Cristian Daniel Panda

CONTACT INFORMATION

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Tucson, AZ 85701

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EDUCATION

Harvard University, Cambridge, MA — 2012 - 2018

Ph.D. in Physics, December 2018
A.M. in Physics, May 2015

Dissertation Title: *Order of magnitude improved limit on the electron's electric dipole moment*
Dissertation Advisor: Gerald Gabrielse

Reed College, Portland, OR — 2008 - 2012

B.A. in Physics, May 2012

Senior Thesis Title: *The role of delay in the isochronal chaos synchronization of delay-coupled opto-electronic oscillators*
Senior Thesis Advisor: Lucas Illing
Academic Advisor: John Essick

HONORS AND AWARDS

Deborah Jin DAMOP Thesis Prize Finalist, 2021
Purcell Fellowship, Harvard University, 2012-2013
Phi Beta Kappa, 2012
Reed College Commendation for Excellence, 2008-2012

RESEARCH EXPERIENCE

University of Arizona — October 2024 - Present

Probing the effects of gravity and other fundamental forces on ultra-sensitive atom interferometry experiments. Testing the limits of coherence of quantum superposition and entanglement states at the minute-scale. Developing quantum sensors for industrial and consumer applications

University of California, Berkeley *with Holger Muller* — March 2019 - October 2024

Developing a lattice atomic intereferometer with record coherence beyond 60 seconds. Measuring the gravitational field of a miniature mass with accuracy surpassing free-fall atom gravimeters. Exploring lattice interferometer applications to precision measurements of new inertial forces and interactions

Harvard University, Northwestern University — December 2018 - March 2019

Advanced techniques for the third generation of the Advanced Cold Molecule Electric Dipole Moment (ACME) experiment

Harvard University *with Gerald Gabrielse* — December 2012 - December 2018

Searched for signals of a permanent electron electric dipole moment (eEDM) in the molecule thorium oxide (ThO), probing new physics at the terra electron volt scale. This work was performed as part of the Advanced Cold Molecule Electric Dipole Moment (ACME) collaboration

Reed College *with Lucas Illing* — May 2010 - July 2012

Studied parameters and network topologies leading to isochronous synchronization behavior of chaotic oscillators, and the role of delayed feedback for synchronization

Reed College Research Reactor September 2009 - May 2011

Performed nuclear physics research as a licensed operator using nuclear activation analysis techniques at the Reed College Research Reactor

Teaching Experience

Harvard University, Teaching Fellow
Physics 123/223: The Art of Electronics — Spring 2018

Reed College, Teaching Assistant
Physics 100: General Physics I — Fall 2010 - Spring 2012

Reed College, Grader
Physics 367: Computational Methods for Physics — Spring 2011
Physics 100: General Physics I — Fall 2009 - Spring 2010

Invited Talks

Matter-wave interferometry with atoms held in an optical lattice for one minute
Precision Atomic Physics Experiments to Probe for New Physics, Bad Honeff, Germany, September 25, 2024

Quantum Metrology with an Optical Lattice Atom Interferometer Interrogated for One Minute
University of Arizona Optics Seminar, Tucson, AZ, February 27, 2024

How to measure gravity by holding atoms
Lake Louise Winter Institute, Alberta, Canada, February 23, 2024

Quantum metrology with an optical lattice atom interferometer interrogated for one minute
University of Wisconsin Madison Physics Seminar, Madison, WI, February 12, 2024

Using minute-long quantum superposition states to probe gravity
Reed College Physics Seminar, Portland, OR, March 8, 2023

Probing gravity with trapped atoms: Atom interferometry with minute coherence
Northwestern Center for Fundamental Physics Colloquium, Evanston, IL, February 14, 2023

Probing gravity with trapped atoms: Atom interferometry with minute coherence
Gordon Research Conference, Ventura, CA, June 21, 2022

Probing gravity with trapped atoms: The optical lattice atom interferometer
Ninth Meeting on CPT and Lorentz Symmetry, online, May 17, 2022

Probing gravity with trapped atoms: The optical lattice atom interferometer
Testing Quantum Aspects of Gravity in the Laboratory, online, March, 2022

Probing TeV Physics with Molecules: The Search for the Electron's EDM
California State University East Bay AMO Seminar, Hayward, CA, October 15, 2021

Probing gravity with trapped atoms: the optical lattice atom interferometer
Challenges for Witnessing Quantum Aspects of Gravity in a Lab, online, June 7-11, 2021

