAR-2 and the Simons Array Experiment", *Journal of Low Temperature Physics*, 184, 805

Hattori, K., et al., 2016, "Development of readout electronics for POLARBEAR-2 Cosmic Microwave Background experiment", *Journal of Low Temperature Physics*, 184, 512

Posada, C., et al., 2015, '"Fabrication of large dual-polarized multichroic TES bolometer arrays for CMB measurements with the SPT-3G camera", *Superconducting Science and Technology*, 28, 094002

Story, K.T., et al., 2015, "A Measurement of the Cosmic Microwave Background Gravitational Lensing Potential from 100 Square Degrees of SPTpol Data", *ApJ*, 810, 50

Keisler, R., et al., 2015, "Measurements of Sub-Degree B-Mode Polarization in the Cosmic Microwave Background from 100 Square Degrees of SPTpol Data", *The Astrophysical Journal*, 807, 15

Crites, A.T., et al., 2015, "Measurements of the E-mode Polarization and Temperature-E-Mode Correlation in the Cosmic Microwave Background from 100 Square Degrees of SPTpol Data", *The Astrophysical Journal*, 805, 36

Hanson, D., et al., "Detection of B-Mode Polarization in the Cosmic Microwave Background with Data from the South Pole Telescope", *Physical Review Letters*, 111,141301

Dobbs, M.A., et al., 2012, "Frequency multiplexed superconducting quantum interference device readout of large bolometer arrays for cosmic microwave background measurements", *Review of Scientific Instruments*, 83, 073113

Schwan, D., et al., 2011, "The APEX-SZ Instrument", *Review of Scientific Instruments*, 82, 091301

Basu, K., et al., 2010, "Non-parametric modeling of the intra-cluster gas using APEX-SZ bolometer imaging data", *Astronomy & Astrophysics*, 519, 29

Nord, M., et al., 2009, "Multi-frequency imaging of the galaxy cluster Abell 2163 using the Sunyaev-Zel'dovich Effect", *Astronomy & Astrophysics*, 506, 623

Reichardt, C.L., et al., 2009, "Constraints on the High-ℓ Power Spectrum of Millimeter-wave Anisotropies from APEX-SZ",*The Astrophysical Journal*, 701, 1958

Halverson, N.W., et al., 2009, "Sunyaev-Zel'dovich Effect Observations of the Bullet Cluster (1E 0657-56) with APEX-SZ", *The Astrophysical Journal*, 701, 42

Mehl, J., et al., 2008, "TES Bolometer Array for the APEX-SZ Camera", *Journal of Low Temperature Physics*, 151, 697

NON-REFEREED PUBLICATIONS

Carlstrom, J., et al., 2019, "CMB-S4", *White Paper submitted to the 2020 Decadal Survey on Astronomy and Astrophysics*

Moravec, E., et al., 2019, "The Early Career Perspective on the Coming Decade, Astrophysics Career Paths, and the Decadal Survey Process", *White Paper submitted to the 2020 Decadal Survey on Astronomy and Astrophysics*

Abazajian, K., et al., 2019, "CMB-S4 Science Case, Reference Design, and Project Plan", *arXiv:1907.04473*

Lowitz, A. E., Bender, A.N., et al., 2018, "Digital frequency multiplexing with sub-Kelvin SQUIDs", *Proceedings of the SPIE*,10708, 107081D

Harke-Hosemann, A., Bender, A. N., et al., 2018, "Investigation of magnetic shielding for superconducting readout", *Proceedings of the SPIE*,10708, 1070846

Dutcher, D., et al., 2018, "Characterization and performance of the second-year SPT-3G focal plane", *Proceedings of the SPIE*,10708, 107081Z

Nadolski, A. et al., 2018, "Broadband anti-reflective coatings for cosmic microwave background experiments", *Proceedings of the SPIE*,10708,1070843

Sobrin, J., et al., 2018, "Design and characterization of the SPT-3G receiver", *Proceedings of the SPIE*,10708, 107081H

"CMB-S4 Technology Book, First Edition", 2017, arXiv:1706.02464

Bender, A.N., et al., 2016, "Integrated Performance of a Frequency Domain Multiplexing Readout in the SPT-3G Receiver", *Proceedings of the SPIE*, 9914, 99141D

Posada, C., et al., 2016, "Large arrays of dual-polarized multichroic TES detectors for CMB measurements with the SPT-3G receiver", *Proceedings of the SPIE*, 9914, 991417

Stebor, N., et al., 2016, "The Simons Array CMB polarization experiment", *Proceedings of the SPIE*, 9914, 99141H

Benson, B.A., et al., 2014, "SPT-3G: A Next-Generation Cosmic Microwave Background Polarization Experiment on the South Pole Telescope", *Proceedings of the SPIE*, 9153, 91531P

Hattori, K., et al., 2014, "Optimization of cold resonant filters for frequency domain multiplexed readout of POLARBEAR-2",*Proceedings of the SPIE*, 9153, 91531B

Barron, D., et al., 2014, "Developement and characterization of the readout system for POLARBEAR-2", *Proceedings of the SPIE*, 9153, 915335

