

## DAVID HANNEKE

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### EDUCATION

Ph.D., Physics, Harvard University, March 4, 2008  
A.M., Physics, Harvard University, March 11, 2003  
B.S., Physics *Summa Cum Laude* (Astronomy minor),  
Case Western Reserve University, May 20, 2001

### POSITIONS and APPOINTMENTS

Assistant Professor of Physics, Amherst College, 2011–present  
Research associate, University of Colorado at Boulder, 2010–2011  
Continuing work in the NIST Ion Storage Group  
Postdoctoral fellow, National Institute of Standards and Technology, Boulder, CO, 2008–2010  
Time and Frequency Division, Ion Storage Group  
Advisor: David Wineland  
Graduate student, Harvard University, Cambridge, MA, 2001–2007  
Advisor: Gerald Gabrielse  
Teaching fellow, Harvard University Physics Department, 2002  
Instructor: Eric Mazur  
Undergraduate student, Case Western Reserve University, Cleveland, OH, 1997–2001  
Tutor, Case Western Reserve University Physics Department, 2000–2001  
Advisor: Mano Singham  
Grader, Case Western Reserve University Physics Department, 1998–2000  
Instructors: Robert Brown, Charles Rosenblatt

### GRANTS RECEIVED

National Science Foundation (PHY-1255170), 2013–2018, *CAREER: Fundamental Physics through Precision Measurement of Trapped Charged Particles*  
Research Corporation, Single-Investigator Cottrell College Science Award (20929), 2012–2014, *Quantum Logic Spectroscopy of Charged Molecules*

### HONORS and AWARDS

Trustee Faculty Fellowship, Amherst College, 2014–2015  
Cottrell Scholar, Research Corporation, Class of 2012  
Michelson Postdoctoral Prize Lectureship, 2010  
American Recovery and Reinvestment Act Postdoctoral Fellowship, 2010  
National Research Council (NRC) Postdoctoral Research Associateship, 2008–2010  
Harold T. White Prize “for excellence in the teaching of physics,” Harvard Physics Dept., 2003  
Certificate of Distinction in Teaching, Harvard, 2002  
National Defense Science and Engineering Graduate (NDSEG) Fellowship, 2001–2004  
*Phi Beta Kappa*, 2000  
CWRU President’s Scholarship, 1997–2001  
Leslie L. Foldy Award “to the outstanding senior in physics,” CWRU, 2001  
John Schoff Millis Award “to the senior with the best academic record,” CWRU, 2001  
Louis K. Levy Prize “for an outstanding junior” (university-wide), CWRU, 2000

B. S. Chandrasekhar Prize “awarded upon completion of the junior year to a physics major who has demonstrated superior performance,” CWRU, 2000

Junior Award of Arts and Sciences “to the junior with the best academic record,” CWRU, 2000

Phi Beta Kappa Prize “to a sophomore with the best academic record,” CWRU, 1999

Case Alumni Association Junior/Senior Scholarship, 1999–2001

Peter Witt Scholarship for demonstrating “a vital and active interest in the improvement of life in Cleveland,” CWRU, 1999 & 2000