Probing TeV Physics with the ThO Molecule: Twelve-fold Improved Measurement of the Electron's EDM
APS Division of Atomic, Molecular and Optical Physics 2021, online, June 1, 2021

Probing gravity with trapped atoms: the optical lattice atom interferometer

SPIE Photonics West, online, March 3, 2021

Atom Interferometry for Fundamental Physics
DND 2020: Developing New Directions in Fundamental Physics, online, November 4 - 6, 2020

Order of Magnitude Improved Limit of the Electron Electric Dipole Moment
Fundamental Physics Using Atoms Conference, Okinawa, Japan, March 1 - 4, 2019

Order of Magnitude Improved Limit of the Electron Electric Dipole Moment
University of Massachusetts - Amherst, Amherst, MA, December 15, 2018

Probing TeV physics with ThO: Order of Magnitude Improved Limit on the Electron Electric Dipole Moment
Stanford University, Palo Alto, CA, November 6, 2018

Probing TeV physics with ThO: Order of Magnitude Improved Limit on the Electron Electric Dipole Moment
University of California - Berkeley, AMOQI Seminar, Berkeley, CA, October 26, 2018

Probing TeV physics with ThO: Order of Magnitude Improved Limit on the Electron Electric Dipole Moment
University of Toronto, Quantum Optics and AMO Physics Seminars, Toronto, Canada, October 12, 2018

Search for the Electric Dipole Moment of the Electron
Discrete Symmetries in Particle, Nuclear and Atomic Physics and Implications for Our Universe, Trento, Italy, October 8 - 12, 2018

STIRAP in Precision Experiments: New Limits for the Electric Dipole Moment of the Electron
Stimulated Raman Adiabatic Passage International Symposium, Kaiserslautern, Germany, September 22 - 25, 2015

Phase Dynamics and Synchronization of Delay-coupled Optoelectronic Oscillators
Departmental Seminar Talk, Reed College, Portland, OR, April 25, 2012

Isochronous Chaos Synchronization of Delay-coupled Optoelectronic Oscillators
Departmental Seminar Talk, Reed College, Portland, OR, September 15, 2010

Conference Presentations

Molecule trapping in a buffer-gas-loaded optical dipole trap: a platform for future precision measurements
55th Annual Meeting of the APS Division of Atomic, Molecular and Optical Physics, Fort Worth, Texas, June 6, 2024 (poster)

Precision Measurement of Gravity in a Lattice Atom Interferometer
55th Annual Meeting of the APS Division of Atomic, Molecular and Optical Physics, Fort Worth, Texas, June 6, 2024 (talk)

Probing Gravity with Trapped Atoms: Atom Interferometry with Minute Coherence
Gordon Research Conference Atomic Physics, Newport, RI, June 13, 2023 (poster)

Quantum Metrology with a Trapped Atom Interferometer Interrogated for One Minute
54th Annual Meeting of the APS Division of Atomic, Molecular and Optical Physics, Spokane, WA, June 6, 2023 (talk)

Probing Gravity with Trapped Atoms: Atom Interferometry with Minute Coherence
54th Annual Meeting of the APS Division of Atomic, Molecular and Optical Physics, Spokane, WA, June 8, 2023 (poster)

Probing Gravity with Trapped Atoms: Atom Interferometry with Minute Coherence
53rd Annual Meeting of the APS Division of Atomic, Molecular and Optical Physics, Orlando, FL, June 2, 2022 (talk)

Lattice Atom Interferometry in an Optical Cavity
53rd Annual Meeting of the APS Division of Atomic, Molecular and Optical Physics, Orlando, Fl, June 2, 2022 (poster)

Probing Gravity with Trapped Atoms: the Optical Lattice Atom Interferometer
51th Annual Meeting of the APS Division of Atomic, Molecular and Optical Physics, online, June 1 - 5, 2020 (talk)

Probing Gravity by Holding Atoms for 20 Seconds
Godon Research Conference Atoms and Molecules, Ultrafast Spectroscopy and Precision Measurements, Newport, RI, June 9 - 14, 2019 (poster)

Progress Towards an Order of Magnitude Improved ACME II Measurement of the Electron Electric Dipole Moment
49th Annual Meeting of the APS Division of Atomic, Molecular and Optical Physics, Fort Lauderdale, FL, May 28 - Jun 1, 2018 (talk)

