

## Thad G. Walker

*Professor of Physics, University of Wisconsin-Madison*

### Education

- 1988 PHD Physics, Princeton University. Dissertation: *Relaxation of Long-Lived Atomic States*
- 1986 MA Physics, Princeton University
- 1983 BS Physics, Abilene Christian University

### Professional and Research Experience

- 1990–1988-90 Professor of Physics, University of Wisconsin-Madison (1990-3 Asst., 1993-7 Assoc.)
- 1988-90 Research Associate, JILA, University of Colorado.
- 1988 Research Associate, Princeton University.

### Awards

- 2000 Vilas Associate Award, University of Wisconsin-Madison
- 1999 Fellow, American Physical Society, *For pioneering research in spin exchange, optical pumping, ultra-cold collisions, spin polarized beams and targets, laser cooling, and electron scattering.*
- 1996 H. I. Romnes Fellowship, University of Wisconsin-Madison
- 1992 Packard Fellowship in Science and Engineering
- 1992 National Science Foundation Young Investigator Award
- 1991 Alfred P. Sloan Fellowship Award
- 1983 Fred J. Barton Award, Abilene Christian University.

### Research Interests

Atomic, Molecular, and Optical Physics: Spin-exchange optical pumping; Biomagnetometry; Laser cooling and trapping of atoms; Quantum computation with Rydberg atoms.

### Publication Summary

- 1985–1988 REFEREED ARTICLES: ~ 119; h-number 32.
- 2010 BOOK: *Optically Pumped Atoms*, by William Happer, Yuan-Yu Jau, and Thad G. Walker
- MAJOR REVIEWS:
- 2010 "[Quantum Information with Rydberg Atoms](#)", *Reviews of Modern Physics*
- 1998 "[Spin-Exchange Optical Pumping of Noble-Gas Nuclei](#)", *Reviews of Modern Physics*
- 1995 "[Measurements of Collisions Between Laser-Cooled Atoms](#)", *Advances in Atomic, Molecular, and Optical Physics*
- RECENT ARTICLES OF NOTE:
- 2015 "[Coherence and Rydberg Blockade of Atomic Ensemble Qubits](#)", *Phys. Rev. Lett.* **115**, 093601.
- 2014 "[Atomic Fock State Preparation Using Rydberg Blockade](#)", *Phys. Rev. Lett.* **112**, 043602.
- 2013 "[Laboratory Search for a Long-Range  \$T\$ -Odd,  \$P\$ -Odd Interaction from Axionlike Particles Using Dual-Species Nuclear Magnetic Resonance with Polarized  \$^{129}\text{Xe}\$  and  \$^{131}\text{Xe}\$  Gas](#)", *Phys. Rev. Lett.* **111**, 102001.
- 2013 "[Suppression of Spin-Exchange Relaxation Using Pulsed Parametric Resonance](#)", *Phys. Rev. Lett.* **111**, 043002.
- 2012 "[Optical Magnetometer Array for Fetal Magnetocardiography](#)", *Opt. Lett.* **37**, 2247.
- 2010 "[Demonstration of a neutral atom controlled-NOT quantum gate](#)", *Phys. Rev. Lett.* **104**, 010503.

## Patents

- 2000 *Frequency-Narrowed High Power Diode Laser Array Method and System*, co-inventors I. Nelson and B. Chann, U. S. patent #6,584,133
- 2000 *Frequency-Narrowed High Power Diode Laser System with External Cavity*, co-inventors I. Nelson and B. Chann, U. S. patent #6,868,099
- 2011 *Noble Gas Magnetic Resonator*, co-inventors B. Lancor, R. Wyllie, US Patent #20,130,033,261
- 2012 *Gas Magnetometer*, co-inventors B. Lancor, R. Wyllie, US Patent #20,130,033,255

## National Committee Service

- 2014-7 Member, NASA Fundamental Physics Science Standing Review Board
- 2013-4 Local host, 45th DAMOP Meeting
- 2012-5 DAMOP Program Committee
- 2009 Chosen as "Outstanding Referee" by the American Physical Society
- 2007 Organizer, Midwest Cold Atoms Workshop
- 2006-7 DAMOP Nomination Committee, Chair.
- 2005 Chair, DLS Nomination Committee.
- 2003-5 DAMOP Program Committee.
- 2000-2003 NRC Panel, NIST Physics Division. Chair, Atomic Physics Panel.
- 1999-2002 Chair, APS DAMOP Education Committee.
- 1997-2000 NIST Precision Measurements Grants Committee.
- 1997 Member, NSF Physics Division Committee of Visitors.
- 1997-2001 APS DAMOP Executive Committee, Program Committee, Education Committee.
- 1996-7 Secretary, 50th Gaseous Electronics Conference.
- 1996-1999 Executive Committee, Gaseous Electronics Conference.

## Research Advisees

PHD (15): D. Hoffmann (1996), P. Feng (1996), R. Williamson (1997), R. Nesnidal (1999), S. Kadlecik (1999), I. Nelson (2001), B. Chann (2003), R. Newell (2003), J. Sebbby-Strabley (2004), E. Babcock (2005), J. Day (2008), E. Brekke (2009), E. Urban (2009), B. Lancor, (2011), R. Wyllie (2012). Current PhD Students: Z. DeLand, M. Ebert, A. Korver, M. Bulatowicz, D. Thrasher.

POSTDOCTORAL ADVISEES: J. Tobiason, S. Bali, R. S. Schappe, C. Sukenik, S. Kadlecik, P. Kulatunga, D. Yavuz, Z. Li, M. Kauer, X. Zhang, B. Lancor, I. Sulai.

## Teaching Highlights

### COURSES TAUGHT

Introductory level: General Physics, Introduction to Modern Physics, Modern Physics for Engineers, A Modern Introduction to Physics

Advanced Undergraduate level: Electric Circuits and Electronics, Electromagnetic Fields, Wave Motion and Optics, Atomic and Quantum Physics

Graduate level: Lasers, Applied Optics, Quantum Electronics

### INNOVATION

Led review (1998-9) of Physics undergraduate program; development of a new introductory course sequence for physics majors, *A Modern Introduction to Physics*, in which modern physics is taught from the very beginning. The number of physics majors doubled as a result. Introduced *Mathematica* into quantum mechanics course to reduce student algebra burdens; allows richer questions to be investigated and improves computer literacy among physics students.

## Research Highlights

### LASER TRAPPING AND COOLING OF ATOMS

Laser cooling methods have made a dramatic impact on atomic physics, resulting in three Nobel Prizes. Laser cooled atoms are used for Bose-Einstein condensation, atomic clocks, ultracold collisions, and quantum information processing. Some of the contributions of Prof. Walker and his group are:

- First diode-laser atom trap, light-intensity dependence of ultracold collisions (Pub. #12)<sup>1</sup>
- Discovery and explanation of light-induced collective phenomena in traps (Pub. #14)
- Spin-polarized trapping of atoms. (Pub. #19)
- First observation of Landau-Zener excitation in ultracold collisions. (Pub. #26)
- First use of trapped atoms as target for scattering experiments. (Pub. # 30,37)
- Demonstration of funnel-loaded trap (Pub. #44)
- Spatial heterodyne imaging of atoms– 1/1000 photon per atom. (Pub. #52)
- New concepts in single atom, single photon sources (Pub. # 62)
- Record trapped-atom densities in Holographic Atom Trap(Pub. # 64,71)
- High fidelity quantum manipulation of atoms in an array of traps (Pub. #77)
- Coherent Rabi Oscillations With Rydberg Atoms (Pub. #82)
- Rydberg Blockade of single atoms 10  $\mu$ m apart. (Pub. #87)
- First Neutral Atom CNOT gate (Pub. #89)
- Deterministic entanglement of neutral atom pairs (Pub. #94)
- Review article on quantum information with Rydberg atoms (Pub. #92)
- Production of Atomic Fock states using Rydberg blockade (Pub. #116)
- Coherence and blockade of W-states of ensembles (Pub. #120)

### SPIN-POLARIZED ATOMS

Optical Pumping is an important method for producing spin polarized samples of atoms and nuclei for magnetic-resonance imaging, polarized ion beams for accelerators, targets for scattering experiments, and high sensitivity detectors such as magnetometers. Major contributions include:

