
Research Interests

Experimental searches for **axion dark matter** using **quantum sensors**

Education

Massachusetts Institute of Technology

Ph.D., Department of Physics 2022

University of North Carolina Chapel Hill

B.S. Physics and Mathematics, Highest Honors, Highest Distinction 2017

Awards and Honors

Rising Stars in Physics

Workshop for outstanding young women physicists 2023

Martin and Beate Block Winter Award

For outstanding achievements by a promising young physicist, Aspen Center for Physics 2023

Porat Fellow

Kavli Institute for Particle Astrophysics and Cosmology (KIPAC), Stanford/SLAC 2022

Dr. Pliny A. and Margaret H. Price Prize

Ohio State University CCAPP 2020

NSF Graduate Research Fellow

2018–2021

MIT Presidential Fellow

2017–2018

Paul E. Shearin Outstanding Senior Award in Physics

UNC Chancellor's Award 2017

Senior Thesis Highest Honors

Magnet Simulations for ABRACADABRA 2017

Phi Beta Kappa

2016

Daniel C. Johnson Award

Award for outstanding junior in the UNC Physics and Astronomy Department 2016

Goldwater Scholar

National scholarship for students pursuing research careers in STEM 2016

Honors Carolina

2013–2017

Appointments

Postdoctoral fellow, axion dark matter and quantum sensing

KIPAC, Stanford University and SLAC 2022–present

Graduate researcher, axion dark matter

Winslow group, Laboratory for Nuclear Science, MIT 2017–2022

Undergraduate researcher, particle astrophysics

Henning group, UNC Chapel Hill 2013–2017

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| Undergraduate research intern, ADMX <i>Fermi National Accelerator Laboratory (Fermilab)</i> | Summer 2016 |
| Undergraduate research intern, ATLAS <i>Organisation Européenne pour la Recherche Nucléaire (CERN)</i> | Fall 2015 |
| Undergraduate research intern, MAJORANA Demonstrator <i>Lawrence Berkeley National Laboratory (LBNL)</i> | Summer 2015 |
| Undergraduate researcher, radio astronomy <i>Reichart group, UNC Chapel Hill</i> | 2014–2015 |

Research and Scientific Collaborations

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| DMRadio | |
| <ul style="list-style-type: none"> ◦ Leading calibration team ◦ Developing SQUID amplifier chain for m^3 experiment ◦ Optimized 50 L (1st generation) dark matter coupling ◦ Worked on alternatives analysis for m^3 detector geometry ◦ Led the proposal for a definitive, large-scale experiment for GUT-scale QCD axions | 2019-present |
| BREAD | |
| <ul style="list-style-type: none"> ◦ Developing qubit-based THz photon sensors ◦ Leading calculations and simulations for TeraBREAD sensitivity determination | 2023-present |
| ADMX-VERA | |
| <ul style="list-style-type: none"> ◦ Advising on the cryomechanical design of the cold experiment | 2023-present |
| ABRACADABRA-10 cm | |
| <ul style="list-style-type: none"> ◦ Designed, constructed, and ran the experiment ◦ Wrote data processing software to FFT long time series datasets ◦ Led the upgrades for runs 2 and 3 ◦ Led the run 2/3 data calibration and contributed to data analysis | 2016-present |
| ADMX | |
| <ul style="list-style-type: none"> ◦ Ran electromagnetic field simulations for multi-cavity designs ◦ Simulated and tested coplanar waveguide resonators to develop nonlinear dielectric tuning | Summer 2016 |
| ATLAS | |
| <ul style="list-style-type: none"> ◦ Analyzed the Higgs diphoton decay channel | Fall 2015 |
| MAJORANA Demonstrator | |
| <ul style="list-style-type: none"> ◦ Designed and tested low-background front-end amplifiers ◦ Analyzed data to measure cosmogenic activation of tritium in germanium | 2014-2016 |
| Skynet Robotic Telescope Network and Green Bank Observatory | |
| <ul style="list-style-type: none"> ◦ Wrote software for radio telescope mapping and statistical analyses | 2014-2015 |
| CALIOPE | |
| <ul style="list-style-type: none"> ◦ Ran Geant4 Monte Carlo detector simulations for tests of CP and CPT violation | 2014-2015 |

