

# DAVID HANNEKE

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- EDUCATION** Ph.D., Physics, Harvard University, March 2008  
A.M., Physics, Harvard University, March 2003  
B.S., Physics *Summa Cum Laude* (Astronomy minor), Case Western Reserve University,  
May 2001
- POSITIONS  
and  
APPOINTMENTS** Research faculty, University of Colorado at Boulder, 2010–present  
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
- HONORS  
and  
AWARDS** 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
- TEACHING  
and  
ADVISING** NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY
- Coordinated the work of three graduate students on a quantum-information experiment
  - Supervised one undergraduate student (projects included designing a control system for

laser intensity stabilization and increasing beam-pointing stability by reducing air turbulence on a laser table)

### HARVARD UNIVERSITY

#### UNDERGRADUATE SUPERVISION

- Supervised five undergraduate students
- Projects all aimed at increasing apparatus stability, including characterizing laboratory vibrations, designing a pump room and vacuum system, and calculating the magnetic field homogeneity and inductance matrix for a new solenoid

#### TEACHING FELLOW

- Assisted in teaching *Principles of Physics: Electricity, Waves, Nuclear Physics (Physics Ib)*, the second semester of a year-long introductory physics course for students in the life sciences
- Received the teaching awards mentioned above
- Co-taught a section of 12 students and whole-class review sessions
- Wrote and graded problem sets and exams
- Aided instruction during main lectures, which were taught using Peer Instruction, an interactive format

### CASE WESTERN RESERVE UNIVERSITY

- Tutored students at all levels of introductory physics through GetHIP (Get Help-In-Physics) Walk-In Tutoring
- Designed a java applet for *Introduction to Quantum Mechanics (PHYS 331)*
- Grader for *Physics and Frontiers I (PHYS 123)* (advanced freshman mechanics)
- Grader for *Physics and Frontiers II (PHYS 124)* (advanced freshman E&M)

### **RESEARCH EXPERIENCE**

### NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY

- Realized the first programmable multi-qubit quantum processor
- Demonstrated a complete methods set for scalable ion-trap-based quantum information processing
- Created the first entangled state of two separated mechanical oscillators
- “Breakthrough of the Year” (*Physics World*, 2009)
- “Science News of the Year” (*Science News*, 2009)
- “Top 100 Stories of 2009” (*Discover*)
- Utilized quantum control of the internal and external degrees of freedom of individually trapped  ${}^9\text{Be}^+$  and  ${}^{24}\text{Mg}^+$  ions

### HARVARD UNIVERSITY

- **Ph.D. Thesis: Cavity Control in a Single-Electron Quantum Cyclotron: An Improved Measurement of the Electron Magnetic Moment**
- Two new measurements of the electron magnetic moment
- Final uncertainty more than 15-times below the celebrated 1987 University of Washington measurement
- Determined the most accurate value of the fine structure constant
- “Physics Story of the Year” (American Institute of Physics’s *Physics News Update*, 2006)
- Performed precision frequency spectroscopy of a single trapped electron through quantum control and detailed analysis of systematic effects

CASE WESTERN RESERVE UNIVERSITY

- Senior Thesis: A New Technique for Measuring Isotopic Impurity Diffusion in Solid Helium (advisor: Arnold Dahm)
- Modeled force propagation in granular matter (advisor: Harsh Mathur)
- Simulated the dynamics of a sonoluminescing bubble and found an experimentally accessible order-to-chaos transition (advisors: Harsh Mathur and Kathleen Kash)

**PUBLICATIONS**    REFEREED PUBLICATIONS

and

**PRESENTATIONS**    **Cavity Control in a Single-Electron Quantum Cyclotron: Measuring the Electron Magnetic Moment**

D. Hanneke, S. Fogwell Hoogerheide, and G. Gabrielse  
Submitted to *Physical Review A* (2010)

**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)

OTHER PUBLICATIONS AND PRESENTATIONS

APS Laser Science (LS), October, 2010, Rochester, NY

Invited talk: **Progress towards Scalable Quantum Information Processing with Trapped Ions**

International Conference on Atomic Physics (ICAP), July, 2010, Cairns, Australia  
Poster presented: **Multi-Qubit Operations using Scalable Techniques**

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**

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

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

Boulder Laboratories Postdoctoral Poster Symposium 2009, Boulder, CO  
Poster presented: **Universal quantum control of two qubits**

APS Division of Atomic, Molecular, and Optical Physics (DAMOP) 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**

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**

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

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

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

### SECONDARY REPORTS ON THE TRAPPED-ION WORK

**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

**The Physics Story of the Year for 2006**, P. Schewe, B. Stein, and D. Castelvechi, *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)