- Origin of spin-rotation interaction in alkali–noble-gas molecules (Pub. #2), (Pub. #39).
- Reliable estimates of spin-exchange and spin-relaxation rates (Pub. #13).
- Prediction (subsequently experimentally confirmed by groups at Argonne and Erlangen) of nuclear polarization of H and D atoms by spin-exchange at high fields. (Pub. #21)
- Discovery of alkali-alkali spin-relaxation due to triplet dimer formation (Pub # 41, 51)
- Invention of new narrow-band high power laser sources (Pub #48, 50, 66).
- Discovery of Xe-Xe molecular spin relaxation (Pub. #58)
- State-of-the-art measurements of spin-relaxation rates. (Pub # 57,59)
- Hybrid spin-exchange optical pumping. (Pub. #65)
- Discovery of ‘X-factor’ polarization limits of Rb-<sup>3</sup>He. (Pub. #76)
- Major review article on spin-exchange optical pumping. (Pub. #38)
- Novel method for atomic magnetometry (Pub. #78)
- Discovery of angular momentum selection rule violation (Pub. #93)
- First detection of fetal magnetocardiography with an atomic magnetometer (Pub. #104)

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<sup>1</sup>Publication numbers refer to the publication list on pages ??-??.

## Publications in Refereed Journals

- 27 Physical Review Letters, Nature Physics  
2 Reviews of Modern Physics  
7 Optics Letters, Optics Express  
13 Applied Physics Letters, Physical Review Rapid Communications, Europhysics Letters, Physics Letters, Chemical Physics Letters, Laser Physics Letters  
3 Advances in Atomic, Molecular, and Optical Physics  
44 Archival journals: Physical Review, Journal of the Optical Society of America, Journal of Applied Physics, Applied Optics, Journal of Chemical Physics
121. "Synchronous Spin-Exchange Optical Pumping", A. Korver, D. Thrasher, M. Bulatowicz, and T. Walker, ArXiv 1506.08797 (2015) [eprint](#)
120. "Coherence and Rydberg Blockade of Atomic Ensemble Qubits", M. Ebert, M. Kwon, T. G. Walker, and M. Saffman, Phys. Rev. Lett. **115**, 093601 (Aug 2015) [eprint](#)
119. "Synchronously Pumped NMR Gyro", T. Walker, A. Korver, D. Thrasher, and M. Bulatowicz, 2015 IEEE International Symposium on Inertial Sensors and Systems (2015) [eprint](#)
118. "Accurate energies of the He atom with undergraduate quantum mechanics", R. C. Massé and T. G. Walker, American Journal of Physics **83**(8), 730 (2015) [eprint](#)
117. "Comment on "New Limit on Lorentz-Invariance- and *CPT*-Violating Neutron Spin Interactions Using a Free-Spin-Precession  $^3\text{He}$ - $^{129}\text{Xe}$  Comagnetometer"", M. V. Romalis, D. Sheng, B. Saam, and T. G. Walker, Phys. Rev. Lett. **113**, 188901 (Oct 2014) [eprint](#)
116. "On the limits of spin-exchange optical pumping of  $3\text{He}$ ", W. C. Chen, T. R. Gentile, Q. Ye, T. G. Walker, and E. Babcock, Journal of Applied Physics **116**(1), (2014) [eprint](#)
115. "Atomic Fock State Preparation Using Rydberg Blockade", M. Ebert, A. Gill, M. Gibbons, X. Zhang, M. Saffman, and T. Walker, Phys. Rev. Lett. **112**, 043602 (2013) [eprint](#)
114. "Preparation of a single atom in an optical microtrap", A. V. Carpentier, Y. H. Fung, P. Sompet, A. J. Hilliard, T. G. Walker, and M. F. Andersen, Laser Phys. Lett. **10**(12) (2013) [eprint](#)
113. "Laboratory Search for a Long-Range *T*-Odd, *P*-Odd Interaction from Axionlike Particles Using Dual-Species Nuclear Magnetic Resonance with Polarized  $^{129}\text{Xe}$  and  $^{131}\text{Xe}$  Gas", M. Bulatowicz, R. Griffith, M. Larsen, J. Mirijanian, C. B. Fu, E. Smith, W. M. Snow, H. Yan, and T. G. Walker, Phys. Rev. Lett. **111**, 102001 (Sep 2013) [eprint](#)
112. "Comment on "Enhanced polarization and mechanisms in optically pumped hyperpolarized  $^3\text{He}$  in the presence of  $^4\text{He}$ ", T. R. Gentile, M. E. Hayden, P. J. Nacher, A. K. Petukhov, B. Saam, and T. G. Walker, Phys. Rev. A **88**, 017401 (Jul 2013)
111. "Suppression of Spin-Exchange Relaxation Using Pulsed Parametric Resonance", A. Korver, R. Wyllie, B. Lancor, and T. G. Walker, Phys. Rev. Lett. **111**, 043002 (Jul 2013) [eprint](#)
110. "Wide Angle Polarization Analysis with Neutron Spin Filters", Q. Ye, T. Gentile, J. Anderson, C. Broholm, W. Chen, Z. DeLand, R. Erwin, C. Fu, J. Fuller, A. Kirchhoff, J. Rodriguez-Rivera, V. Thampy, T. Walker, and S. Watson, Physics Procedia **42**(0), 206 (2013) [eprint](#)

109. "Diffusive suppression of AC-Stark shifts in atomic magnetometers", I. A. Sulai, R. Wyllie, M. Kauer, G. S. Smetana, R. T. Wakai, and T. G. Walker, *Opt. Lett.* **38**(6), 974 (Mar 2013) [eprint](#)
108. "Quantum optics: Strongly interacting photons", T. G. Walker, *Nature* **488**(7409), 39 (2012) [eprint](#)
107. "Excitation suppression due to interactions between microwave-dressed Rydberg atoms", E. Brekke, J. O. Day, and T. G. Walker, *Phys. Rev. A* **86**, 033406 (Sep 2012) [eprint](#)
106. "Matrix Numerov method for solving Schrödinger's equation", M. Pillai, J. Goglio, and T. G. Walker, *Am. J. Phys.* **80**(11), 1017 (2012) [eprint](#)
105. "Entanglement of Two Atoms Using Rydberg Blockade", T. G. Walker and M. Saffman, *Adv. At. Mol. Opt. Phys.* **61**, 81 (2012) [eprint](#)
104. "Optical magnetometer array for fetal magnetocardiography", R. Wyllie, M. Kauer, R. T. Wakai, and T. G. Walker, *Opt. Lett.* **37**(12), 2247 (Jun 2012) [eprint](#)
103. "Fidelity of a Rydberg-blockade quantum gate from simulated quantum process tomography", X. L. Zhang, A. T. Gill, L. Isenhower, T. G. Walker, and M. Saffman, *Phys. Rev. A* **85**, 042310 (Apr 2012) [eprint](#)
102. "Magnetocardiography with a modular spin-exchange relaxation-free atomic magnetometer array", R. Wyllie, M. Kauer, G. S. Smetana, R. T. Wakai, and T. G. Walker, *Phys. Med. Biol.* **57**(9), 2619 (2012) [eprint](#)
101. "Rydberg state mediated quantum gates and entanglement of pairs of neutral atoms", M. Saffman, X. L. Zhang, A. T. Gill, L. Isenhower, and T. G. Walker, *J. Phys. Conf. Ser.* **264**(1), 012023 (2011) [eprint](#)
100. "Formation and dynamics of van der Waals molecules in buffer-gas traps", N. Brahm, T. V. Tscherbul, P. Zhang, J. Klos, R. C. Forrey, Y. S. Au, H. R. Sadeghpour, A. Dalgarno, J. M. Doyle, and T. G. Walker, *Phys. Chem. Chem. Phys.* **13**, 19125 (2011) [eprint](#)
99. "Polarization limits in K-Rb spin-exchange mixtures", B. Lancor and T. G. Walker, *Phys. Rev. A* **83**, 065401 (Jun 2011) [eprint](#)
98. "Effects of high intensity neutron flux on in-situ spin-exchange optical pumping of  $^3\text{He}$ ", E. Babcock, S. Boag, C. Beecham, T. E. Chupp, T. R. Gentile, G. L. Jones, A. K. Petukhov, and T. G. Walker, *J. Phys. Conf. Ser.* **294**(1), 012011 (2011) [eprint](#)
97. "Fundamentals of Spin-Exchange Optical Pumping", T. G. Walker, *J. Phys. Conf. Ser.* **294**(1), 012001 (2011) [eprint](#)
96. "Effects of nitrogen quenching gas on spin-exchange optical pumping of  $^3\text{He}$ ", B. Lancor and T. G. Walker, *Phys. Rev. A* **82**, 043417 (Oct 2010) [eprint](#)
95. "Circular dichroism of RbHe and RbN<sub>2</sub> molecules", B. Lancor, E. Babcock, R. Wyllie, and T. G. Walker, *Phys. Rev. A* **82**, 043435 (Oct 2010) [eprint](#)
94. "Deterministic entanglement of two neutral atoms via Rydberg blockade", X. L. Zhang, L. Isenhower, A. T. Gill, T. G. Walker, and M. Saffman, *Phys. Rev. A* **82**, 030306 (Sep 2010) [eprint](#)