Mortar Board, 1999

National Merit Corporate Scholarship (Union Pacific Corp.), 1997–2001

Dean’s High Honors, every semester enrolled at CWRU

Eagle Scout, 1997

**PROFESSIONAL SOCIETIES**

American Physical Society, 1999–present

American Association of Physics Teachers, 2011–present

**TEACHING and ADVISING**

**COURSES TAUGHT**

- The Newtonian Synthesis: Dynamics of Particles and Systems, Waves (PHYS 123), Fall 2017
- Signals and Noise Laboratory (PHYS 226), Spring 2017
- The Newtonian Synthesis: Dynamics of Particles and Systems, Waves (PHYS 123), Fall 2016
- Intermediate Laboratory (PHYS 226), Spring 2016
- The Newtonian Synthesis: Dynamics of Particles and Systems, Waves (PHYS 123), Fall 2015
- Quantum Mechanics (PHYS 348), Spring 2014
- Statistical Mechanics and Thermodynamics (PHYS 230), Spring 2014
- Introductory Physics II: Electromagnetism and Optics (PHYS 117), Fall 2013
- Quantum Mechanics (PHYS 348), Spring 2013
- Statistical Mechanics and Thermodynamics (PHYS 230), Spring 2013
- Introductory Physics II: Electromagnetism and Optics (PHYS 117), Fall 2012
- Modern Physics (PHYS 225), Fall 2012
- Quantum Mechanics (PHYS 348), Spring 2012
- Introductory Physics II: Electromagnetism and Optics, Lab sections (PHYS 117L), Spring 2012
- Modern Physics (PHYS 225), Fall 2011
- Introductory Physics I: Mechanics and Wave Motion, Lab section (PHYS 116L), Fall 2011

**HONORS THESIS STUDENTS ADVISED**

- Alex Frenett (2018)
- Christian Pluchar (2018)
- David Lane, *Developing a Quantum Toolbox: Experiments with a Single-Atom Harmonic Oscillator and Prospects for Probing Molecular Ions* (2017)
- Edward (Ned) Kleiner, *Quantum Control of Be<sup>+</sup> Ions* (2016)
- Jiajun Shi, *Radiofrequency Synthesis System for Laser Modulation* (2014)
- Phyong Aung Kyaw, *Constructing an Ultra-High Vacuum Chamber and a Radio Frequency Helical Resonator for Trapping Ions* (2014)

- Chu Cheyenne Teng, *Frequency Control and Stabilization of a Laser System* (2013)
- Celia Ou, *Third Harmonic Conversion* (2013)
- Shenglan Qiao, *Constructing a Linear Paul Trap System for Measuring the Time-variation of Electron–Proton Mass Ratio* (2013)

#### SPECIAL TOPICS COURSES

- Quantum Physics Research, Spring 2012
- Laser Applications, Fall 2012

#### ADVISING

- Postdoctoral advisor for Dr. Ryan Carollo
- Academic advisor for 35 students
- First-year academic advisor for 27 students
- Faculty advising network, 2017–2018
- Research supervision of 25 students: Summer 2011: Steven Santos '13; Fall 2011: Ben Scheetz '12; Interterm 2012: Shah Saad Alam '14, Celia Ou '13; Spring 2012: Ben Scheetz '12; Summer 2012: Dvij Bajpai '15, Celia Ou '13, Shenglan Qiao '13, Cheyenne Teng '14E; Fall 2012: Dvij Bajpai '15, Celia Ou '13, Shenglan Qiao '13, Cheyenne Teng '14E; Interterm 2013: Shah Saad Alam '14, Dan Kang '15, Owen Marschall '15, Celia Ou '13, Shenglan Qiao '13; Spring 2013: Dvij Bajpai '15, Celia Ou '13, Shenglan Qiao '13, Cheyenne Teng '14E; Summer 2013: Ned Kleiner '16, Phyo Kyaw '14, Julian Ricardo '15, Cheyenne Teng '14E; Fall 2013: Sung Joo Choi '16, Phyo Kyaw '14, Cheyenne Teng '14E; Interterm 2014: Ned Kleiner '16, Phyo Kyaw '14, Wonjae Lee '16, Jean-Loup McIlvain-Cellier '15, Jiajun Shi '15E; Spring 2014: Phyo Kyaw '14, Jiajun Shi '15E; Summer 2014: Phong Hoang '16, Ned Kleiner '16, Jiajun Shi '15E; Fall 2014: Jiajun Shi '15E; Summer 2015: Ned Kleiner '16, Alex Frenett '18, Jack Zhao HC'17; Fall 2015: Ned Kleiner '16, Alex Frenett '18, Jack Zhao HC'17; Interterm 2016: Ned Kleiner '16, Alex Frenett '18, Trevor Wright '18; Spring 2016: Ned Kleiner '16, David Lane '17; Summer 2016: David Lane '17, Alex Frenett '18, Lauren Weiss '18; Fall 2016: David Lane '17, Alex Frenett '18, Christian Pluchar '18, Marissa Radensky '19; Interterm 2017: Alex Frenett '18, David Lane '17; Spring 2017: David Lane '17; Summer 2017: Alex Frenett '18, Jacob Gendelman '20

