

Windell H. Oskay

Time and Frequency Division (847)
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Education

The University of Texas at Austin, August 1996 – December 2001

Ph.D. in Physics

Areas of specialization: experimental atom optics and quantum chaos

Lake Forest College, August 1992 – May 1996

B.A. in Physics and Mathematics (dual major)

Summa Cum Laude, with honors in physics

Experience

Postdoctoral Research, August 2002 – Present

Time and Frequency Division, National Institute of Standards and Technology.

Supervisor: Dr. James C. Bergquist.

- Operated and made improvements to an optical frequency standard based upon a single trapped mercury ion. Made substantial progress in the evaluation of systematic frequency shifts for this system, thereby reducing the overall uncertainty in the clock frequency. Participated in comparisons versus microwave and other optical frequency standards. Studied long-term frequency stability as it relates to possible changes in fundamental constants.

Doctoral Research, August 1996 – August 2002

Department of Physics and Center for Nonlinear Dynamics, The University of Texas at Austin.

Supervisor: Dr. Mark G. Raizen.

- Performed a series of atom optics experiments that addressed several fundamental problems in quantum transport. These studies were conducted by observing the center-of-mass motion of ultracold cesium atoms in one-dimensional, far-detuned optical lattices. Results included a detailed study of the effects of noise on dynamical localization, and the direct observation of chaos-assisted tunneling.
- Gained experience in designing, building, and operating the range of apparatus required for precise measurements with the tools of atomic and optical physics. This range includes mechanical design, ultra-high vacuum systems, optical sources and systems, analog and digital electronics, data acquisition and computer automation.
- Successfully constructed and applied quantum dynamics simulations to analyze results of experiments.

Physics Laboratory Instructor, January 1998 – January 1999 and August 1996 – January 1997:

The University of Texas at Austin. Supervisors: Dr. Kenneth W. Gentle, Dr. Roger D. Bengtson.

- Taught undergraduate laboratory sections for introductory electromagnetism class (one semester).
- Taught undergraduate laboratory sections for modern physics class (two semesters).

Summer Research, May 1996 – August 1996

Lawrence Berkeley National Laboratory. Supervisor: Dr. Michael Levi.

- Worked on data acquisition electronics for the BaBar detector, later installed at Stanford Linear Accelerator Center. Debugged embedded systems that transfer output signals from various detector components to conventional (non-embedded) computer systems. Gained experience with the hardware, firmware, and software components of high speed digital electronics, including field-programmable gate arrays.

Undergraduate Research, May 1993 – May 1996

Lake Forest College. Supervisor: Dr. Michael M. Kash.

- Contributed to a project investigating the angular distribution of resonance fluorescence from lithium atoms. Gained experience in many of the basic methods used in atomic physics research. Worked with a high vacuum system, thermal atomic beam, and external cavity diode laser system. Constructed several major pieces of optical and electronic equipment for the laboratory. Wrote data acquisition software to automate the experiment.

Tutor, September 1994 – May 1996

Lake Forest College. Supervisors: Dr. Michael M. Kash, Dr. Edward W. Packel.

- Individually assisted students in elementary physics and mathematics classes.
- Supervised mathematics department computer laboratory.

Honors and Awards

1. National Research Council/National Institutes of Standards and Technology Postdoctoral Research Associateship, 2002-2004.
2. Hutchison Endowment Fellowship, The University of Texas at Austin, 2000-2001.
3. Student Paper Award, Texas Section of the American Physical Society, Fall 1999.
4. Phi Beta Kappa Senior Thesis Award, Lake Forest College, May 1996.
5. Harald C. Jensen Prize for Research in Experimental Physics, Lake Forest College, May 1996.
6. Frederika L. Stahl Memorial Award for Excellence in Science– Physics, Lake Forest College, May 1996.
7. Emma O. Haas Memorial Award for Merit in Scholarship– Senior, Lake Forest College, May 1996.
8. Phi Beta Kappa, Theta of Illinois at Lake Forest College, April 1996.
9. Sigma Xi, Associate Member, Lake Forest College Chapter, 1995.

10. Pearl E. Pauker Prize in Science, Lake Forest College, September 1995.
11. Emma O. Haas Memorial Award for Merit in Scholarship– Junior, Lake Forest College, September 1995.
12. Emma O. Haas Memorial Award for Merit in Scholarship– Sophomore, Lake Forest College, October 1994.
13. Richter Apprentice Scholar, Lake Forest College, Summer 1993.