93. "Breakdown of Angular Momentum Selection Rules in High Pressure Optical Pumping Experiments", B. Lancor, E. Babcock, R. Wyllie, and T. G. Walker, *Phys. Rev. Lett.* **105**, 083003 (Aug 2010) [eprint](#)
92. "Quantum information with Rydberg atoms", M. Saffman, T. G. Walker, and K. Mølmer, *Rev. Mod. Phys.* **82**, 2313 (Aug 2010) [eprint](#)
91. "Formation of van der Waals Molecules in Buffer-Gas-Cooled Magnetic Traps", N. Brahm, T. V. Tscherbul, P. Zhang, J. Klos, H. R. Sadeghpour, A. Dalgarno, J. M. Doyle, and T. G. Walker, *Phys. Rev. Lett.* **105**, 033001 (Jul 2010) [eprint](#)
90. "Method for deducing anisotropic spin-exchange rates", T. G. Walker, I. A. Nelson, and S. Kadlecek, *Phys. Rev. A* **81**, 032709 (Mar 2010) [eprint](#)
89. "Demonstration of a Neutral Atom Controlled-NOT Quantum Gate", L. Isenhower, E. Urban, X. L. Zhang, A. T. Gill, T. Henage, T. A. Johnson, T. G. Walker, and M. Saffman, *Phys. Rev. Lett.* **104**, 010503 (Jan 2010) [eprint](#) This work was [written up](#) in the Feb. 2010 issue of *Physics Today* and highlighted in a *Physics* synopsis, [Opening the gate to quantum computation](#).
88. "Effects of high-flux neutron beams on  $^3\text{He}$  cells polarized *in situ* with spin-exchange optical pumping", E. Babcock, S. Boag, M. Becker, W. C. Chen, T. E. Chupp, T. R. Gentile, G. L. Jones, A. K. Petukhov, T. Soldner, and T. G. Walker, *Phys. Rev. A* **80**, 033414 (Sep 2009) [eprint](#)
87. "Observation of Rydberg blockade between two atoms", E. Urban, T. A. Johnson, T. Henage, L. Isenhower, D. D. Yavuz, T. G. Walker, and M. Saffman, *Nature Phys.* **5**, 110 (2009) [eprint](#) Articles by others concerning this paper were [Rydberg atoms: There can be only one](#), M. Weidemüller, *Nature Physics* **5**, 91 - 92 (2009), [Experiments show blockading interaction of Rydberg atoms over long distances](#), B. Schwarzschild, *Physics Today*, Feb. 2009, pg 15.
86. "Four-wave mixing in ultracold atoms using intermediate Rydberg states", E. Brekke, J. O. Day, and T. G. Walker, *Phys. Rev. A* **78**(6), 063830 (2008) [eprint](#)
85. "Neutron Beam Effects on Spin-Exchange-Polarized  $^3\text{He}$ ", M. Sharma, E. Babcock, K. H. Andersen, L. Barrón-Palos, M. Becker, S. Boag, W. C. Chen, T. E. Chupp, A. Danagoulian, T. R. Gentile, A. Klein, S. Penttila, A. Petoukhov, T. Soldner, E. R. Tardiff, T. G. Walker, and W. S. Wilburn, *Phys. Rev. Lett.* **101**, 083002 (Aug 2008) [eprint](#)
84. "Dynamics of low-density ultracold Rydberg gases", J. O. Day, E. Brekke, and T. G. Walker, *Phys. Rev. A* **77**(5), 052712 (2008) [eprint](#)
83. "Consequences of Zeeman degeneracy for the van der Waals blockade between Rydberg atoms", T. G. Walker and M. Saffman, *Phys. Rev. A* **77**, 032723 (2008) [eprint](#)
82. "Rabi Oscillations between Ground and Rydberg States with Dipole-Dipole Atomic Interactions", T. A. Johnson, E. Urban, T. Henage, L. Isenhower, D. D. Yavuz, T. G. Walker, and M. Saffman, *Phys. Rev. Lett.* **100**(11), 113003 (2008) [eprint](#)
81. "Optical forces on particles of arbitrary shape and size", D. Bonessi, K. Bonin, and T. Walker, *J. Opt. A* **9**(8), S228 (2007) [eprint](#)
80. "Comment on " $M_F$ -Dependent Lifetimes Due to Hyperfine Induced Interference Effects"", T. G. Walker and C. J. Goebel, *Phys. Rev. Lett.* **98**, 269303 (Jun 2007)

79. "Spin-exchange optical pumping of [<sup>3</sup>He with Rb-K mixtures and pure K", W. C. Chen, T. R. Gentile, T. G. Walker, and E. Babcock, *Phys. Rev. A* **75**(1), 013416 (2007)
78. "Parametric modulation of an atomic magnetometer", Z. Li, R. T. Wakai, and T. G. Walker, *Appl. Phys. Lett.* **89**(13), 134105 (2006) [eprint](#)
77. "Fast Ground State Manipulation of Neutral Atoms in Microscopic Optical Traps", D. D. Yavuz, P. B. Kulatunga, E. Urban, T. A. Johnson, N. Proite, T. Henage, T. G. Walker, and M. Saffman, *Phys. Rev. Lett.* **96**, 063001 (2006) [eprint](#)
76. "Limits to the Polarization for Spin-Exchange Optical Pumping of <sup>3</sup>He", E. Babcock, B. Chann, T. G. Walker, W. C. Chen, and T. R. Gentile, *Phys. Rev. Lett.* **96**, 083003 (Mar 2006) [eprint](#)
75. "Analysis of a quantum logic device based on dipole-dipole interactions of optically trapped Rydberg atoms", M. Saffman and T. G. Walker, *Phys. Rev. A* **72**, 022347 (2005)
74. "Entangling single- and N-atom qubits for fast quantum state detection and transmission", M. Saffman and T. G. Walker, *Phys. Rev. A* **72**, 042302 (2005)
73. "Nonlinear motion of optically torqued nanorods", W. A. Shelton, K. D. Bonin, and T. G. Walker, *Phys. Rev. E* **71**, 036204 (Mar 2005)
72. "He-3 polarization-dependent EPR frequency shifts of alkali-metal He-3 pairs", E. Babcock, I. A. Nelson, S. Kadlecsek, and T. G. Walker, *Phys. Rev. A* **71**(1), 013414 (Jan 2005)
71. "High-density mesoscopic atom clouds in a holographic atom trap", J. Sebby-Strabley, R. T. R. Newell, J. O. Day, E. Brekke, and T. G. Walker, *Phys. Rev. A* **71**(2), 021401 (Feb 2005) [eprint](#)
70. "Frequency-narrowed diode array bar", E. Babcock, B. Chann, I. A. Nelson, and T. G. Walker, *Appl. Opt.* **44**(15), 3098 (2005)
69. "Polarized <sup>3</sup>He Spin Filters for Slow Neutron Physics.", T. R. Gentile, W. C. Chen, and G. L. Jones, *J. Res. Nat. Inst. Stand. & Tech.* **110**(3), 299 (2005)
68. "Polarized spin filters in neutron scattering", T. Gentile, E. Babcock, J. Borchers, W. Chen, D. Hussey, G. Jones, W. Lee, C. Majkzrak, K. O'Donovan, W. Snow, X. Tong, S. te Velthuis, T. Walker, and H. Yan, *Physica B* **356**(1-4), 96 (2005)
67. "Zeros of Rydberg-Rydberg Föster interactions", T. G. Walker and M. Saffman, *J. Phys. B* **38**, S309 (2005)
66. "Production of highly polarized <sup>3</sup>-He using spectrally narrowed diode laser array bars", B. Chann, E. Babcock, L. W. Anderson, T. G. Walker, W. C. Chen, T. B. Smith, A. K. Thompson, and T. R. Gentile, *J. Appl. Phys.* **94**(10), 6908 (2003)
65. "Hybrid Spin-Exchange Optical Pumping of He-3", E. Babcock, I. Nelson, S. Kadlecsek, B. Driehuys, L. W. Anderson, F. W. Hersman, and T. G. Walker, *Phys. Rev. Lett.* **91**(12), 123003 (Sep 2003) [eprint](#)
64. "Dense atom clouds in a holographic atom trap", R. Newell, J. Sebby, and T. G. Walker, *Opt. Lett.* **28**(14), 1266 (2003) [eprint](#)



