

Paul W. Hess

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Current Position

Middlebury College
Assistant Professor of Physics

Middlebury, VT
July, 2019 - Present

Education

Harvard University

Ph.D. in Physics

Cambridge, MA

May, 2014

- *Dissertation:* Improving the Limit on the Electron EDM – Data Acquisition and Systematics Studies in the ACME Experiment

Williams College

B.A. with High Honors in Astrophysics

Williamstown, MA

June, 2008

- *Thesis:* Measurement of the Indium $6P_{3/2}$ Hyperfine Structure Using Two-Step Excitation
 - Magna cum laude. Phi Beta Kappa and Sigma Xi honors societies.
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Prior Employment

Middlebury College

Visiting Assistant Professor of Physics

July, 2017 –

June, 2019

University of Maryland – Joint Quantum Institute

Postdoctoral Research Associate

Group: Trapped Ion Quantum Information

August, 2014 –

June, 2017

Harvard University

Graduate Researcher

Group: ACME Collaboration

January, 2009 –

May, 2014

Teaching & Mentorship

Professor, Middlebury College

Physics for Educated Citizens

Fall 2017

- An introductory physics course for non-majors, including a substantial writing component

Electromagnetic Theory

Winter 2018

- Time dependent E&M and electromagnetic waves, taught in a “tutorial” format

Newtonian Physics + Lab

Spring 2018,

Spring 2019

- Calculus based introduction to motion, including a weekly laboratory component

Intermediate Electromagnetism + Discussion Section

Fall 2018

- Vector calculus based. Student presentations and discussion are a major component.

Senior Research Seminar Instructor

Fall 2018,

Spring 2019

- Provided guidance to students doing independent senior research

Co-Instructor, University of Maryland

Modern Physics

Spring, 2016

- Taught active lectures to a 40 person class on quantum and statistical mechanics

Teaching Fellow in Physics, Harvard University

Electromagnetism and Statistical Physics from an Analytic, Numerical and Experimental Perspective

Fall, 2013

- Advised on development of course material. Awarded White Teaching Prize.

Introductory Mechanics and Relativity

Spring, 2011

- Prepared material for and lead weekly 90 minute discussion sections

Teaching Assistant, Williams College

- Introduction to Astronomy and Astrophysics (Observatory)

2005-2008

- Introduction to Computer Science (Lab)

2005-2006

- Quantum Physics

2007

Undergraduate Mentorship

Sasha Clarick (*Middlebury College*)

2018

- *Project:* Computing long range ferromagnetic conditions for trapped ion quantum simulation

David Cohen (*Middlebury College*)

2017

- *Projects:* Fiber coupling and transfer cavity lock for Rydberg laser

Eric Brickelbaw (*University of Maryland*)

- *Projects:* Data Acquisition and Laser Locking Software

2015 – 2016

Micah Hernandez (*University of Maryland*)

- *Projects:* RF Electronics Construction; DC Filter Design; Transfer cavity lock

2015 – 2016

Chris Overstreet (*Harvard University*)

- *Project:* Construction of ultra-stable transfer cavity chamber

2011-2012

Marianna Mao (*Harvard University*)

- *Project:* Diode laser construction

2011

Mark Martinez (*Harvard University*)

- *Project:* Temperature stabilization of wavelength meter

2010

Hank Yan (*Harvard University*)

- *Project:* TTL to Fiber converter electronics

2010

Awards and Grants

Ada Howe Kent Fund

2018

- Grant from Middlebury College to attend AAPT workshop for new physics faculty

White Teaching Prize

2014

- Award from Harvard University for excellence in teaching an introductory physics course

Department of Energy Office of Science Graduate Fellowship

2010 -2013

- 100 fellowships awarded, 800 applicants. Merit based scholarship.
- Full stipend and tuition for three years of graduate research

Purcell Fellowship

2008 -2009

- Awarded to all first-year graduate students in Harvard physics Ph.D. program

Howard P. Stabler Prize in Physics

2008

- Awarded to one Williams College senior in physics for excellence in a senior thesis.
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Outreach & Communication