#### COLLEGE SERVICE

Student Fellowships Committee, 2015–2017  
Advisor to the Electronics Club, 2013–present  
College Housing Committee, 2012–2014  
Laura Ayres Snyder Poetry Prize Committee, 2016  
Physics & Astronomy Department Curriculum Committee, 2012–present  
Physics & Astronomy Department seminar co-coordinator, spring 2012  
Public lectures associated with *Amherst Today* (2013) and the SURF program (2012–2016)  
Search committees for tenure-track faculty (2), visiting faculty and other teaching staff (5), and technical or administrative staff (3)  
Moodle pilot program, 2011–2012

#### PROFESSIONAL SERVICE

Member-at-Large, Executive Committee of the APS's Topical Group on Precision Measurement & Fundamental Constants, 2015–2018  
Review panelist for the National Science Foundation

Ad hoc reviewer for the National Science Foundation  
Reviewer for the Research Corporation for Science Advancement  
Referee for *Physical Review Letters*  
Referee for *Physical Review A*  
Referee for *Physical Review X*  
Referee for *Review of Scientific Instruments*  
Referee for *Foundations of Physics*  
Referee for *Physics Today*  
Session chair for DAMOP meeting

**PUBLICATIONS** \* indicates an undergraduate co-author

and

**PRESENTATIONS** PEER-REVIEWED PUBLICATIONS

**Third-harmonic-generation of a diode laser for quantum control of beryllium ions**

Ryan A. Carollo, David A. Lane\*, Edward K. Kleiner\*, Phyo Aung Kyaw\*, Chu C. Teng\*,  
Celia Y. Ou\*, Shenglan Qiao\*, David Hanneke  
*Optics Express* **25** 7220–7229 (2017)

**High sensitivity to variation in the proton-to-electron mass ratio in  $O_2^+$**

D. Hanneke, R. A. Carollo, D. A. Lane\*  
*Physical Review A* **94**, 050101(R) (2016)

**Coherent Diabatic Ion Transport and Separation in a Multizone Trap Array**

R. Bowler, J. Gaebler, Y. Lin, T. R. Tan, D. Hanneke, J. D. Jost, J. P. Home, D. Leibfried, and  
D. J. Wineland  
*Physical Review Letters* **109**, 080502 (2012)

**Randomized Benchmarking of Multiqubit Gates**

J. P. Gaebler, A. M. Meier, T. R. Tan, R. Bowler, Y. Lin, D. Hanneke, J. D. Jost, J. P. Home,  
E. Knill, D. Leibfried, and D. J. Wineland  
*Physical Review Letters* **108**, 260503 (2012)  
Ibid. **109**, 179902(E) (2012)

**Normal modes of trapped ions in the presence of anharmonic trap potentials**

J. P. Home, D. Hanneke, J. D. Jost, D. Leibfried, D. J. Wineland  
*New Journal of Physics* **13**, 073026 (2011)

**Cavity control of a single-electron quantum cyclotron: Measuring the electron magnetic moment**

D. Hanneke, S. Fogwell Hoogerheide, and G. Gabrielse  
*Physical Review A* **83**, 052122 (2011)

**Realization of a programmable two-qubit quantum processor**

D. Hanneke, J. P. Home, J. D. Jost, J. M. Amini, D. Leibfried & D. J. Wineland  
*Nature Physics* **6**, 13–16 (2010)

**Complete Methods Set for Scalable Ion Trap Quantum Information Processing**

Jonathan P. Home, David Hanneke, John D. Jost, Jason M. Amini, Dietrich Leibfried, David J. Wineland  
*Science* **325**, 1227–1230 (2009)