63. "Methods of measuring electron-atom collision cross sections with an atom trap", R. Schappe, M. Keeler, T. A. Zimmerman, M. Larsen, P. Feng, R. C. Nesnidal, J. B. Boffard, T. G. Walker, L. Anderson, and C. C. Lin, *Adv. At. Mol. Opt. Phys.* **48**, 357 (2002)
62. "Creating single-atom and single-photon sources from entangled atomic ensembles", M. Saffman and T. G. Walker, *Phys. Rev. A* **66**, 065403 (2002) [eprint](#)
61. "Skew light propagation in optically thick optical pumping cells", B. Chann, E. Babcock, L. W. Anderson, and T. G. Walker, *Phys. Rev. A* **66**(3), 033406 (2002)
60. "Light torque nanocontrol, nanomotors and nanorockers", K. Bonin, B. Kourmanov, and T. Walker, *Opt. Express* **10**(19), 984 (Sep 2002)
59. "Measurements of  $^3\text{He}$  spin-exchange rates", B. Chann, E. Babcock, L. W. Anderson, and T. G. Walker, *Phys. Rev. A* **66**(3), 032703 (2002) [eprint](#)
58. "Xe129-Xe Molecular Spin Relaxation", B. Chann, I. A. Nelson, L. W. Anderson, B. Driehuys, and T. G. Walker, *Phys. Rev. Lett.* **88**(11), 113201 (2002) [eprint](#)
57. "Rb-Xe spin relaxation in dilute Xe mixtures", I. A. Nelson and T. G. Walker, *Phys. Rev. A* **65**(1), 012712 (Dec 2001) [eprint](#)
56. "Spin relaxation in alkali-metal  $^1\Sigma_g^+$  dimers", S. Kadlecsek, L. W. Anderson, C. J. Erickson, and T. G. Walker, *Phys. Rev. A* **64**, 052717 (Oct 2001)
55. "Nuclear Polarization of Hydrogen Molecules from Recombination of Polarized Atoms", T. Wise, W. Haeberli, B. Lorentz, P. A. Quin, F. Rathmann, B. Schwartz, T. G. Walker, A. Wellinghausen, J. T. Balewski, J. Doskow, H. O. Meyer, R. E. Pollock, B. v. Przewoski, T. Rinckel, S. K. Saha, and P. V. Pancella, *Phys. Rev. Lett.* **87**, 042701 (Jul 2001) [eprint](#)
54. "Spin-axis relaxation in spin-exchange collisions of alkali-metal atoms", S. Kadlecsek, T. Walker, D. K. Walter, C. Erickson, and W. Happer, *Phys. Rev. A* **63**(5), 052717 (Apr 2001)
53. "Faraday rotation density measurements of optically thick alkali metal vapors", E. Vliegen, S. Kadlecsek, L. Anderson, T. Walker, C. Erickson, and W. Happer, *Nuc. Inst. Meth. Phys. Res. A* **460**(2-3), 444 (2001)
52. "Nondestructive spatial heterodyne imaging of cold atoms", S. Kadlecsek, J. Sebby, R. Newell, and T. G. Walker, *Opt. Lett.* **26**(3), 137 (2001) [eprint](#)
51. "Spin Relaxation Resonances due to the Spin-Axis Interaction in Dense Rubidium and Cesium Vapor", C. J. Erickson, D. Levron, W. Happer, S. Kadlecsek, B. Chann, L. W. Anderson, and T. G. Walker, *Phys. Rev. Lett.* **85**, 4237 (Nov 2000) [eprint](#)
50. "Frequency-narrowed external-cavity diode-laser-array bar", B. Chann, I. Nelson, and T. G. Walker, *Opt. Lett.* **25**(18), 1352 (2000) [eprint](#)
49. "Light-induced ultracold spin-exchange collisions", R. C. Nesnidal and T. G. Walker, *Phys. Rev. A* **62**, 030701 (Aug 2000)
48. "Spin-exchange optical pumping using a frequency-narrowed high power diode laser", I. A. Nelson, B. Chann, and T. G. Walker, *Appl. Phys. Lett.* **76**(11), 1356 (2000) [eprint](#)
47. "Holography without photography", T. G. Walker, *Am. J. Phys.* **67**(9), 783 (1999)



46. "Role of spontaneous emission in ultracold two-color optical collisions", C. I. Sukenik and T. Walker, *Phys. Rev. A* **59**, 889 (Jan 1999)
45. "Estimates of the relative magnitudes of the isotropic and anisotropic magnetic-dipole hyperfine interactions in alkali-metal-noble-gas systems", D. K. Walter, W. Happer, and T. G. Walker, *Phys. Rev. A* **58**, 3642 (Nov 1998)
44. "A magneto-optical trap loaded from a pyramidal funnel", R. Williamson, P. Voytas, R. Newell, and T. Walker, *Opt. Express* **3**, 111 (1998) [eprint](#)
43. "Elastic and Inelastic Collisions of Cold Spin-Polarized  $^{133}\text{Cs}$  Atoms", P. J. Leo, E. Tiesinga, P. S. Julienne, D. K. Walter, S. Kadlecek, and T. G. Walker, *Phys. Rev. Lett.* **81**(7), 1389 (1998)
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41. "Field Dependence of Spin Relaxation in a Dense Rb Vapor", S. Kadlecek, L. W. Anderson, and T. G. Walker, *Phys. Rev. Lett.* **80**, 5512 (Jun 1998) [eprint](#)
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39. "Spin-rotation interaction of alkali-metal-He-atom pairs", T. G. Walker, J. H. Thywissen, and W. Happer, *Phys. Rev. A* **56**, 2090 (Sep 1997) [eprint](#)
38. "Spin-exchange optical pumping of noble-gas nuclei", T. G. Walker and W. Happer, *Rev. Mod. Phys.* **69**(2), 629 (Apr 1997) [eprint](#)
37. "Absolute Electron-Impact Ionization Cross Section Measurements Using a Magneto-Optical Trap", R. S. Schappe, T. Walker, L. W. Anderson, and C. C. Lin, *Phys. Rev. Lett.* **76**, 4328 (Jun 1996) [eprint](#)
36. "Trap-depth measurements using ultracold collisions", D. Hoffmann, S. Bali, and T. Walker, *Phys. Rev. A* **54**, R1030 (Aug 1996)
35. "Multilayer dielectric structure for enhancement of evanescent waves", R. C. Nesnidal and T. G. Walker, *Appl. Opt.* **35**(13), 2226 (May 1996)
34. "Measurements of intensity correlations of scattered light from laser-cooled atoms", S. Bali, D. Hoffmann, J. Simán, and T. Walker, *Phys. Rev. A* **53**, 3469 (May 1996) [eprint](#)
33. "Magneto-optical trapping and ultracold collisions of potassium atoms", R. S. Williamson and T. Walker, *J. Opt. Soc. Am. B* **12**(8), 1393 (Aug 1995) [eprint](#)
32. "Inexpensive diode laser microwave modulation for atom trapping", P. Feng and T. Walker, *Am. J. Phys.* **63**, 905 (Oct. 1995)
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30. "Electron Collision Cross-Sections Measured with the Use of a Magneto-Optical Trap", R. S. Schappe, P. Feng, L. W. Anderson, C. C. Lin, and T. Walker, *Euro. Phys. Lett.* **29**, 439 (Feb. 1995) [eprint](#)