Refereed Publications

1. W. H. Oskay, W. M. Itano, and J. C. Bergquist, “Measurement of the $^{199}\text{Hg}^+ 5d^96s^2 2D_{5/2}$ Electric Quadrupole Moment and a Constraint on the Quadrupole Shift,” *Physical Review Letters* **94**, 163001 (2005).
2. L. Hollberg, C. W. Oates, G. Wilpers, C. W. Hoyt, Z. W. Barber, S. A. Diddams, W. H. Oskay, and J. C. Bergquist “Optical Frequency / wavelength References,” *Einstein Year Special Issue, Journal of Physics B: Atomic Molecular and Optical Physics* **38**, S469-S495 (2005).
3. A. Bartels, S. A. Diddams, C. W. Oates, G. Wilpers, J. C. Bergquist, W. H. Oskay, and L. Hollberg, “Femtosecond-laser-based synthesis of ultrastable microwave signals from optical frequency references,” *Optics Letters* **30**, 667 (2005).
4. S. Bize, S. A. Diddams, U. Tanaka, C. E. Tanner, W. H. Oskay, R. E. Drullinger, T. E. Parker, T. P. Heavner, S. R. Jefferts, L. Hollberg, W. M. Itano, and J. C. Bergquist “Testing the stability of fundamental constants with the $^{199}\text{Hg}^+$ single-ion optical clock,” *Physical Review Letters* **90**, 150802 (2003). (31 citations)
5. Windell H. Oskay, Daniel A. Steck, and Mark G. Raizen “Timing Noise Effects on Dynamical Localization,” *Chaos Solitons and Fractals* **16**, 409 (2003).
6. Windell H. Oskay, Daniel A. Steck, and Mark G. Raizen “Observation of Cumulative Spatial Focusing of Atoms,” *Physical Review Letters* **89**, 283001 (2002). This work was highlighted in an article by Phillip Espinasse, “Atom focusing gets its kicks,” *OE Magazine*, March 2003, p. 10.
7. Daniel A. Steck, Windell H. Oskay, and Mark G. Raizen “Fluctuations and decoherence in chaos-assisted tunneling,” *Physical Review Letters* **88**, 120406 (2002). (15 citations)
8. Daniel A. Steck, Windell H. Oskay, and Mark G. Raizen “Observation of Chaos-Assisted Tunneling Between Islands of Stability,” *Science* **293**, 274 (2001). Published online on July 5, 2001 (10.1126/science.1061569). Supplementary material is available online at <http://www.sciencemag.org/cgi/content/full/1061569/DC1>. (65 citations)

Scientific and popular press coverage:

- Salman Habib, “No Mere Anarchy,” *Science* **293**, 221 (2001) (10.1126/science.1062985).
- Eric J. Heller, “Air juggling and other tricks,” *Nature* **412**, 33 (2001).
- Barbara Goss Levi, “Atoms Hop between Islands of Regular Motion in a Sea of Chaos,” *Physics Today*, August 2001, p. 15.
- Amaury Mouchet and Denis Ullmo, “Chaos gives quantum tunnelling a hand,” *Physics World*, September 2001, p. 24.
- Mark Sincell, “Atoms Island-Hop,” *ScienceNOW* 2001 (706):1.
- “Atoms perform a quantum flip,” *PhysicsWeb News*, 5 July 2001.