**Entangled Mechanical Oscillators**

J. D. Jost, J. P. Home, J. M. Amini, D. Hanneke, R. Ozeri, C. Langer, J. J. Bollinger, D. Leibfried, and D. J. Wineland  
*Nature* **459**, 683–685 (2009)

**New Measurement of the Electron Magnetic Moment and the Fine Structure Constant**

D. Hanneke, S. Fogwell, and G. Gabrielse  
*Physical Review Letters* **100**, 120801 (2008)

**New Measurement of the Electron Magnetic Moment Using a One-Electron Quantum Cyclotron**

B. Odom, D. Hanneke, B. D'Urso, and G. Gabrielse  
*Physical Review Letters* **97**, 030801 (2006)

**New Determination of the Fine Structure Constant from the Electron  $g$  Value and QED**

G. Gabrielse, D. Hanneke, T. Kinoshita, M. Nio, and B. Odom  
*Physical Review Letters* **97**, 030802 (2006)  
An error by our theory collaborators was fixed in *Ibid.* **99**, 039902(E) (2007)

**Single-Particle Self-Excited Oscillator**

B. D'Urso, R. Van Handel, B. Odom, D. Hanneke, and G. Gabrielse  
*Physical Review Letters* **94**, 113002 (2005)

**INVITED TALKS**

1<sup>st</sup> North American Conference on Trapped Ions (NACTI), August, 2017, Boulder, CO  
Invited talk: **Nonpolar Molecular Ions for Precision Measurements**

International Workshop on Cold Molecular Ions, May–June, 2017, Haute Savoie, France  
Invited talk: **Nonpolar molecular ions for precision measurements**

Hamilton College, October, 2016, Clinton, NY  
Colloquium: **Quantum Control of Molecular Ions**

Bates College, November, 2014, Lewiston, ME  
Colloquium: **A Programmable Quantum Information Processor**

Williams College, February, 2013, Williamstown, MA  
Colloquium: **A Programmable Quantum Information Processor**

New Laser Scientists Conference, October, 2012, Rochester, NY  
Invited talk: **Precision Measurements with Trapped Ions**

Amherst College, February, 2011, Amherst, MA  
Colloquium: **Measuring the Electron Magnetic Moment**

Harvey Mudd College, January, 2011, Claremont, CA  
Colloquium: **Measuring the Electron Magnetic Moment**

APS Laser Science (LS), October, 2010, Rochester, NY  
Invited talk: **Progress towards Scalable Quantum Information Processing with Trapped Ions**

International Symposium on Lepton Moments, July, 2010, Centerville, Cape Cod, MA  
Invited talk: **Measuring the Electron Magnetic Moment**

Michelson Postdoctoral Prize Lectures, May 10–14, 2010, Cleveland, OH  
**Entangled Mechanical Oscillators and a Programmable Quantum Computer: Adventures in Coupling Two-Level Systems to Quantum Harmonic Oscillators**  
**Optical Atomic Clocks**  
**Cavity Control in a Single-Electron Quantum Cyclotron: An Improved Measurement of the Electron Magnetic Moment**  
**High-Energy Physics with Low-Energy Symmetry Studies**

NIST Time and Frequency Division Seminar, March 18, 2010, Boulder, CO  
Invited talk: **Cavity Control in a Single Electron Quantum Cyclotron: An Improved Measurement of the Electron Magnetic Moment**

SPiE Photonics West, January, 2010, San Francisco, CA  
Invited talk: **Recent progress in quantum information processing with trapped ions**

#### **OTHER PUBLICATIONS AND PRESENTATIONS**

Advance Laboratory Physics Association (ALPhA) New England Regional Conference, June, 2017, Amherst, MA  
Led tours of Amherst College's laboratory facilities.