29. "Measurements of Collisions Between Laser-Cooled Atoms", T. Walker and P. Feng, *Adv. At. Mol. Opt. Phys.* **34**, 125 (1994)
28. "Dynamical Effects of Hyperfine Structure on Trap-loss Collisions of Optically Trapped Alkali Atoms", T. G. Walker and D. Pritchard, *Laser Phys.* **4**, 1085 (1994)
27. "Three-dimensional Analytical Calculation of the Magneto-optical Trapping Forces on a Stationary  $J = 0 \rightarrow J = 1$  Atom", T. G. Walker, *Laser Phys.* **4**, 965 (1994)
26. "Novel Intensity Dependence of Ultracold Collisions Involving Repulsive States", S. Bali, D. Hoffmann, and T. Walker, *Euro. Phys. Lett.* **27**(4), 273 (1994) [eprint](#)
25. "Laser-induced ultracold Rb( $5S_{1/2}$ )+Rb( $5P_{1/2}$ ) collisions", M. G. Peters, D. Hoffmann, J. D. Tobiasson, and T. Walker, *Phys. Rev. A* **50**, R906 (Aug 1994)
24. "Measurements of Rb trap-loss collision spectra", D. Hoffmann, P. Feng, and T. Walker, *JOSA B* **11**, 712 (May 1994)
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22. "Spin-exchange collisions and their consequences for spin-polarized gas targets of hydrogen and deuterium", T. Walker and L. W. Anderson, *Nuc. Inst. Meth. Phys. Res. A* **334**, 313 (Oct. 1993)
21. "Consequences of spin-exchange collisions for polarized hydrogen and deuterium targets", T. Walker and L. W. Anderson, *Phys. Rev. Lett.* **71**, 2346 (Oct. 1993) [eprint](#)
20. "Comparison of trap-loss collision spectra for  $^{85}\text{Rb}$  and  $^{87}\text{Rb}$ ", P. Feng, D. Hoffmann, and T. Walker, *Phys. Rev. A* **47**, R3495 (May 1993)
19. "Spin-polarized spontaneous-force atom trap", T. Walker, P. Feng, D. Hoffmann, and R. S. Williamson, III, *Phys. Rev. Lett.* **69**, 2168 (Oct. 1992) [eprint](#)
18. "Excited-state collisions of trapped  $^{85}\text{Rb}$  atoms", D. Hoffmann, P. Feng, R. S. Williamson, III, and T. Walker, *Phys. Rev. Lett.* **69**, 753 (Aug. 1992) [eprint](#)
17. "The effect of radiation trapping on a high field spin exchange optically pumped target", L. W. Anderson and T. Walker, *Nuc. Inst. Meth. Phys. Res. A* **316**, 123 (Jun. 1992)
16. "A vortex-force atom trap", T. Walker, D. Hoffmann, P. Feng, and R. S. Williamson, *Phys. Lett. A* **163**, 309 (Mar. 1992) [eprint](#)
15. "Behavior of neutral atoms in a spontaneous force trap", D. W. Sesko, T. G. Walker, and C. E. Wieman, *JOSA B* **8**, 946 (May 1991) [eprint](#)
14. "Collective behavior of optically trapped neutral atoms", T. Walker, D. Sesko, and C. Wieman, *Phys. Rev. Lett.* **64**, 408 (Jan 1990) [eprint](#) This work was featured as a Science news item, [Making Atoms Jump Through Hoops](#).
13. "Estimates of spin-exchange parameters for alkali-metal-noble-gas pairs", T. G. Walker, *Phys. Rev. A* **40**, 4959 (1989) [eprint](#)

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11. "Frequency shifts of the magnetic-resonance spectrum of mixtures of nuclear spin-polarized noble gases and vapors of spin-polarized alkali-metal atoms", S. R. Schaefer, G. D. Cates, T.-R. Chien, D. Gonatas, W. Happer, and T. G. Walker, *Phys. Rev. A* **39**(11), 5613 (1989) [eprint](#)
10. "Deexcitation of metastable Ba<sup>+</sup>", T. G. Walker and K. D. Bonin, *J. Chem. Phys.* **89**, 1358 (Aug. 1988)
9. "Relaxation of gaseous spin-polarized <sup>3</sup>He targets due to ionizing radiation", K. D. Bonin, T. G. Walker, and W. Happer, *Phys. Rev. A* **37**, 3270 (May 1988)
8. "Modulation technique for measuring diffusion coefficients of Ba in noble gases", T. G. Walker, K. D. Bonin, and W. Happer, *J. Chem. Phys.* **87**, 660 (Jul. 1987)
7. "The stability of spin-polarized nitrogen crystals", W. Happer, K. D. Bonin, and T. G. Walker, *Chem. Phys. Lett.* **135**, 451 (Apr. 1987)
6. "Electron-noble-gas spin-flip scattering at low energy", T. G. Walker, K. Bonin, and W. Happer, *Phys. Rev. A* **35**, 3749 (May 1987)
5. "The spin-rotation interaction of atoms with half-filled electron shells", W. Happer, K. D. Bonin, and T. G. Walker, *Phys. Lett. A* **120**, 293 (Mar. 1987)
4. "Near-infrared spectra of the NaK molecule", J. Huennekens, T. G. Walker, and S. C. McClain, *J. Chem. Phys.* **83**, 4949 (Nov. 1985)
3. "Analyzing powers in <sup>+</sup>p elastic scattering at intermediate energies", A. Mokhtari, W. J. Briscoe, A. D. Eichon, D. H. Fitzgerald, G. J. Kim, B. M. K. Nefkens, J. A. Wightman, S. D. Adrian, M. E. Sadler, and T. Walker, *Phys. Rev. Lett.* **55**, 359 (Jul. 1985)
2. "Spin-Rotation Interaction of Noble-Gas Alkali-Metal Atom Pairs", Z. Wu, T. G. Walker, and W. Happer, *Phys. Rev. Lett.* **54**, 1921 (Apr 1985) [eprint](#)
1. "Ionization, excitation of high-lying atomic states, and molecular fluorescence in Cs vapor excited at  $\lambda = 455.7$  and  $459.4$  nm", J. Huennekens, Z. Wu, and T. G. Walker, *Phys. Rev. A* **31**, 196 (Jan. 1985)

### Conference Proceedings (Unrefereed)

T. R. Gentile, E. Babcock, J. A. Borchers, W. C. Chen, D. Hussey, G. L. Jones, W. T. Lee, C. F. Majkrzak, K. V. O'Donovan, W. M. Snow, X. Tong, S. G. E. te Velthuis, T. G. Walker, and H. Yan, "Polarized <sup>3</sup>He spin filters in neutron scattering", *Proceedings of the Fifth International Workshop on Polarised Neutrons in Condensed Matter Investigations*, F. Klose, W. Lee, and G. Ehlers eds, 96 (2005).

Keith D. Bonin, W. Andrew Shelton, Douglas Bonessi, and Thad G. Walker, "Nonlinear motion of rotating glass fibers". in *Optical Trapping and Optical Micromanipulation*, edited by Kishan Dholakia and Gabriel C. Spalding, *Proceedings of SPIE Vol. xxxx* (SPIE, Bellingham, WA, 2005) xxx-xxx.

Keith Bonin, Andrew Shelton, Bakhit Kourmanov, and Thad G. Walker, "Light torqued nanomotors in a standing wave", in *Clusters and Nano-Assemblies, Physical and Biological Systems*, ed. P. Jena, S.N. Khanna, and B.K. Rao, (World Scientific, New Jersey, 2005), pp. 257-263.

Keith D. Bonin, W. Andrew Shelton, and Thad G. Walker, "Light-torqued nanomotors free of a surface". in *Optical Trapping and Optical Micromanipulation*, edited by Kishan Dholakia and Gabriel C. Spalding, Proceedings of SPIE Vol. 5514 (SPIE, Bellingham, WA, 2004) 678-686.