Arnold, K., et al., 2014, "The Simons Array: expanding POLARBEAR to three multi-chroic telescopes", *Proceedings of the SPIE*, 9153, 91531F

Inoue, Y., et al., 2014, "Thermal and optical characterization for POLARBEAR-2 optical system", *Proceedings of the SPIE*, 9153, 91533A

George, E.M., et al., 2012, "Performance and on-sky characterization of the SPTpol instrument", *Proceedings of the SPIE*, 8452

Austermann, J.E., et al., 2012, " SPTpol: an instrument for CMB polarization measurements with the South Pole Telescope", *Proceedings of the SPIE*, 8452

Story, K., Leitch, E., et al., 2012, "South Pole Telescope software systems: control, monitoring , and data acquisition", *Proceedings of the SPIE*, 8452

Bender, A.N. "Galaxy Cluster Scaling Relations with APEX-SZ", Ph.D. thesis, 2011

TALKS & PRESENTATIONS

May 2020	**Invited Talk**: "The bright future of cosmology with SPT-3G", Fermilab, Particle Astrophysics Seminar
April 2020	"CMB-S4 Instrumentation", April APS Physics Meeting
March 2020	**Invited Talk**: "The bright future of cosmology with SPT-3G", Argonne National Laboratory, High Energy Physics Seminar
July 2019	"On sky performance of the SPT-3G frequency-domain multiplexed readout", 18th International Workshop on Low Temperature Detectors
April 2019	**Invited Talk**: "Cosmology, the cosmic microwave background, and the technology that makes it possible", University of Illinois at Urbana-Champaign, Astrophysics, Gravitation, and Cosmology Seminar
Nov 2018	**Invited Talk**: "Multiplexed readout of TES bolometers for the South Pole Telescope", Applied Superconductivity Conference
June 2018	**Invited Talk**: "CMB with the South Pole Telescope (SPT-3G and SPTpol) and planning for 'Stage 4' (S4)", Fermilab Users Meeting
June 2018	"Year 2 instrument status from the SPT-3G cosmic microwave background receiver", International Society for Optics and Photonics Astronomical Telescopes and Instrumentation Meeting
Mar 2018	"Year 2 Update from the SPT-3G Cosmic Microwave Background Experiment", Recontres de Moriond, Cosmology Session
July 2017	**Invited Talk**, "Recent Progress from the SPT-3G Experiment",Meeting of the Division of Particles and Fields of the American Physical Society
May 2017	**Invited Talk**: "Cosmic Microwave Background Measurements with the South Pole Telescope", Recontres de Blois

April 2017	**Invited Talk**: "The South Pole Telescope: Searching for cosmological answers with the CMB", University of Iowa, Physics Colloquium
March 2017	**Invited Talk**: "The South Pole Telescope: Searching for cosmological answers with the CMB", Northwestern University, Astrophysics Seminar
Aug. 2016	"Superconducting Detector Development for the SPT-3G Cosmic Microwave Background Experiment", poster presentation at the 38th International Conference on High Energy Physics
July 2016	"Integrated Performance of a Frequency Domain Multiplexing Readout in the SPT-3G Receiver", International Society for Optics and Photonics Astronomical Telescopes and Instrumentation Meeting
June 2016	**Invited Talk**:"Building a Next-Generation Cosmic Microwave Background Experiment", Argonne National Laboratory, High Energy Physics Seminar
March 2016	"Measurements of the Cosmic Microwave Background Polarization with the South Pole Telescope Polarization Receiver (SPTpol)", Recontres de Moriond, Cosmology Session
Jan. 2016	**Invited Talk**:"Advances in Millimeter-Wavelength Instrumentation with the South Pole Telescope", Fermi National Accelerator Laboratory, Particle Astrophysics Seminar
Aug. 2015	"SPT-3G: The Next Generation Receiver for Polarized Cosmic Microwave Background Measurements with the South Pole Telescope", Meeting of the Division of Particles and Fields of the American Physical Society
July 2015	"SPT-3G: The Next Generation Receiver for the South Pole Telescope", 16th International Workshop on Low Temperature Detectors
March 2015	"SPT-3G Readout Electronics: Design and Commissioning", Kavli Institute for Cosmological Physics Postdoctoral Winter Symposium
June 2014	"Digital Frequency Domain Multiplexing Readout Electronics for the Next Generation of Millimeter Telescopes", International Society for Optics and Photonics Astronomical Telescopes and Instrumentation Meeting
Feb. 2014	**Invited Talk**: "Advances in Cosmology and Millimeter-Wavelength Instrumentation with the South Pole Telescope", Argonne National Laboratory High Energy Physics Division Seminar
May 2013	**Invited Talk**: "Measurements of the CMB Polarization with the South Pole Telescope", Congress of the Canadian Association of Physicists
Jan. 2011	**Invited Talk:** "Sunyaev-Zel'dovich Scaling Relations with APEX-SZ", McGill University astrophysics seminar
Jan. 2011	"Measuring Sunyaev-Zel'dovich Scaling Relations with APEX-SZ", Winter meeting of the American Astronomical Society
Mar. 2010	"Recent Results with APEX-SZ", SnowPAC Conference, Utah
July 2009	"APEX-SZ Data Analysis Techniques", Sunyaev-Zel'dovich Clusters workshop, Bonn, Germany
May 2009	"Measuring Sunyaev-Zel'dovich Scaling Relations with APEX-SZ", American Physical Society April Meeting
Aug. 2006	"The Evolution of Galaxy Populations in Clusters Along the Road to Coma", poster, International Astronomical Union General Assembly