Publications

- [13] S. Knirck et al. *First Results from a Broadband Search for Dark Photon Dark Matter in the 44 to 52 μeV range with a coaxial dish antenna*. 2023. arXiv: 2310.13891 [hep-ex].
- [12] *C. W. Fink et al. *The Superconducting Quasiparticle-Amplifying Transmon: A Qubit-Based Sensor for meV Scale Phonons and Single THz Photons*. 2023. arXiv: 2310.01345 [physics.ins-det].

- [11] J. N. Benabou et al. “Lumped-element axion dark matter detection beyond the magnetoquasistatic limit”. In: *Phys. Rev. D* 108 (3 Aug. 2023), p. 035009. DOI: 10.1103/PhysRevD.108.035009. URL: <https://link.aps.org/doi/10.1103/PhysRevD.108.035009>.
- [10] A. AlShirawi et al. *Electromagnetic modeling and science reach of DMRadio- m^3* . 2023. DOI: 10.48550/ARXIV.2302.14084. URL: <https://arxiv.org/abs/2302.14084>.
- [9] * L. Brouwer et al. “Proposal for a definitive search for GUT-scale QCD axions”. In: *Phys. Rev. D* 106 (11 Dec. 2022), p. 112003. DOI: 10.1103/PhysRevD.106.112003. URL: <https://link.aps.org/doi/10.1103/PhysRevD.106.112003>.
- [8] L. Brouwer et al. “Projected sensitivity of DMRadio- m^3 : A search for the QCD axion below $1\mu\text{eV}$ ”. In: *Phys. Rev. D* 106 (10 Nov. 2022), p. 103008. DOI: 10.1103/PhysRevD.106.103008. URL: <https://link.aps.org/doi/10.1103/PhysRevD.106.103008>.
- [7] C. B. Adams et al. *Axion Dark Matter (Snowmass 2021 White Paper)*. 2023. arXiv: 2203.14923 [hep-ex].
- [6] * C. P. Salemi et al. “Search for Low-Mass Axion Dark Matter with ABRACADABRA-10 cm”. In: *Phys. Rev. Lett.* 127 (8 Aug. 2021), p. 081801. DOI: 10.1103/PhysRevLett.127.081801. URL: <https://link.aps.org/doi/10.1103/PhysRevLett.127.081801>.
- [5] * C. P. Salemi. “First Results from ABRACADABRA-10 cm: A Search for Low-Mass Axion Dark Matter”. In: *Proceedings of the 54th Rencontres de Moriond: Electroweak Interactions and Unified Theories*. Ed. by Étienne Augé, Jacques Dumarchez, and Jean Trân Thanh Vân. ARISF, 2019, pp. 229–234.
- [4] J. L. Ouellet et al. “First Results from ABRACADABRA-10 cm: A Search for Sub- μeV Axion Dark Matter”. In: *Phys. Rev. Lett.* 122 (12 Mar. 2019), p. 121802. DOI: 10.1103/PhysRevLett.122.121802. URL: <https://link.aps.org/doi/10.1103/PhysRevLett.122.121802>.
- [3] J. L. Ouellet et al. “Design and implementation of the ABRACADABRA-10 cm axion dark matter search”. In: *Phys. Rev. D* 99 (5 Mar. 2019), p. 052012. DOI: 10.1103/PhysRevD.99.052012. URL: <https://link.aps.org/doi/10.1103/PhysRevD.99.052012>.
- [2] J. R. Martin et al. “Skynet Algorithm for Single-dish Radio Mapping. I. Contaminant-cleaning, Mapping, and Photometering Small-scale Structures”. In: *The Astrophysical Journal Supplement Series* 240.1 (Jan. 2019), p. 12. DOI: 10.3847/1538-4365/aad7c1. URL: <https://doi.org/10.3847/1538-4365/aad7c1>.
- [1] M. P. Maples et al. “Robust Chauvenet Outlier Rejection”. In: *The Astrophysical Journal Supplement Series* 238.1 (Aug. 2018), p. 2. DOI: 10.3847/1538-4365/aad23d. URL: <https://doi.org/10.3847/1538-4365/aad23d>.