APS Division of Atomic, Molecular and Optical Physics (DAMOP) Meeting, June, 2017, Sacramento, CA  
Poster presented: **Towards measurements with sympathetically cooled state-selected molecular ions**  
Ryan A. Carollo, David A. Lane\*, Alexander Frenett\*, David Hanneke

APS Division of Atomic, Molecular and Optical Physics (DAMOP) Meeting, May, 2016, Providence, RI  
Poster presented: **Towards quantum control of molecular ions**  
David Hanneke, Edward Kleiner\*, Alexander Frenett\*

APS Division of Atomic, Molecular and Optical Physics (DAMOP) Meeting, June, 2015, Columbus, OH  
Poster presented: **Trapped ion system for multi-species quantum control**

Southwest Quantum Information and Technology (SQuInT), February, 2011, Boulder, CO  
Poster presented: **Quantum Information Processing using Scalable Techniques**  
R. Bowler, D. Hanneke, J. D. Jost, J. P. Home, Y. Lin, T-R. Tan, D. Leibfried, D. J. Wineland

Workshop on Ion Trap Technology, February, 2011, Boulder, CO  
Poster presented: **Quantum Information Processing using Scalable Techniques**  
R. Bowler, D. Hanneke, J. D. Jost, J. P. Home, Y. Lin, T-R. Tan, D. Leibfried, D. J. Wineland

International Conference on Atomic Physics (ICAP), July, 2010, Cairns, Australia  
Poster presented: **Multi-Qubit Operations using Scalable Techniques**  
J. P. Home, D. Hanneke, J. D. Jost, R. Bowler, J. Amini, Y. Lin, T-R. Tan, D. Leibfried, D. J. Wineland

Southwest Quantum Information and Technology (SQuInT), February, 2010, Santa Fe, NM  
Contributed talk: **Putting the pieces together: Recent progress with trapped ions at NIST**

Boulder Laboratories Postdoctoral Poster Symposium 2009, Boulder, CO  
Poster presented: **Universal quantum control of two qubits**  
David Hanneke, Jonathan Home, John Jost, Jason Amini, Dietrich Leibfried, David Wineland

APS Division of Atomic, Molecular and Optical Physics (DAMOP) Meeting, 2009, Charlottesville, VA  
Contributed talk: **Sympathetic cooling and trapped-ion quantum logic (Repeated two-qubit logic gates with scalable techniques)**  
David Hanneke, J. D. Jost, J. P. Home, J. M. Amini, R. Ozeri, C. Langer, J. J. Bollinger, D. Leibfried, D. J. Wineland

Gordon Research Conference 2008 (Quantum Information Science), Big Sky, MT  
Poster presented: **Distribution of entanglement in an ion trap array**  
J. D. Jost, J. P. Home, J. Amini, C. Langer, R. Ozeri, D. Hanneke, J. J. Bollinger, R. B. Blakestad, K. R. Brown, J. Britton, D. Leibfried, S. Seidelin, N. D. Walrath, D. J. Wineland

International Conference on Atomic Physics (ICAP) 2008, Storrs, CT  
Proceedings: **More Accurate Measurement of the Electron Magnetic Moment and the Fine Structure Constant**  
D. Hanneke, S. Fogwell, N. Guise, J. Dorr, and G. Gabrielse  
In R. Côté, P. L. Gould, M. Rozman, W. W. Smith (eds.), *Pushing the Frontiers of Atomic Physics: Proceedings of the XXI International Conference on Atomic Physics*  
World Scientific, pp. 46–55, 2009

### **Precision pins down the electron's magnetism**

G. Gabrielse and D. Hanneke  
*CERN Courier*, October 2006, pp. 35–37

International Conference on Atomic Physics (ICAP) 2006, Innsbruck, Austria

Poster presented: **New Measurement of the Electron Magnetic Moment and Fine Structure Constant**

D. Hanneke, B. Odom, B. D'Urso, G. Gabrielse

Proceedings: **New Measurement of the Electron Magnetic Moment and Fine Structure Constant**