Twelve-fold Increase in the Number of Usable ThO Molecules for the ACME Electron Electric Dipole Measurement Through STIRAP
47th Annual Meeting of the APS Division of Atomic, Molecular and Optical Physics, Providence, RI, May 23 - 27, 2016 (poster)

The Second Generation ACME Electron EDM Experiment
5th International Symposium on Lepton Moments, Centerville, MA, July 21 - 24, 2014 (poster)

The Second Generation ACME Electron EDM Experiment
45th Annual Meeting of the APS Division of Atomic, Molecular and Optical Physics, Madison, WI, June 2 - 6, 2014 (poster)

Isochronal Chaos Synchronization of Delay-coupled Optoelectronic Oscillators
13th Annual Meeting of the Northwest Section of the APS, Corvallis, OR, October 20 - 22, 2011 (poster)

Isochronous Chaos Synchronization of Delay-coupled Optoelectronic Oscillators
12th Annual Meeting of the Northwest Section of the APS, Walla Walla, WA, September 30 - October 2, 2010 (poster)

Publications

Measuring gravitational attraction with a lattice atom interferometer
Cristian D. Panda, Matthew J. Tao, Miguel Ceja, Justin Khoury, Guglielmo M. Tino, and Holger Müller, *Nature* **631**, 515–520 (2024).

Minute-scale gravimetry using a coherent atomic spatial superposition
Cristian D. Panda, Matt Tao, James Eggelhof, Miguel Ceja, Andrew Reynoso, Victoria Xu, Holger Muller, *Nature Physics* **20**, 1234–1239 (2024).

Atomic gravimeter robust to environmental effects

Cristian D. Panda, Matt Tao, Miguel Ceja, Andrew Reynoso, Holger Müller, *Appl. Phys. Lett.* **123**, 064001 (2023).

Dynamics of a buffer-gas-loaded, deep optical trap for molecules
Ashwin Singh, Lothar Maisenbacher, Ziguang Lin, Jeremy Axelrod, Cristian Panda, Holger Müller, *Phys. Rev. Research* **5**, 033008 (2023).

High-sensitivity low-noise photodetector using large-area silicon photomultiplier
Takahiko Masuda, Ayami Hiramoto, Daniel G. Ang, Cole Meisenhelder, Cristian D. Panda, Noboru Sasao, Satoshi Uetake, Xing Wu, David P. DeMille, John M. Doyle, Gerald Gabrielse, Koji Yoshimura, *Opt. Express* **31**, 1943-1957 (2023).

Probing gravity for one minute with an optical lattice atom interferometer
C. D Panda, M. Tao, J. Eggelhof, M. Ceja, A. Reynoso, V. Xu and H. Muller *Proceedings of the Ninth Metting on CPT and Lorentz Symmetry*, World Scientific (2022).

Measurement of the $H^3\Delta_1$ Radiative Lifetime in ThO
Daniel G. Ang, Cole Meisenhelder, Cristian D. Panda, Xing Wu, David DeMille, John M. Doyle, Gerald Gabrielse *Phys. Rev. A* **106** (2), 022808 (2022).

Snowmass 2021 White Paper: Tabletop experiments for infrared quantum gravity
Daniel Carney, Yanbei Chen, Andrew Geraci, Holger Müller, Cristian D. Panda, Philip C. E. Stamp, Jacob M. Taylor *arXiv:2203.11846* (2022).

Raman Transitions Driven by Phase-modulated Light in a Cavity Atom Interferometer
S. L. Kristensen, M. Jaffe, V. Xu, C. D. Panda, H. Müller, *Physical Review A* **103** (2), 023715 (2021).

Simple self-calibrating polarimeter for measuring the Stokes parameters of light
V. Andreev, C. D. Panda, P. W. Hess, B. Spaun, G. Gabrielse, *OSA Continuum* **4** 11 (2021).

The Metastable $Q^3\Delta_2$ State of ThO: A New Resource for the ACME Electron EDM Search
X. Wu, Z. Han, J. Chow, D. G. Ang, C. Meisenhelder, C. D. Panda, E. P. West, G. Gabrielse, J. M. Doyle, D. DeMille, *New J. Phys.* **22** 023013 (2020).

Probing Gravity by Holding Atoms for 20 Seconds
V. Xu, M. Jaffe, C. D. Panda, S. L. Kristensen, L. W. Clark, H. Muller, *Science* **366**, 745 (2019).

