Thomas C. Killian

Rice University
Department of Physics and Astronomy, MS-61
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Professional Interests

Ultracold neutral plasmas, laser-cooled atomic gases, atom-photon interactions, and electro-magnetic characterization and control of biological structures

Professional Experience

William Marsh Rice University Houston, TX
Associate Professor of Physics and Astronomy, 2006-present.
Assistant Professor of Physics and Astronomy, 2000-2006.
Office of Naval Research Young Investigator.
Department of Energy Junior Faculty Development Program Award Winner.
Alfred P. Sloan Research Fellow.
Research Corporation, Research Innovation Award Winner.
David and Lucille Packard Foundation Science and Engineering Fellow.

Education and Training

National Institute of Standards and Technology, 1999-2000, Gaithersburg, MD
National Research Council Postdoctoral Fellow.

Studies of laser-cooled and trapped metastable xenon in the research group of Dr. W. Phillips and Dr. S. Rolston. Emphasis on the formation and characterization of ultracold neutral plasmas.

Massachusetts Institute of Technology, 1993-1999, Cambridge, MA
National Science Foundation Graduate Fellow, MIT Karl Taylor Compton Fellow.

Ph.D. in Physics, 1999.
Thesis under Professors T. Greytak and D. Kleppner, "1S-2S Spectroscopy of Trapped Hydrogen: The Cold Collision Frequency Shift and Studies of BEC."
Observation of hydrogen Bose-Einstein condensation. High resolution spectroscopic studies of trapped, spin-polarized atomic hydrogen, focusing on cold collisions.

Cambridge University, 1991-1993, Cambridge, England
Marshall Scholar.

M.Phil. in Physical Chemistry, 1993.
Thesis under Dr. P. Davies. Vibrational and rotational spectroscopy of large molecules in a supersonic jet.

Certificate of Advanced Studies in Mathematics with High Honors, Department of Applied Mathematics and Theoretical Physics, 1992.

Harvard College, 1987-1991, Cambridge, MA
GTE Academic All-American, National Merit Scholar, Presidential Scholar.

A.B. in Physics, *summa cum laude*, Phi Beta Kappa, 1991.
Harvard Hoopes Prize for excellence in undergraduate research studying the laboratory millimeter-wave absorption spectra and astrophysical abundances and radio-wave spectra of small, reactive hydrocarbons under Professor P. Thaddeus and Dr. C. Gottlieb.

Teaching

Spring 2001, Physics 600, *Cold Atoms in Atomic Physics*

Fall 2001, Physics 311, *Introductory Quantum Physics I*

Fall 2002, Physics 537, *Methods of Experimental Physics I*

Spring 2003, Physics 538, *Methods of Experimental Physics II*

Fall 2003, Physics 537, *Methods of Experimental Physics I*

Spring 2004, Physics 538, *Methods of Experimental Physics II*

Fall 2004, Physics 537, *Methods of Experimental Physics I*

Fall 2005, Physics 537, *Methods of Experimental Physics I*

Fall 2005, Physics 537, *Methods of Experimental Physics I*

Spring 2006, Physics 538, *Methods of Experimental Physics II*

Fall 2006, Physics 537, *Methods of Experimental Physics I*

Spring 2007, Physics 538, *Methods of Experimental Physics II*

Fall 2007, Physics 537, *Methods of Experimental Physics I*

Spring 2008, Physics 302, *Intermediate Electrodynamics*

University Service

2002-present, Martel College Faculty Associate, Outstanding Associate 2004.

2002-present, Fellowships and Awards Committee.

2004-2007, Natural Sciences Divisional Advisor.

2005-present, Faculty Senate.

Other Professional Activities

Member, American Physical Society

Member, Defense Science Study Group, Institute for Defense Analysis, 2006-2007

Executive Committee of the Division of Atomic, Molecular and Optical Physics (DAMOP) of the American Physical Society, 2006-present.