Jan. 2004	"The Massive Black Hole in the Dwarf Galaxy NGC 4486B", poster, Winter meeting of American Astronomical Society
Jan. 2004	"Quantifying the Local Environment of Low Redshift Quasars", poster, Winter meeting of American Astronomical Society

HONORS & AWARDS

2017	Physical Sciences and Engineering Excellence Award Argonne National Laboratory
2011 - 2014	Astronomy and Astrophysics Postdoctoral Fellowship Dept. of Physics, McGill University
2007	Chance Irick Cooke Graduate Fellowship Dept. of Astrophysics and Planetary Sciences, University of Colorado at Boulder
2007	Departmental Teaching Assistant Award Dept. of Astrophysics and Planetary Sciences, University of Colorado at Boulder
2006	Parmenter Graduate Fellowship Dept. of Astrophysics and Planetary Sciences, University of Colorado at Boulder
2005	Returning Graduate Student Supplemental Fellowship Dept. of Astrophysics and Planetary Science, University of Colorado at Boulder
2004	Phi Beta Kappa University of Illinois at Urbana-Champaign
2004	Laura B. Eisenstein Award Dept. of Physics, University of Illinois at Urbana-Champaign
2004	Stanley P. Wyatt Memorial Award Dept. of Astronomy, University of Illinois at Urbana-Champaign

STUDENT AND POSTDOCTORAL MENTORING

2020 - present	Riccardo Gualtieri (postdoctoral researcher, Argonne National Laboratory)
2019	Margaret Panetta (graduate researcher, University of Chicago)
2018 - 2020	Amy Lowitz (postdoctoral researcher, University of Chicago)
2017 - 2018	Angelina Harke-Hosemann (undergraduate researcher & post-baccalaureate research assistant, Argonne National Laboratory)
2015 - 2017	Lauren Saunders (undergraduate researcher, University of Chicago; post-baccalaureate research assistant, Argonne National Laboratory)
2014 - 2017	Anthony Corso (undergraduate researcher, University of Chicago)
2014	Gabrielle Cole (graduate researcher, University of Chicago)
2013 - 2014	Amy Tang (undergraduate researcher, McGill University)
2011 - 2014	Joshua Montgomery (graduate researcher, McGill University)

SYNERGISTIC ACTIVITIES

2018 - present	Reviewer for DOE
2019	Scientific organizing committee for CMB-S4 collaboration meeting
2018 - 2020	Member of governing board for CMB-S4 collaboration
2018	Delegate at Early Career Focus Session for the Astro2020 Decadal Survey on Astronomy and Astrophysics
2018	Local organizing committee and organizer of parallel session on readout technology at CMB-S4 workshop
2017	Kavli Roundtable on "Astrophysics at the Ends of the Earth"
2016	Session convener for CPAD Instrumentation Frontier Meeting
2016 - present	Co-creator and organizer of Young Scientist Symposium for Argonne High Energy Physics Division
2015 - present	Adler Planetarium Astronomy Conversations Program Presenter
2013	"The South Pole Telescope: Observing the Infant Universe from the End of the World" Public lecture for Astro McGill Public Astronomy Night
2012 - 2014	Astro McGill Public Outreach Group Activities include hosting monthly public lectures followed by observing and lab tours, primary school visits, and hosting special events such as the Quebec-wide "24 hours of Science".
2012 - 2014	Women in Physics Committee at McGill
2004 - 2011	Volunteer host for Friday night public open house at Sommers-Bausch Observatory Volunteer host for Astronomy Day University of Colorado at Boulder
2004 - 2011	Student Representative on Departmental Committees Dept. of Astrophysics and Planetary Sciences, University of Colorado at Boulder *2005:* Graduate Admissions *2006:* Graduate Admissions, Graduate Exams *2007:* Student Representative to Faculty Meetings *2008:* Student Representative to Faculty Meetings

TEACHING EXPERIENCE

2017	**CMB Detectors and Instrumentation**, Instructor for summer school, Kavli Institute for Cosmological Physics
2012	**Galaxies & Cosmology: The CMB** Co-Instructor for graduate course, Dept. of Physics, McGill University
2004 - 2007	Teaching Assistant Dept. of Astrophysics and Planetary Sciences, University of Colorado at Boulder 2006, 2007: **Observations and Instrumentation 1** Laboratory section instructor for upper level astronomy course. 2004, 2005: **Introductory Astronomy** Laboratory section instructor. 2007: Grading Assistant