Peer Reviewer for <i>Entropy</i>, <i>New Journal of Physics</i>, <i>Journal of Physics B</i>, <i>Physical Review Letters</i>, and <i>The Physics Teacher</i>	<i>2017-Present</i>
Participant – American Association of Physics Teachers – Workshop for New Physics and Astronomy Faculty	<i>June, 2018</i>
Judge – Spencer Prize for Oratory: Atwater Commons Competition	<i>January 21, 2018</i>
Review Panelist for NSF Graduate Research Fellowship Program	<i>January, 2018</i>
Session Organizer – JQI 10th Anniversary Symposium	<i>May, 2017</i>
Speaker - The Schrödinger Sessions: Science for Science Fiction	<i>July, 2015</i>
Panelist – Society for Scholarly Publishing’s 37th Annual Meeting	<i>May, 2015</i>
Sorting Committee – DAMOP 2015	<i>February, 2015</i>
Session Leader - Harvard Energy Journal Club	<i>2010-2014</i>
Special Edition Contributor - Science in the News Flash	<i>2010-2014</i>
Tutoring Plus Mentor	<i>2010-2013</i>

Invited Presentations:

Fall Faculty Forum – Middlebury, VT “Building a crystal, atom by atom, using levitated atomic ions”	<i>October 5, 2018</i>
Carol Rifej Faculty Lecture – Middlebury, VT (with Shelby Kimmel) “Infinity Machines: Will Quantum Computers Live up to the Hype?”	<i>April 25, 2018</i>
Amherst College Physics and Astronomy Colloquium – Amherst, MA “Quantum Magnets and Time Crystals: Having Fun with Trapped Ions”	<i>September 26, 2017</i>
North American Conference on Trapped Ions (NACTI) – Boulder, CO “Quantum Simulation of Spin Models: From Adiabatic Evolution to Dynamics”	<i>August 14, 2017</i>
Indiana University Condensed Matter Physics Seminar – Bloomington, IN “Observing discrete time crystals in a spin chain of trapped ions”	<i>April 13, 2017</i>
Breakdown of Ergodicity in Quantum Systems – Royal Society in London, UK “Non-thermalization in trapped atomic ion spin chains”	<i>February 7, 2017</i>
Harvey Mudd Physics Colloquium – Claremont, CA “Building a Quantum Magnet from the Bottom Up”	<i>January 31, 2017</i>
IQOQI Seminar – Innsbruck, Austria “Observing Many-Body Localization and Discrete Time Crystals using trapped ion quantum magnets”	<i>December 7, 2016</i>
MPL Seminar – Erlangen, Germany “Observing Many-Body Localization and Discrete Time Crystals using trapped ion quantum magnets”	<i>December 5, 2016</i>
Washington College Physics Colloquium – Chestertown, MD “Building a quantum magnet from the bottom up”	<i>December 1, 2016</i>
GTRI Seminar – Atlanta, GA “Observing Many-Body Localization and Discrete Time Crystals using trapped ion quantum magnets”	<i>November 29, 2016</i>

Designer Quantum Systems Out of Equilibrium – KITP in Santa Barbara, CA “Thermalization and non-thermalization in a programmable spin chain of trapped ions”	<i>November 14, 2016</i>
Informal Statistical Physics Seminar – IPST in College Park, MD “Quantum Thermalization and Localization in a Trapped Ion Spin Chain”	<i>September 27, 2016</i>
Quantum Non-Equilibrium Phenomena Workshop at IIP – Natal, Brazil “Quantum Thermalization and Localization in a Trapped Ion Quantum Simulator”	<i>June 9, 2016</i>
NIST Center for Neutron Research Lunch Seminar – Gaithersburg, MD “Quantum Computing and Quantum Simulation with Trapped Atomic Ions”	<i>March 22, 2016</i>
Hamilton College Physics Department – Clinton, NY “Measuring the Shape of the Electron: What table top physics can tell us about our universe”	<i>December 2, 2015</i>
NIST Center for Neutron Research Lunch Seminar – Gaithersburg, MD “An order of magnitude smaller limit on the electron’s electric dipole moment”	<i>October 6, 2015</i>
The Schrödinger Sessions: Science for Science Fiction at the JQI – College Park, MD “Technology: Ion Traps”	<i>July 30, 2015</i>
JQI Summer School – College Park, MD “Trapped Ions”	<i>July 10, 2015</i>
Workshop on Quantum Simulations – Benasque, Spain “Beyond Ising: Dynamics and Integer Spins in a Trapped Ion Quantum Simulator”	<i>February 25, 2015</i>
Williams College Physics and Astronomy Colloquium – Williamstown, MA “How round is the electron? ACME’s improved limit on the electron’s dipole moment”	<i>May 2, 2014</i>
Quantum Lunch Seminar at Los Alamos National Labs – Los Alamos, NM “How round is the electron? An improved limit on the electron’s electric dipole moment”	<i>February 20, 2014</i>
NIST Ion Storage Group Seminar – Boulder, CO “Probing particle physics with molecules: An improved limit on the electron’s electric dipole moment”	<i>January 24, 2014</i>
JQI Special Seminar – College Park, MD “Probing particle physics on the tabletop: ACME’s improved limit on the electron’s electric dipole moment”	<i>January 21, 2014</i>
IQC Waterloo Seminar – Waterloo, Ontario “Probing particle physics on the tabletop: ACME’s improved limit on the electron’s electric dipole moment”	<i>December 17, 2013</i>
CUA Student Lunch Talk – Cambridge, MA “A Twelve-Fold Smaller Limit on the electron’s EDM”	<i>November 8, 2013</i>
CUA Student Lunch Talk – Cambridge, MA “The search for an electron EDM using thorium monoxide”	<i>February 10, 2012</i>