- Nicole Stricker, “Quantum wizardry: New research turns a bright light on atoms’ tunneling phenomenon,” *The Dallas Morning News*, 30 July 2001, p. 3C.
9. Jianxin Zhong, R. B. Diener, Daniel A. Steck, Windell H. Oskay, Mark G. Raizen, Zhenyu Zhang, E. Ward Plummer, and Qian Niu, “Shape of the Quantum Diffusion Front,” *Physical Review Letters* **86**, 2485 (2001).
 10. Daniel A. Steck, Valery Milner, Windell H. Oskay, and Mark G. Raizen, “Quantitative study of amplitude noise effects on dynamical localization,” *Physical Review E* **62**, 3461 (2000). (23 citations)
 11. V. Milner, D. A. Steck, W. H. Oskay, and M. G. Raizen, “Recovery of classically chaotic behavior in a noise-driven quantum system,” *Physical Review E* **61**, 7223 (2000). (14 citations)
 12. W. H. Oskay, D. A. Steck, V. Milner, B. G. Klappauf, and M. G. Raizen, “Ballistic peaks at quantum resonance,” *Optics Communications* **179**, 137 (2000). (25 citations)
 13. B. G. Klappauf, W. H. Oskay, D. A. Steck, and M. G. Raizen, “Quantum chaos with cesium atoms: pushing the boundaries,” *Physica D* **131**, 78 (1999). (19 citations)
 14. B. G. Klappauf, W. H. Oskay, D. A. Steck, and M. G. Raizen, “Experimental Study of Quantum Dynamics in a Regime of Classical Anomalous Diffusion,” *Physical Review Letters* **81**, 4044 (1998). (38 citations)
 15. B. G. Klappauf, W. H. Oskay, D. A. Steck, and M. G. Raizen, “Observation of Noise and Dissipation Effects on Dynamical Localization,” *Physical Review Letters* **81**, 1203 (1998); Erratum, *Physical Review Letters* **82**, 241 (1999). (69 citations)
- Scientific and popular press coverage:
- Graham P. Collins, “The World of Quantum Chaos,” *Physical Review Focus* **2**, story 8 (10 August 1998).
 - Meher Antia, “Action at the Classical-Quantum Border,” *InSCIght* (27 August 1998).

Other Publications

1. W. H. Oskay, A. Bartels, S. A. Diddams, C. W. Oates, G. Wilpers, L. Hollberg, W. M. Itano, C. E. Tanner, and J. C. Bergquist “The Mercury-Ion Optical Clock: Towards a Measurement of the Quadrupole Shift,” *Proceedings of the 18th European Frequency and Time Forum* paper 59 (2004).
2. W. H. Oskay, S. Bize, S. A. Diddams, R. E. Drullinger, T. P. Heavner, L. Hollberg, W. M. Itano, S. R. Jefferts, T. E. Parker, U. Tanaka, C. E. Tanner, and J. C. Bergquist “The Mercury-Ion Optical Clock and the Search for Temporal Variation of Fundamental Constants,” *Proceedings of the 2003 IEEE International Frequency Control Symposium and 17th European Frequency and Time Forum* p. 78 (2003).
3. D. J. Wineland, J. C. Bergquist, T. Rosenband, P. O. Schmidt, W. M. Itano, J. J. Bollinger, D. Leibfried, and W. H. Oskay “Ion Optical Clocks and Quantum Information Processing,” *Proceedings of the 2003 IEEE International Frequency Control Symposium and 17th European Frequency and Time Forum* p. 68 (2003).
4. Windell Haven Oskay, “Atom Optics Experiments in Quantum Chaos,” Ph.D. dissertation, The University of Texas at Austin (2001). (Available online at <http://www.ph.utexas.edu/~quantopt/disses.html>.)
5. M. G. Raizen, V. Milner, W. H. Oskay, and D. A. Steck, “Experimental Study of Quantum Chaos with Cold Atoms,” in *Proceedings of the International School of Physics “Enrico Fermi,” Course CXLIII (20-30 July 1999): New Directions in Quantum Chaos*, G. Casati, I. Guarneri and U. Smilansky, Eds. (IOS Press, Amsterdam, 2000).

- W. H. Oskay, D. A. Steck, B. G. Klappauf, and M. G. Raizen, "Quantum Chaos with Cold Cesium Atoms," *Laser Physics* **9**, 265 (1999).