T.G.Walker, R.Newell, J. Sebby, and M.Saffman, "High-Density Trapped Atoms in a Holographic Atom Trap", 2002 NASA Workshop on Fundamental Physics in Space.

Jennifer Sebby, Raymond Newell, Stephen Kadlecsek, and Thad Walker, "Spatial Heterodyne Imaging of Cold Atoms", 2nd Pan Pacific Basin Workshop on Microgravity Sciences, FP-1100, (2001).

S. Bali, D. Hoffmann, and T. Walker, "Investigations of Intensity Correlations of Scattered Light from Laser-Cooled Atoms", in *Coherence and Quantum Optics VII*, J. Eberly *et al.* eds, 373 (1996).

L. W. Anderson and T. Walker, "Spin-Exchange Optical Pumping in a High Magnetic Field", *AIP Conference Proceedings* **293**, 142 (1993). C. Martin, T. Walker, L. W. Anderson, and D. Swenson, "Laser Optical Pumping of Potassium in a High Magnetic Field Using Linearly Polarized Light", *AIP Conference Proceedings* **293**, 146 (1993).

T. Walker and L. W. Anderson, "Limitations of Optically Pumped Spin-Exchange-Polarized Targets", *AIP Conference Proceedings* **293**, 138 (1993).

Carl Wieman, Thad Walker, David Sesko, and Chris Monroe, "Curious Behavior of Optically Trapped Neutral Atoms", proceedings of ICAP-12, 1990.

T. G. Walker, D. Sesko, C. Monroe, and C. Wieman, "Collisional Loss Mechanisms in Light-Force Atom Traps," *AIP Conference Proceedings* **205**, 593 (1990).

### Invited Talks at Conferences and Workshops

"Coherence and Interactions of Atomic Ensemble Qubits", MURI Workshop, Oct. 20, 2015.

"Manipulation of Atomic Ensemble Qubits Using Rydberg Blockade", Atomic Physics Gordon Conference, Newport, RI, June 17, 2015.

"W-State Encoding of Atomic Ensembles Using Rydberg Blockade", Photonics North, Ottawa, June 11, 2015

"Synchronous Hyperpolarization and NMR of Xe Gas", Exotica Session, 56th Experimental Nuclear Magnetic Resonance Conference, April 22, 2015.

"Spin-Exchange Optical Pumping of He-3", Mini-symposium on Optically Pumped Polarized Targets, Sources and Methods, April APS Meeting, April 14, 2015s

"Synchronously Pumped NMR Gyro", IEEE International Symposium on Inertial Sensors and Systems, Mar 25, 2015

"Synchronous Spin Exchange Optical Pumping",Hyperpolarized Noble Gases Workshop, Les Houches , Oct. 1, 2014.

"From Optical Pumping to Optical Marshak Waves; Happer physics above and below the h-line", Happer Symposium, Princeton, NJ, Sept. 26, 2014.

"Generation of Atomic Fock States Using Rydberg Blockade", Hot Topics Session, DAMOP, June 6, 2014.

"Optical Magnetometry", Plenary Speaker, Texas Section of the American Physical Society, Mar 22, 2014.

"Generation of Atomic Fock States", MURI workshop, Dec 18, 2013.

"Quantum Manipulation with Rydberg Atoms", Laser Science XXIX, October 6, 2013.

"NMR Rotation Sensors", Fifth Annual Autonomous Guidance, Navigation, and Control (AGN&C) Symposium, 16 May, 2013. "Distinguished Lecturer" Award.

"NMR Oscillators", Northrop-Grumman Navigation Systems Division, January 8, 2013.

"Application of Atomic Magnetometers to fMCG", BioMag, August 28, 2012.

"Quantum state control in Rydberg blockaded ensembles", MURI Light-Atom Interfaces Workshop, Santa Barbara, CA, December 11, 2012.

"Entanglement of two atoms by Rydberg Blockade", Canadian Institute for Advanced Research UltraCold Matter Meeting, February 16, 2012.

"Light-matter entanglement and quantum gates based on Rydberg blockade", MURI workshop, October 25, 2011.

"Single atom loading", invited talk, CRYP10 workshop on Cold Rydberg Gases and Ultracold Plasmas, 7 September 2010.

"Photon budget for spin-exchange optical pumping", invited talk, JCNS Workshop on Modern Trends in Production and Applications of Polarized  $^3\text{He}$ , July 11, 2010.

"Fundamentals of SEOP", invited talk, JCNS Workshop on Modern Trends in Production and Applications of Polarized  $^3\text{He}$ , July 11, 2010.

"Rydberg-mediated quantum manipulation of atoms", DAMOP invited talk, May 30, 2010.

"Quantum Manipulation of Ensembles", ITAMP Workshop: "Engineering Rydberg Interactions in Atoms, Molecules and Plasmas: A Collaborative Workshop", Sept. 21, 2009.

"Rydberg Atoms and Quantum Computation", DAMOP Graduate Student Symposium, May 14, 2009. "Atomic and Molecular Collisions", Session Chair, 2009 Gordon Conference on Atomic Physics, Tilton, NH, July 1, 2009.

"Atomic Processes in Spin-Exchange Optical Pumping", Workshop on Spin-Exchange Optical Pumping, University of Virginia, May 14, 2009.

"Ultrasensitive Atomic Magnetometers", BIOMAG 2008, Saporro, Japan, August 25, 2008.

"Consequences of Forster Resonances for Rydberg Blockade", Workshop on Rydberg Excited Atoms, Sandbjerg, Denmark, May 16 2008.

"Quantum Manipulation of Atoms Using Rydberg States", SQuINT Meeting, February 17, 2006.

"Turning photons into polarized nuclei", Invited Talk, Gordon Research Conference on Atomic Physics, June 18, 2003.

"Spin-Exchange Optical Pumping with Frequency-Narrowed Diode Arrays", Invited Talk, HELION02, Mainz, Germany, September 9, 2002.

"Non-destructive imaging of atoms in FORTs", invited talk, 2001 CAP Congress, June 2001.

"Electron Collisions Using a Trapped Atom Target", invited talk, DAMOP, May 27, 1998.

"Excited-State Ultracold Collisions", invited talk, ESCOLAR '98, Burgenland, Austria, April 1, 1998.

"Two-photon energy pooling collisions of Rb", invited talk, Workshop on Collisions of Cold, Trapped Atoms, JILA, November 1997.

"Excited-State Ultracold Collisions", invited talk, Gaseous Electronics Conference, October 1997.

"Measurements of Electron-Scattering Cross Sections Using Optically-Trapped Atoms", invited talk, APS DAMOP Meeting, May 1996.

"Beta-Asymmetry Experiments Using Trapped Atoms", invited talk, APS Washington Meeting, April 1995.

"Novel Collisional Processes in Traps", invited discussion leader, Telluride workshop on Ultracold Collision Dynamics, August 1994.

"Spin-Exchange in Polarized H and D Targets", invited talk, Workshop on Polarized Beams and Targets, Les Houches, June 1994.

"Collective Behavior of Atoms in Optical Traps", invited talk, Optical Society of America meeting, October 4, 1993.

"Collisions of Optically Trapped Atoms", invited talk, Gaseous Electronics Conference, Boston, October 29, 1992.

"Dynamics of Trap-loss Collisions", Symposium on Cold Atom Collisions, Harvard, April 26, 1992.

"Collective Phenomena in Optical Traps", invited discussion leader, Telluride workshop on Cold Atoms, August 1990.

"Collisional Loss Mechanisms in Light-Force Atom Traps", invited talk, XVI International Conference on the Physics of Electron and Atomic Collisions, New York, July 1989.

### Invited Colloquia and Seminars

"Synchronous Spin-Exchange Optical Pumping", Northwestern University AMO Seminar, Oct. 13, 2015.

"Enhancing Quantum Mechanics Using Mathematica", Educational Innovation Seminar, Univ. of Wisconsin-Madison, Mar 11, 2015.

"Quantum Manipulation Without Forces", Purdue University Physics Colloquium, Oct 30, 2014.