Contributed Oral and Poster Presentations:

DAMOP 2018 – 10-min Abstract V07.00004 “Prethermal Dynamics of Trapped Ion Discrete Time Crystals”	<i>June 1, 2018</i>
DAMOP 2015 - Poster Abstract Q1.00081 “A Cryogenic Linear Paul Trap for Quantum Simulation”	<i>June 11, 2015</i>
DAMOP 2015 – 10-min Abstract B7.00002 “Realization of Quantum Integer-Spin Chains with Controllable Interactions”	<i>June 9, 2015</i>

Gordon Research Conference: Atomic Physics 2013 - Poster #38 "The Search for an Electron EDM Using ThO"	June 24, 2013
KITP Conference: New Science with Ultracold Molecules 2013 - Poster "Using Cold ThO in a Search for the Electron EDM"	March 12, 2013
ICAP 2012 - Poster Tu-021 "Progress towards measuring the electron EDM with Thorium Monoxide"	July 24, 2012
DAMOP 2011 – 10-min Abstract: K2.00002 "Spectroscopic Characterization of Thorium Monoxide for use in an Electron Electric Dipole Moment Measurement"	June 15, 2011
ICAP 2010 – Poster Tu-153 "Towards an Improved Limit on the Electron Electric Dipole Moment in Thorium Monoxide"	July 27, 2010
4th International Symposium on Lepton Moments – Poster Presentation "Towards an Improved Limit on the Electron Electric Dipole Moment in Thorium Monoxide"	July 21, 2010
ICAP 2008 – Poster Tu-28 "Precise measurements of hyperfine structure and atomic polarizability in indium and thallium"	July 29, 2008
DAMOP 2008 - Undergraduate Research Session, Abstract: K3.00001 "Precise measurement of the hyperfine splittings within the 6P _{3/2} level of atomic indium using two-color diode laser spectroscopy"	May 29, 2008

Publications and Patents:

- 19) "Programmable Quantum Simulations of Spin Systems with Trapped Ions." C. Monroe, W.C. Campbell, L.-M. Duan, Z.-X. Gong, A.V. Gorshkov, **P.W. Hess**, R. Islam, K. Kim, G. Pagano, P. Richerme, C. Senko, N.Y. Yao. *arXiv* 1912.07845 (2019)
- 18) "Quantum Approximate Optimization with a Trapped Ion Quantum Simulator." G. Pagano, A. Bapat, P. Becker, K.S. Collins, A. De, **P.W. Hess**, H.B. Kaplan, A. Kyprianidis, W.L. Tan, C. Baldwin, L.T. Brady, A. Deshpande, F. Liu, S. Jordan, A.V. Gorshkov, C. Monroe. *arXiv* 1906.02700 (2019)
- 18) "Cryogenic Trapped-Ion System." C. Monroe, G. Pagano, **P.W. Hess**, H.B. Kaplan, W.L. Tan, P. Richerme. U.S. Patent Application 20190348251 A1, filed May 9, 2019
- 17) "Cryogenic Trapped-Ion System for Large Scale Quantum Simulation." G. Pagano, **P.W. Hess**, H.B. Kaplan, W.L. Tan, P. Richerme, P. Becker, A. Kyprianidis, J. Zhang, E. Birckelbaw, M.R. Hernandez, Y. Wu, C. Monroe. *Quantum Sci. Technol.* **4**, 014004 (2018)
- 16) "Observation of a Many-Body Dynamical Phase Transition with a 53-Qubit Quantum Simulator." J. Zhang, G. Pagano, **P.W. Hess**, A. Kyprianidis, P. Becker, H. Kaplan, A.V. Gorshkov, Z.-X. Gong, C. Monroe. *Nature* **551**, 601–604 (2017)
- 15) "Non-thermalization in trapped atomic ion spin chains." **P.W. Hess**, P. Becker, H.B. Kaplan, A. Kyprianidis, A.C. Lee, B. Neyenhuis, G. Pagano, P. Richerme, C. Senko, J. Smith, W.L. Tan, J. Zhang, C. Monroe. *Phil. Trans. R. Soc. A* **375**: 20170107 (2017)
- 14) "Observation of Prethermalization in Long-Range Interacting Spin Chains." B. Neyenhuis, J. Smith, A.C. Lee, J. Zhang, P. Richerme, **P.W. Hess**, Z.-X. Gong, A.V. Gorshkov, C. Monroe. *Science Advances*, **3**, e:1700672 (2017)
- 13) "Methods, Analysis, and the Treatment of Systematic Errors for the Electron Electric Dipole Moment Search in Thorium Monoxide." 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, B. Spaun, A.C. Vutha, A.D. West, E.P. West. *New J. Phys.*, **19**, 073029 (2017)
- 12) "Observation of a discrete time crystal." J. Zhang, **P.W. Hess**, A. Kyprianidis, P. Becker, A. Lee, J. Smith, G. Pagano, I.-D. Potirniche, A.C. Potter, A. Vishwanath, N.Y. Yao, C. Monroe. *Nature*, **543**, 217-220 (2017)