Attaining the Shot-noise-limit in the ACME Measurement of the Electron Electric Dipole Moment
C. D. Panda, C. Meisenhelder, M. Verma, D. G. Ang, J. Chow, Z. Lasner, X. Wu, D. DeMille, J. M. Doyle, and G. Gabrielse, *J. Phys. B: At. Mol. Opt. Phys.* **52**, 235003 (2019).

Roadmap on STIRAP Applications
K. Bergmann, H-C, Nagerl, C. D. Panda, G. Gabrielse, E. Miloglyadov, M. Quack, G. Seyfang, G. Wichmann, S. Ospelkaus, A. Kuhn *et al.*, *J. Phys. B: At. Mol. Opt. Phys.* **52**, 202001 (2019).

Improved Limit on the Electric Dipole Moment of the Electron
The ACME Collaboration: V. Andreev, D. G. Ang, D. DeMille, J. M. Doyle, G. Gabrielse, J. Haefner, N. R. Hutzler, Z. Lasner, C. Meisenhelder, B. R. O'Leary, C. D. Panda, A. D. West, E. P. West & X. Wu, *Nature* **562**, 355-360 (2018).

Methods, Analysis, and the Treatment of Systematic Errors for the Electron Electric Dipole Moment Search in Thorium Monoxide
The ACME Collaboration: J. Baron, W. C. Campbell, D. DeMille, J. M. Doyle, G. Gabrielse, Y.

V. Gurevich, P. W. Hess, N. R. Hutzler, E. Kirilov, I. Kozyryev, B. R. O'Leary, C. D. Panda, M. F. Parsons, E. P. West, B. Spaun, A. C. Vutha, A. D. West, *New J. Phys.* **19**, 073029 (2017).

An Underappreciated Radiation Hazard from High Voltage Electrodes in Vacuum
A. D. West, Z. Lasner, D. DeMille, E. P. West, C. D. Panda, J. M. Doyle, G. Gabrielse, A. Kryskow, C. Mitchell, *Health Physics* **112(1)**, 33-41 (2017).

Stimulated Raman Adiabatic Passage Preparation of a Coherent Superposition of ThO $H^3\Delta_1$ States for an Improved Electron Electric-dipole-moment Measurement
C. D. Panda, B. R. O'Leary, A. D. West, J. Baron, P. W. Hess, C. Hoffman, E. Kirilov, C. B. Overstreet, E. P. West, D. DeMille, J. M. Doyle, and G. Gabrielse, *Phys. Rev. A* **93**, 052110 (2016).

Order of Magnitude Smaller Limit on the Electric Dipole Moment of the Electron
The ACME Collaboration: J. Baron, W. C. Campbell, D. DeMille, J. M. Doyle, G. Gabrielse, Y. V. Gurevich, P. W. Hess, N. R. Hutzler, E. Kirilov, I. Kozyryev, B. R. O'Leary, C. D. Panda, M. F. Parsons, E. S. Petrik, B. Spaun, A. C. Vutha, A. D. West, *Science* **343**, 269-272 (2014).

Capacitance-Voltage Profiling: Research-Grade Approach versus Low-Cost Alternatives
N. D. Reynolds, C. D. Panda, and J. M. Essick, *Am. J. Phys.* **82**, 196 (2014).

Isochronal Chaos Synchronization of Delay-coupled Optoelectronic Oscillators
L. Illing, C. D. Panda, and L. Shareshian, *Phys. Rev. E* **84**, 016213 (2011).

Memberships

American Physical Society
DAMOP Precision Measurement Group

Reviewer activity

Physical Review A
Physical Review Research
Science Advances
OSA Continuum
Quantum
Results in Physics

Community Involvement and Other Work

UC Berkeley Department of Physics, Berkeley, CA
Equity and Inclusion ("E&I") Committee Postdoctoral Representative 2023-2024

UC Berkeley Berkeley Mathematical and Physical Science (MPS) program, Berkeley, CA
Mentored undergraduate students 2023

UC Berkeley Compass program, Berkeley, CA
Mentored undergraduate students 2022

Martin Luther King Jr. Middle School, Berkeley, CA
Mentor for the "Be a Scientist" teaching program 2021

Harvard University Environmental Health and Safety, Cambridge, MA
Laboratory safety officer 2014 - 2018

Reed College International Student Services, Portland, OR
Student Assistant to Director 2010 - 2012

Reed College Library, Portland, OR
Library Staff, 2009 - 2010