Seminars and Invited Talks

- W. H. Oskay, "The Mercury-Ion Optical Clock," seminar given at
 - 30th annual NIST Time and Frequency Metrology Seminar, 9 June 2005.
 - NIST Optical Frequency Measurements group, 15 March 2005.
 - Trinity College, Hartford Connecticut, 11 March 2005.
 - Reed College, Portland Oregon, 2 February 2005.
 - Oregon Center for Optics, University of Oregon, 10 January 2005.
 - National Physical Laboratory (UK), 2 April 2004.
- W. H. Oskay, "The mercury ion optical clock: Beyond the quadrupole shift," NIST Time and Frequency Division seminar, National Institute of Standards and Technology, Boulder, CO, 22 April 2005.
- W. H. Oskay, "Technical graphics with ray tracing," Tutorial series (6 lectures), National Institute of Standards and Technology, Boulder, CO, April 2005.
- W. H. Oskay, "Measuring the quadrupole moment in the mercury ion optical clock," Ion storage group seminar, National Institute of Standards and Technology, Boulder, CO, 25 March 2005.
- W. H. Oskay, "Metrology with Atomic Clocks," review talk presented at the 2004 QUEST Summer Retreat, Santa Fe, NM, 9 August 2004.
- W. H. Oskay, "Focusing atoms with the aperiodic kicked-rotor potential," Ion storage group seminar, National Institute of Standards and Technology, Boulder, CO, 30 August 2002.
- W. H. Oskay, "Focusing atoms with the aperiodic kicked-rotor potential," Ph.D. Final Defense, The University of Texas at Austin, 23 November 2001.
- W. H. Oskay, "Quantum Chaos in Atom Optics: Recent Results," Ph.D. Qualifying Seminar, The University of Texas at Austin, 16 October 1998.

Selected Conference Papers

- W. H. Oskay, W. M. Itano, and J. C. Bergquist, "Measurement of the Quadrupole Moment in the Mercury Ion Optical Clock," *To be presented at the 2005 IEEE/LEOS Summer Topical Meetings, San Diego, CA, 25 - 27 July 2005, paper TuB2.2.*
- W. H. Oskay, W. M. Itano, and J. C. Bergquist, "Constraining the Quadrupole Shift in the Mercury Ion Optical Clock," Presented at the 2005 Annual Meeting of the Division of Atomic, Molecular, and Optical Physics (DAMOP) of the American Physical Society, Lincoln, NE, 17 - 21 May 2005, paper M6.00103 (poster session).
- W. H. Oskay, M. J. Jensen, S. R. Jefferts, E. A. Donley, T. P. Heavner, T. E. Parker, K. Kim, T. M. Fortier, S. A. Diddams, L. Hollberg, W. M. Itano, J. C. Bergquist, "Absolute Frequency Measurement of the Optical Clock Frequency in a Single $^{199}\text{Hg}^+$ Ion," Presented at the 19th European Frequency and Time Forum (EFTF), Besançon, France, 21 - 24 March 2005 (postdeadline paper).