"Quantum Manipulation Without Forces", Abilene Christian University, Feb 6, 2014.

"Search for axions using dual-species NMR and the NGC Test Station", Northrop-Grumman Navigation Division, Jan 7, 2014.

"Pulsed Parametric Magnetometers and NMR Resonators", Symmetricom Inc., 17 May 2013.

"Deterministic Single-Atom Loading", Harvard-MIT Center for Ultracold Atoms Seminar, April 16, 2013.

"Magnetometers for Fetal Biomagnetism and Fundamental Physics", Old Dominion University Physics Colloquium, February 19, 2013.

"NMR Oscillators", Northrop-Grumman Navigation Systems Division, January 8, 2013.

"Detection of Fetal Magnetocardiography with an Atomic Magnetometer", Northrop-Grumman Navigation Systems Division, January 10, 2012.

"Quantum Manipulation of Atoms-Without Forces", Northrop-Grumman Navigation Systems Division, March 24, 2011.

"Turning Photons into Polarized Nuclei", Atomic Physics Seminar, Univ. of Utah, Nov. 6, 2009.

"Quantum Manipulation of Atoms-Without Forces", Physics Colloquium, Univ. of Utah, Nov. 5, 2009.

"Quantum Manipulation of Atoms-Without Forces", Penn State Physics Colloquium, Oct. 8, 2009.

"Observation of Rydberg Blockade between Pairs of Atoms", University of Virginia Physics Colloquium, March 27, 2009.

"Observation of Rydberg Blockade between Pairs of Atoms", Joint ITAMP/Harvard Atomic Physics Colloquium, Nov. 19, 2008.

- "Quantum Manipulation of Atoms–Without Forces", Marietta College Physics Colloquium, Oct. 17, 2008.
- "Turning photons into polarized nuclei", Physics Colloquium, College of William and Mary, Dec. 7, 2007.
- "Quantum Manipulations Using Rydberg Atoms", Joint Quantum Institute Seminar, University of Maryland, October 22, 2007.
- "Quantum Entanglement of Atoms–Without Forces", Physics Colloquium, St. Olaf College, November 8, 2006.
- "Quantum Manipulations Using Rydberg Atoms", University of Connecticut Physics Colloquium, October 6, 2006.
- "Quantum Manipulations Using Rydberg Atoms", Ohio State Atomic Physics Seminar, April 27, 2006.
- "Quantum Manipulations Using Rydberg Atoms", LANL Quantum Lunch Seminar, March 23, 2006.
- "Quantum Manipulation of Trapped Neutral Atoms", Harvard/MIT Center for Ultracold Atoms, November, 2005.
- "Quantum Entanglement of Atoms–Without Forces", Physics Seminar, Abilene Christian University, March 1, 2005.
- "Cold Atoms at High Densities: One at a Time", Physics Colloquium, University of Nevada-Reno, October 18, 2004.
- "Turning photons into polarized nuclei", Physics Colloquium, University of Central Michigan, April 15, 2004.
- "Cold Atoms at High Densities: One at a Time", Physics Colloquium, University of Delaware, February 18, 2004.
- "Converting photons into polarized nuclei", Colloquium, University of New Hampshire, January 27, 2003.
- "High-Density Atom Traps", Colloquium, Harvard/MIT Center for Ultracold Atoms, November 26, 2002.
- "Fundamental Processes in Rb-Xe Spin Exchange", Surface Physics Seminar, Marburg University, Marburg, Germany, September 6, 2002.
- "High-Density Trapped Atoms in a Holographic Atom Trap", Quantum Optics Seminar, Aarhus University, June 14, 2002.
- "Hot and Cold Collisions", Atomic Physics Seminar, Oersted Laboratory, Niels Bohr Institute, June 12, 2002.
- "Spin-exchange optical pumping", NIST Physics Colloquium, Nov. 29, 2000.
- "Spin-exchange optical pumping of  $^3\text{He}$  and  $^{129}\text{Xe}$  using frequency narrowed diode lasers", P-23 Seminar, Los Alamos National Laboratory, Oct. 12, 2000.
- "Towards the Ultimate Laser Cooling", Washington University Condensed Matter Seminar, Feb. 28, 2000.
- "Laser Cooling", Lawrence University Science Colloquium, Jan. 20, 2000.
- "Hyperpolarized Noble Gases", Lawrence University Physics Seminar, Jan. 20, 2000.
- "Limits on Production of Hyperpolarized Noble Gases", Monday Morning Seminar Series, Argonne National Laboratory Chemistry Division, Jan. 10, 2000.
- "Physical Limits on Production of Hyperpolarized Noble Gases", Univ. of Texas Quantum Optics Seminar, Nov. 5, 1999.
- "Collisions Hot and Cold", Michigan Atomic Physics Seminar, March 14, 1999.



- "Light-Induced Ultracold Collision Dynamics", Ohio State Atomic Physics Seminar, May 18, 1998.
- "Excited-State Ultracold Collisions", Notre Dame Atomic Physics Seminar, Feb. 24, 1998.
- "Converting Photons into Polarized Nuclei", Old Dominion University Physics Colloquium, Feb. 13, 1998.
- "Ultracold Collisions", Kansas State University Atomic Physics Seminar, Oct. 11, 1996.
- "The Physics of Laser Cooling", Kansas State University Physics Colloquium, Oct. 10, 1996.
- "Interactions Between Laser-Cooled Rb Atoms", Yale University Atomic Physics Seminar, May 15, 1995.
- "Interactions Between Laser-Cooled Rb Atoms", University of Toledo Physics Department Colloquium, April 13, 1995.
- "Interactions Between Laser-Cooled Rb Atoms", joint seminar of the Harvard-Smithsonian Institute for Theoretical Atomic and Molecular Physics and Harvard University, March 29, 1995.
- "Laser-Cooled Atoms: Ultracold Collisions and Spin-Polarized Traps", Laser Cooling Seminar, L'Ecole Normale Supérieure, June 10, 1994. "Strange Behavior of Laser-Cooled Atoms", Abilene Christian University Colloquium, October 4, 1994.
- "Spin-polarized Atom Traps", TRIUMF Colloquium, February 10, 1994.
- "Strange Behavior of Laser-Cooled Atoms", University of Wisconsin-Whitewater Colloquium, September 15, 1993.
- "Spin-polarized Atom Traps", LAMPF Seminar, Los Alamos Meson Physics Facility, July 8, 1993.
- "Spin-exchange Collisions and their Consequences for Polarized H and D Targets", Nuclear Physics Seminar, University of Wisconsin, September 10, 1992.
- "Spin-exchange Collisions and their Consequences for Polarized H and D Targets", Atomic Physics Seminar, University of Wisconsin, September 3, 1992.
- "Spin-exchange Collisions and their Consequences for Polarized H and D Targets", Nuclear Physics Seminar, Argonne National Laboratory, August 27, 1992.
- "Dynamics of Rb Traploss Collisions", Atomic Physics Seminar, University of Connecticut, April 29, 1992.
- "Strange Behavior of Optically Trapped Atoms", National Institute of Standards and Technology, February 25, 1991.
- "Strange Behavior of Optically Trapped Atoms", Atomic Physics Seminar, Notre Dame University, November 19, 1990.
- "Strange Behavior of Optically Trapped Atoms", Atomic Physics Seminar, Argonne National Laboratory, October 23, 1990.
- "Strange Behavior of Optically Trapped Atoms", Physics Colloquium, University of Wisconsin, September 21, 1990.
- "Collective Behavior of Trapped Atoms", Laser Spectroscopy Seminar, Massachusetts Institute of Technology, Feb. 27, 1990.
- "Collective Behavior of Trapped Atoms", Physics Colloquium, Purdue University, Feb. 13, 1990.
- "Collective Behavior of Trapped Atoms", Atomic Physics Seminar, University of Wisconsin, Feb. 1, 1990.
- "Collective Behavior of Trapped Atoms", Physics Colloquium, University of Rochester, Jan. 23, 1990.
- "Collisions Between Optically Trapped Atoms", Quantum Optics Seminar, University of Rochester, Jan. 22, 1990.