* paper for which I am a corresponding author

Invited Talks

Caltech (seminar)

Qubit-based sensing for axion dark matter
HEP Seminar

Pasadena, CA

Oct 2023

IBS/CAPP (seminar)

DMRadio: Searching for Low-Mass Axion Dark Matter
Center for Axion and Precision Physics Research

Daejeon, South Korea

July 2023

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| Fermilab (seminar) <i>Seeing the Invisible: The Search for Low-Mass Axion Dark Matter</i> Cosmic Physics Center Seminar | Batavia, IL May 2023 |
| Prospecting for New Physics through Flavor, Dark Matter, and Machine Learning <i>Seeing the Invisible: The Search for Low-Mass Axion Dark Matter</i> Aspen Center for Physics Conference | Aspen, CO Mar 2023 |
| King's College London (seminar) <i>Seeing the Invisible: The Search for Low-Mass Axion Dark Matter</i> EPAP Seminar | Virtual Dec 2022 |
| FISICA Workshop <i>Lumped element detection for low-mass axions: ABRACADABRA and DMRadio</i> | Virtual Mar 2022 |
| Lawrence Berkeley National Laboratory (seminar) <i>Seeing the Invisible: The Search for Low-Mass Axion Dark Matter</i> Institute for Nuclear and Particle Astrophysics Seminar | Virtual Dec 2021 |
| Kavli Institute for Particle Astrophysics and Cosmology, Stanford <i>Seeing the Invisible: The Search for Low-Mass Axion Dark Matter</i> KIPAC Tea | Virtual Dec 2021 |
| Yale (seminar) <i>Seeing the Invisible: The Search for Low-Mass Axion Dark Matter</i> Mossman Seminar | Virtual Dec 2021 |
| Laboratory for Nuclear Science, MIT (seminar) <i>Seeing the Invisible: The Search for Low-Mass Axion Dark Matter</i> Lunchtime Seminar | Cambridge, MA Nov 2021 |
| Johns Hopkins University (seminar) <i>Seeing the Invisible: The Search for Low-Mass Axion Dark Matter</i> Experimental HEP Seminar | Virtual May 2021 |
| Rutgers University (seminar) <i>Seeing the Invisible: The Search for Low-Mass Axion Dark Matter</i> High Energy Experiment Seminar | Virtual Apr 2021 |
| Project 8 collaboration meeting (seminar) <i>The Search for Low-Mass Axion Dark Matter</i> External Speaker | Virtual Mar 2021 |
| CENPA, University of Washington (mini-seminar) <i>Seeing the Invisible: The Search for Low-Mass Axion Dark Matter</i> CENPA Monday Meeting | Virtual Mar 2021 |
| Axions Beyond Gen 2 Workshop <i>Lumped Element Searches for Low-Mass Axion Dark Matter</i> | Virtual Jan 2021 |
| Boston University (seminar) <i>The Search for Low-Mass Axion Dark Matter</i> Student Seminar | Virtual Dec 2020 |
| University of Illinois Urbana-Champaign (seminar) <i>The Search for Low-Mass Axion Dark Matter</i> HEP/MEP Seminar | Virtual Nov 2020 |
| CCAPP, Ohio State University (seminar) <i>The Search for Low-Mass Axion Dark Matter</i> Price Prize Seminar | Virtual Sep 2020 |

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| Rencontres de Moriond <i>First Results from ABRACADABRA-10 cm</i> | La Thuile, Italy Mar 2019 |
| Purdue University (seminar) <i>First Results from ABRACADABRA-10 cm</i> Particle Physics Seminar | West Lafayette, IN Nov 2018 |
| Wright Laboratory, Yale (seminar) <i>ABRACADABRA: A Search for Low-Mass Axion Dark Matter</i> Weak Interactions Discussion Group Seminar | New Haven, CT May 2018 |