4. W. H. Oskay, T. Rosenband, U. Tanaka, C. E. Tanner, S. A. Diddams, L. Hollberg, W. M. Itano, J. C. Bergquist, "The Mercury Ion Optical Clock," presented at the 2004 Annual Meeting of the Division of Atomic, Molecular, and Optical Physics (DAMOP) of the American Physical Society, Tucson, AZ, 25 - 29 May 2004, paper J1.50 (poster session). Abstract published as *Bulletin of the American Physical Society* **49**, No. 3, 76 (2004).
5. A. Bartels, S. A. Diddams, C. W. Oates, W. H. Oskay, J. Bergquist, and L. Hollberg "Extremely low noise microwave signals synthesized from stable CW lasers with femtosecond frequency combs" presented at the 2004 Conference on Lasers and Electro-Optics/International Quantum Electronics Conference (CLEO/IQEC), Baltimore, MD, 18 - 20 May 2004, paper CPDC10 (postdeadline session).
6. W. H. Oskay, T. Rosenband, U. Tanaka, C. E. Tanner, S. A. Diddams, L. Hollberg, W. M. Itano, and J. C. Bergquist, "The Mercury-Ion Optical Clock," Presented at the 18th European Frequency and Time Forum (EFTF), Guildford, UK, 5 - 7 April 2004.
7. W. H. Oskay, S. Bize, S. A. Diddams, U. Tanaka, C. E. Tanner, T. Parker, R. E. Drullinger, T. Heavner, S. R. Jefferts, L. Hollberg, W. M. Itano, J. C. Bergquist, "Testing the stability of fundamental constants with the $^{199}\text{Hg}^+$ single-ion optical clock," presented at the 2003 Annual Meeting of the Division of Atomic, Molecular, and Optical Physics (DAMOP) of the American Physical Society, Boulder, CO, 21 - 24 May 2003, paper B4.4. Abstract published as *Bulletin of the American Physical Society* **48**, No. 3, 14 (2003).
8. W. H. Oskay, S. Bize, S. A. Diddams, U. Tanaka, C. E. Tanner, T. Parker, R. E. Drullinger, T. Heavner, S. R. Jefferts, L. Hollberg, W. M. Itano, D. J. Wineland, and J. C. Bergquist, "The Mercury-Ion Optical Clock and the Search for Time Variation of Fundamental Constants," Presented at the 2003 IEEE International Frequency Control Symposium (FCS) and PDA Exhibition and the 17th European Frequency and Time Forum (EFTF), Tampa, FL, 5 - 8 May 2003.
9. W. H. Oskay, D. A. Steck, and M. G. Raizen, "Chaos-assisted tunneling in atom optics," presented at the 2001 Annual Meeting of the Division of Atomic, Molecular, and Optical Physics (DAMOP) of the American Physical Society, London, Ontario, Canada, 16 - 19 May 2001, paper J4.004. Abstract published as *Bulletin of the American Physical Society* **46**, No. 3 55 (2001).
10. D. A. Steck, W. H. Oskay, and M. G. Raizen, "Probing mixed phase space dynamics using atom optics," presented at the 2001 Quantum Electronics and Laser Science Conference (QELS), Baltimore, MD, 6 - 11 May 2001, paper QThI26 (poster session). Abstract published as *Technical Digest; Summaries of Papers Presented at the Quantum Electronics and Laser Science Conference, 2001* (Optical Society of America, Washington, DC, 2001) p. 217.
11. W. H. Oskay, V. Milner, D. A. Steck, and M. G. Raizen, "Recovering the Classical Limit with Noise in the Quantum Kicked Rotor," presented at the International School of Physics "Enrico Fermi," CXLVI Course, "Recent advances in Metrology and Fundamental Constants," Varenna Italy, 25 July - 4 August 2000, (poster session).
12. D. A. Steck, V. Milner, W. H. Oskay, and M. G. Raizen, "Recovery of Classically Chaotic Behavior with Noise in the Quantum Kicked Rotor," presented at the 2000 Quantum Electronics and Laser Science Conference (QELS), San Francisco, CA, 7 - 12 May 2000, paper QThB2. Abstract published as *Technical Digest; Quantum Electronics and Laser Science Conference, 2000*, (Optical Society of America, Washington, DC, 2000) p. 165.
13. W. H. Oskay, V. Milner, D. A. Steck, and M. G. Raizen, "Recovering the Classical Limit with Noise in the Quantum Kicked Rotor," presented at the Fall 1999 Meeting of the Texas Section of the American Physical Society, Austin, TX, 28 - 30 October 1999, paper H54.06.

14. W. H. Oskay, D. A. Steck, B. G. Klappauf, and M. G. Raizen, "Quantum Signatures of Anomalous Diffusion" presented at the 1999 Quantum Electronics and Laser Science Conference (QELS), Baltimore, MD, 23 - 28 May 1999, paper QThK3. Abstract published as *Technical Digest; Summaries of papers presented at the Quantum Electronics and Laser Science Conference, 1999* (Optical Society of America, Washington, DC, 1999) p. 240.
15. W. H. Oskay, B. G. Klappauf, V. Milner, D. A. Steck, and M. G. Raizen, "Experiments on the Role of Noise, Dissipation, and Dimensionality on Dynamical Localization," presented at the American Physical Society Centennial Meeting, Atlanta, GA, 20 - 26 March 1999, paper RP01.03 (poster session). Abstract published as *Bulletin of the American Physical Society* **44**, No. 1, 1244 (1999).
16. D. A. Steck, W. H. Oskay, B. G. Klappauf, and M. G. Raizen, "Experimental Study of Quantum Chaos with Cesium Atoms," presented at the 1998 Annual Meeting of the Division of Atomic, Molecular, and Optical Physics (DAMOP) of the American Physical Society, Santa Fe, NM, 27 - 30 May 1998, paper HP72 (poster session). Abstract published as *Bulletin of the American Physical Society* **43**, No. 3 1308 (1998).
17. B. G. Klappauf, W. H. Oskay, D. A. Steck, and M. G. Raizen, "Quantum Signatures of Anomalous Diffusion in Atom Optics," presented at the 1998 International Quantum Electronics Conference (IQEC), Baltimore, MD, 3 - 8 May 1998, paper QPD9-2 (postdeadline session).

Professional Affiliations

American Physical Society
American Association of Physics Teachers
Phi Beta Kappa

Personal Information

Born: Portland, Oregon, October 26, 1974.
Citizenship: United States of America

References

Available upon request.

5 July 2005