"Relaxation of Metastable Ba and Ba<sup>+</sup>", seminar given at University of California at Berkeley, University of Washington, Los Alamos National Laboratory, Joint Institute for Laboratory Astrophysics, and Harvard-Smithsonian Center for Astrophysics, April 1-15, 1988.

"Near-Infrared Spectroscopy of the NaK Molecule", Physics Colloquium, Abilene Christian University, Feb. 10, 1985.

### Selected Local Seminars

"New laboratory limits on P-odd T-odd Interactions Using Dual-Species NMR", NPAC Forum, Univ. of Wisconsin-Madison, March 26, 2013

"Turning Photons into Polarized Nuclei", Physics Dept. Colloquium, Univ. of Wisconsin-Madison, Feb. 19, 2010.

"Turning photons into polarized nuclei", Electrical and Computer Engineering Colloquium, University of Wisconsin, November 10, 2003.

"Cold Atom Physics", University of Wisconsin-Madison Physics Colloquium, Oct. 18, 1996.

"Spin-Rotation Interactions of Alkali-Noble-Gas Atom Pairs", University of Wisconsin Atomic Physics Seminar, January 26, 1995.

"Progress in Understanding Ultracold Collision Dynamics", Atomic Physics Seminar, University of Wisconsin, February 17, 1994.

"Atomic Collisions at 100 K", Physical Chemistry Seminar, University of Wisconsin, September 15, 1992.

"A Spin-Polarized Atom Trap", Atomic Physics Seminar, University of Wisconsin, March 5, 1992.

"What's Cold in Atomic Collision Physics", Atomic Physics Seminar, University of Wisconsin, October 4, 1990 (continued on October 21, 1990).

### Publications by Students and Post-docs

"The Development of a Multichannel Atomic Magnetometer Array for Fetal Magnetocardiography", R. Wyllie, Ph. D. Thesis, University of Wisconsin-Madison, 2012.

"Efficiency of Spin-Exchange Optical Pumping", B. Lancor, Ph. D. Thesis, University of Wisconsin-Madison, 2011.

"Stimulated Emission Studies of Ultracold Rydberg Atoms", E. Brekke, Ph. D. Thesis, University of Wisconsin-Madison, 2009.

"Coherent Manipulation of Single Atom Qubits Using Rydberg States", E. Urban, Ph. D. Thesis, University of Wisconsin-Madison, 2009.

"Towards a Deterministic Single Photon Source", J. Day, Ph. D. Thesis, University of Wisconsin-Madison, 2008.

"Spin-Exchange Optical Pumping with Alkali Metal Vapors", E. Babcock, Ph. D. Thesis, University of Wisconsin-Madison, 2005.

"Demonstration of Dense Mesoscopic Samples in a Holographic Atom Trap", J. Sebby-Strabley, Ph. D. Thesis, University of Wisconsin-Madison, 2004.

"Studies of Spin-Exchange Optical Pumping", B. Chann, Ph. D. thesis, University of Wisconsin-Madison, 2003. "Cold and Dense Clouds of Atoms in a Holographic Atom Trap", R. Newell, Ph. D. Thesis, University of Wisconsin-Madison, 2003.

"Physics of Practical Spin-Exchange Optical Pumping", I. Nelson, Ph. D. thesis, University of Wisconsin-Madison, 2001.

- "Spin-Relaxation in Alkali Vapors", S. Kadlecik, Ph. D. thesis, University of Wisconsin-Madison, 2000.
- "Light-Induced Ultracold Spin-Exchange Collisions", R. Nesnidal, Ph. D. thesis, University of Wisconsin-Madison, 2000.
- "A Portable Magneto-Optical Trap", R. Newell, M. S. thesis, University of Wisconsin-Madison, 1999.
- "Magneto-optical Trapping of Potassium Isotopes", R. S. Williamson III, Ph. D. thesis, University of Wisconsin-Madison, 1997.
- "Spin-polarized Atom Traps", Paul Feng, Ph. D. thesis, University of Wisconsin-Madison, 1996.
- "Light-Induced Collisions of Ultracold Rubidium Atoms", Dominikus Hoffmann, Ph. D. thesis, University of Wisconsin-Madison, 1996.
- "*In Situ* Temperature Measurements of Laser-Cooled Atoms Using Intensity Correlations", Jose Simán, senior thesis, University of Wisconsin.
- "Excited-state Collisions of Rubidium, Induced by  $5^2P_{1/2}$  Light", Michiel Peters, equivalent to Diplomarbeit, University of Utrecht.
- "Excited-state Collisions Between Trapped Rubidium Atoms", Dominikus Hoffmann, Diplomarbeit, University of Hamburg, 1993.

## Extramural Funding

- "Rydberg blockaded ensemble qubits and atom-photon quantum interfaces", NSF PIF, with M. Saffman, 2011-2014, \$610,000.
- "Multi-functional light-matter interfaces based on neutral atoms and solids", AFOSR MURI, with M. Saffman, 2011-2016, \$1,250,000.
- "Rydberg States in Localized Ensembles", NSF, 2009-2012, \$445,000.
- "Polarized  $^3\text{He}$  Spin Filters", with W. M. Snow (PI, Indiana University), Tom Gentile (NIST), and G. Jones (Hamilton College), DOE, Wisconsin portion \$271,884, 2010-2013.
- "Atomic Biomagnetometer for Fetal Biomagnetism", NIH, 2009-2013, \$1,300,000.
- "Rydberg States in Dense Atom Traps", NSF, 2006-2009, \$450,000.
- "Fast Quantum Logic Gates using Optically Trapped Neutral Atom Arrays", with Mark Saffman (PI), NSF, \$990,000, 2007-2010, \$140,000 2011.
- "Polarized  $^3\text{He}$  in Neutron Scattering", with W. M. Snow (PI, Indiana University), Tom Gentile (NIST), and G. Jones (Hamilton College), DOE, Wisconsin portion \$215,000, 2006-2009.
- "Atomic Biomagnetometer", NIH, with R. Wakai (co-PI), \$387,249, 2005-2007.
- "QNTM: Entanglement in mesoscopic atom clouds and quantum networking", with M. Saffman (PI), \$300,000, 2005-2008.
- "Two-dimensional arrays of neutral atom quantum gates", with M. Saffman (PI), \$2,655,744, 2005-2009
- "Polarized  $^3\text{He}$  in Neutron Scattering", with W. M. Snow (PI, Indiana University), Tom Gentile (NIST), and G. Jones (Hamilton College), DOE, Wisconsin portion \$150,000, 2003-2006.
- "Quantum information processing with two-dimensional atomic arrays", with M. Saffman (PI), Dieter van Melkebeek (Co-PI), Kelvin Wagner (Co-PI), NSF, \$2,100,000, 2002-2007.
- "Single photon and single atom sources for quantum information processing", with M. Saffman (PI), NSF \$484,000, 2002-2005.
- "Quantum Logic with Cold Neutral Atoms", with M. Saffman (PI), DOD-Army, 2002-2004, \$471,118.
- "Rydberg states in dense atom traps", NSF, 2002-2006, \$580,000.

"All-Optical High Density Cold Atom Sources", NASA, \$356,000, 2001-2006.

"Spin-Physics Using Hyperpolarized Noble Gases", National Science Foundation, \$462,152, 1997-2002.

"Interactions in Dense Atom Traps", National Science Foundation, \$105,000, 2001-2003.

"Ultracold Collision Dynamics", National Science Foundation, \$210,000, 1999-2002.

"Light-Induced Interactions of Laser-Cooled Atoms", National Science Foundation, \$315,000, 1996-1999.

"Dynamics of Ultracold Collisions", National Science Foundation, \$315,000, 1993-1996.

"Beta Asymmetry Experiments Using Trapped Atoms", National Institute of Standards and Technology Precision Measurements Grant, \$90,000, 1992-1995.

"Interactions of Optically Trapped Atoms", National Science Foundation Young Investigator Award, \$312,500, 1992-1998.

Fellowship in Science and Engineering, David and Lucille Packard Foundation, \$500,000, 1992-1997. Twenty of these fellowships are given each year in all fields of science and engineering. Prof. Walker was the third UW-Madison faculty member, the first from physics, to receive one of these fellowships.

Alfred P. Sloan Foundation, \$30,000, 1991-1993.

## Professional Service

2012- DAMOP Program Committee