Other Talks

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| Topics in Astroparticle and Underground Physics (TAUP) <i>The Search for Low-Mass Axion Dark Matter with DMRadio</i> | Vienna, Austria Aug 2023 |
| Rising Stars in Physics Workshop <i>Seeing the Invisible: the Search for Axion Dark Matter</i> | Berkeley, CA May 2023 |
| APS April Meeting <i>Recent results from the ABRACADABRA-10 cm search for low-mass axion dark matter</i> | Virtual Apr 2021 |
| Laboratory for Nuclear Science, MIT (seminar) <i>Axion Cosmology</i> Student Lunch Seminar | Virtual Apr 2020 |
| APS Division of Particles and Fields Meeting <i>The Search for Low-Mass Axions with ABRACADABRA-10 cm: Preparations for Run 2</i> | Boston, MA July 2019 |
| APS April Meeting <i>COMSOL Simulations for ABRACADABRA</i> | Denver, CO Apr 2019 |
| Laboratory for Nuclear Science, MIT (seminar) <i>ABRACADABRA: A Search for Low-Mass Axion Dark Matter</i> Student Lunch Seminar | Cambridge, MA Apr 2018 |

Posters

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| Low-Temperature Detectors (LTD20) Conference <i>Qubit-Based Sensing of THz Photons and Phonons for Dark Matter Detection</i> | Daejeon, South Korea July 2023 |
| Quantum Information and Systems for Fundamental Physics Conference <i>ABRACADABRA: Searching for Low-Mass Axion Dark Matter</i> | Aspen, CO Feb 2020 |
| Dept of Physics, MIT <i>First Results from ABRACADABRA-10 cm, A Search for Low-Mass Axion Dark Matter</i> Won second prize at open house poster session | Cambridge, MA Apr 2018 |
| UCLA Dark Matter <i>ABRACADABRA: A Search for Low-Mass Axion Dark Matter</i> | Los Angeles, CA Feb 2018 |
| Division of Nuclear Physics (DNP) Fall Meeting <i>Microwave cavity tuning with nonlinear dielectric films for axion searches</i> Awarded funding by the Conference Experience for Undergraduates (CEU) | Vancouver, Canada Oct 2016 |
| 38th International Conference on High Energy Physics (ICHEP) <i>Tuning microwave cavities with biased nonlinear dielectrics for axion searches</i> | Chicago, IL Aug 2016 |
| Division of Nuclear Physics (DNP) Annual Fall Meeting <i>Testing new designs for the MAJORANA DEMONSTRATOR's low-mass front-end board</i> | Santa Fe, NM Oct 2015 |

Awarded maximum funding by the Conference Experience for Undergraduates (CEU)

Teaching

Teaching Assistant

MIT graduate particle physics, 8.811

Fall 2019, 2020, 2021

Physics and math tutor

UNC Physics Tutorial Center

Spring 2016

Service and Outreach

Journal Referee

Physical Review D

Cosmology and dark matter lecture

SPINWIP program for high school girls, KIPAC, Stanford University

July 2023

Public lecture—Shining light on dark matter

KIPAC Community Day, Stanford University

April 2023

Booth volunteer (WIMP dark matter)

KIPAC Community Day, Stanford University

April 2023

Faculty hiring pre-search committee member

MIT Laboratory for Nuclear Science

Spring & Fall 2021

Application reviewer for MIT Summer Research Program (MSRP)

MIT

2021

University-wide internship program for under-represented minority undergraduates

Mentor in Undergraduate Mentoring Program

MIT Physics Department

Fall 2020

Mentor in Graduate Student Buddy Program

MIT Physics Department

2018–2020

Founded and organized neutrinos and dark matter journal club

MIT Laboratory for Nuclear Science

2018–2020

Mentor in Graduate/Undergraduate Women in Physics Buddy Program

MIT Physics Department

Fall 2019

Girl's Day activity leader

MIT Museum

2017

On-campus outreach director

Carolina Women in Physics (WiP)

2016–2017

Tour co-leader for two elementary school programs

Morehead Observatory, UNC

2016