G. Gabrielse and D. Hanneke

In C. Roos, H. Haffner, R. Blatt (eds.), *Atomic Physics 20: XX International Conference on Atomic Physics – ICAP 2006*

AIP Conference Proceedings, Vol. 869, pp. 68–75, 2006

Conference on the Intersections of Particle and Nuclear Physics (CIPANP) 2006, Puerto Rico

Proceedings: **New Measurement of the Electron Magnetic Moment and Fine Structure Constant**

G. Gabrielse and D. Hanneke

In T. Liss (ed.), *Intersections of Particle and Nuclear Physics: 9th Conference CIPANP 2006*

AIP Conference Proceedings, Vol. 870, pp. 328–332, 2006

Lepton Moments International Symposium 2006, Cape Cod, MA

Poster presented: **New Measurement of the Electron Magnetic Moment and Fine Structure Constant**

D. Hanneke, B. Odom, B. D'Urso, G. Gabrielse

International Conference on Atomic Physics (ICAP) 2004, Rio de Janeiro, Brazil

Poster presented: **Toward an Improved Electron  $g-2$  Measurement**

David A. Hanneke, Brian C. Odom, Gerald Gabrielse

## SECONDARY REPORTS ON THE TRAPPED-ION WORK

**Moving Traps Offer Fast Delivery of Cold Ions**, Christian Roos, *Physics* **5**, 94 (2012)

**Highlight of 2011**, *New Journal of Physics*

**Breakthrough of the Year**, *Physics World*, posted online December 21, 2009

**2009 Science News of the Year: Matter & Energy**, *Science News*, January 2, 2010, Vol. 177 #1, p. 24

**Top 100 Stories of 2009 – #40**, Elizabeth Svoboda, *Discover*, January/February 2010, p.49

**First Programmable Quantum Computer Created**, Laura Sanders, *Science News*, December 19, 2009, Vol. 176 #13, p. 13

**First universal programmable quantum computer unveiled**, Colin Barras, *New Scientist* online, November 15, 2009

**The pieces put together**, *Nature Physics* **5**, 622 (2009)

**Mechanical Systems All Tangled Up**, Laura Sanders, *Science News*, July 4, 2009, Vol. 176 #1, p.8

**Physics Update: Entangled mechanical oscillators**, *Physics Today*, July 2009, 22

**Entanglement goes mechanical**, Rainer Blatt, *Nature* **459**, 653–654 (2009)

**Quantum Computing with Ions**, Christopher R. Monroe and David J. Wineland, *Scientific American*, August 2008, 64–71



**SECONDARY REPORTS ON THE  $g$ -VALUE WORK**

**Deviations from 2**, A. Moscatelli, *Nature Physics* **13**, 518 (2017)

**Fundamental constants: The teamwork of precision**, E. G. Myers, *Nature* **506**, 440–441 (2014)

**The standard model's greatest triumph**, G. Gabrielse, *Physics Today* **66**(12), 64 (2013)

**The Physics Story of the Year for 2006**, P. Schewe, B. Stein, and D. Castelvecchi, *Physics News Update* 804, December 5, 2006

**Plumbing the Electron's Depths**, P. Schewe and B. Stein, *Physics News Update* 783, July 5, 2006

**A More Precise Fine Structure Constant**, D. Kleppner, *Science* **313**, 448–449 (2006)

**A Finer Constant**, A. Czarnecki, *Nature* **442**, 516–517 (2006)

**Gyromagnetic Ratio of a Lone Trapped Electron is Measured to Better than a Part Per Trillion**, B. Schwarzschild, *Physics Today*, August 2006, 15–17

**Precision pins down the electron's magnetism**, G. Gabrielse and D. Hanneke, *CERN Courier*, October 2006, 35–37

**The Magnet in the Electron**, G. Gabrielse, *Physics World*, February 2007, 32–36

**In Constant Search of 'alpha'**, M. Inman, *New Scientist* **2568**, 40–43 (2006)