- 11) "A self-calibrating polarimeter to measure Stokes parameters." V. Andreev, C.D. Panda, **P.W. Hess**, B. Spaun, G. Gabrielse. *arXiv*: 1703.00963 (2017)
 - 10) "Engineering large stark shifts for control of individual clock state qubits." A.C. Lee, J. Smith, P. Richerme, B. Neyenhuis, **P.W. Hess**, J. Zhang, C. Monroe. *Phys. Rev. A*, 94, 042308 (2016)
 - 9) "Many body localization in a quantum simulator with programmable random disorder." J. Smith, A. Lee, P. Richerme, B. Neyenhuis, **P.W. Hess**, P. Hauke, M. Heyl, D.A. Huse, and C. Monroe. *Nature Physics*, 12, 907-911 (2016)
 - 8) "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)
 - 7) "Zeeman interaction in ThO $H^3\Delta_1$ for the electron electric-dipole-moment search." A.N.Petrov, L.V. Skripnikov, A.V. Titov, N.R. Hutzler, **P.W. Hess**, B.R. O'Leary, B. Spaun, D. DeMille, G. Gabrielse, J. M. Doyle. *Phys. Rev. A*, 89, 062505 (2014)
 - 6) "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, E.S. Petrik, B. Spaun, A.C. Vutha, and A.D. West. *Science*, 343 (6168), 269-272 (2014)
 - 5) "Advanced Cold Molecule Electron EDM." The ACME Collaboration: Wesley C. Campbell, Cheong Chan, David DeMille, John M. Doyle, Gerald Gabrielse, Yulia V. Gurevich, **Paul W. Hess**, Nicholas R. Hutzler, Emil Kirilov, Brendon O'Leary, Elizabeth S. Petrik, Ben Spaun, and Amar C. Vutha. *EPJ Web of Conferences*, 57, 02004 (2013)
 - 4) "Shot-noise-limited spin measurements in a pulsed molecular beam." E. Kirilov, W. C. Campbell, J. M. Doyle, G. Gabrielse, Y. V. Gurevich, **P. W. Hess**, N. R. Hutzler, B. R. O'Leary, E. Petrik, B. Spaun, A. C. Vutha, and D. DeMille. *Phys. Rev. A.*, 88, 013844 (2013)
 - 3) "A cryogenic beam of refractory, chemically reactive molecules with expansion cooling." N.R. Hutzler, M.F. Parsons, Y.V. Gurevich, **P.W. Hess**, E. Petrik, B.Spaun, A.C. Vutha, D. DeMille, G. Gabrielse and J.M. Doyle. *Phys. Chem. Chem. Phys.*, 13, 18976-18985 (2011)
 - 2) "Measurement of hyperfine structure within the $6P_{3/2}$ excited state of ^{115}In " M. Gunawardena, H. Cao, **P.W. Hess**, and P.K. Majumder. *Phys. Rev. A*, 80, 032519 (2009)
 - 1) "A frequency stabilization technique for diode lasers based on frequency-shifted beams from an acousto-optic modulator" M. Gunawardena, **P.W. Hess**, J.H. Strait, and P.K. Majumder. *Rev. Sci. Instrum.*, 79, 103110 (2008)
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