Referee: Physical Review, Journal of Physics B, and NSF and DOE grant proposals.

Grant review panel member: NSF and NSF/DOE partnerships.

Subcommittee member: *2002 Quantum Electronics and Laser Science Conference* (5/02), "Atom Cooling and Atom Optics."

Session chair: *2002 Quantum Electronics and Laser Science Conference* (5/02); *2002 International Conference on Atomic Physics* (7/02); *2004 Annual Meeting of the Division of Atomic, Molecular, and Optical Physics of the American Physical Society* (5/04).

Program Committee: *2004 Annual Meeting of the Division of Atomic, Molecular, and Optical Physics of the American Physical Society*, Tucson, Arizona (5/04)

Graduate Thesis Prize Committee: *2008 Annual Meeting of the Division of Atomic, Molecular, and Optical Physics of the American Physical Society*, College Station, Pennsylvania (5/08)

Conference Organizer: *ITAMP Workshop on Cold and Ultracold Plasma and Rydberg Physics* (9/05), *9th International Workshop on Non-neutral Plasma Physics* (6/08)

Selected Invited Talks

"Ultracold Neutral Plasmas," 2008 International Conference on Strongly Coupled Coulomb Systems, Camerino, Italy, (7/08).

"Ultracold Neutral Plasmas," 35th European Physical Society Conference on Plasma Physics, Crete, (6/08).

"Watching Ions Dance Near Absolute Zero," University of Texas at Austin, Center for Complex Quantum Systems Seminar, Austin, TX, (1/08).

"Watching Ions Dance Near Absolute Zero," University of Illinois at Urbana-Champagne Physics Department Colloquium, Urbana, IL, (11/07).

"Watching Ions Dance Near Absolute Zero," University of Houston Physics Department Colloquium, Houston, TX, (11/07).

"Ultracold Collisions in Atomic Strontium," *Frontier in Optics 2007 / Laser Science XXIII*, San Jose, CA, (9/07).

"Equilibration of Ultracold Neutral Plasmas," *The 15th International Conference on Atomic Processes in Plasmas*, National Institute of Standards and Technology, Gaithersburg, MD, (5/07).

"Photoassociative Spectroscopy of Ultracold Strontium," *ITAMP Workshop on Ultracold Group II Atoms: Theory and Applications*, Institute for Theoretical Atomic, Molecular and Optical Physics, Cambridge, MA, (9/06).

"Ion Dynamics in Ultracold Neutral Plasmas," *Workshop on Non-Neutral Plasmas*, Aarhus, Denmark, (6/06).

"Expansion Dynamics of Ultracold Neutral Plasmas," *2006 Annual Meeting of the Division of Atomic, Molecular, and Optical Physics of the American Physical Society*, Knoxville, Tennessee, (5/06).

"Photoassociative Spectroscopy of Ultracold Strontium," *Achievements and Perspectives of Cold Molecules, École de Physique*, Les Houches, France, (3/06).

"Pushing the Envelope of Plasma Physics: Ultracold Neutral Plasmas," *The Academy of Medicine, Engineering and Sciences of Texas*, Houston, TX, (1/06).

"Ultracold Neutral Plasmas," *Texas Section of the American Physical Society*, Houston, TX, (10/05).

"Expansion Dynamics of Ultracold Neutral Plasmas," *ITAMP Workshop on Cold and Ultracold Plasma and Rydberg Physics*, Cambridge, MA, (9/05).

"Early Dynamics of Ultracold Neutral Plasmas," *Ultracold PARYS (Ultracold Plasmas And Rydberg Systems)*, Centre National de la Recherche Scientifique, Gif-sur-Yvette, France, (3/05).

"Ultracold Neutral Plasmas," *German Physical Society Meeting*, Berlin, Germany, (3/05).

"Ultracold Neutral Plasmas," University of Utah Physics Department Colloquium, Salt Lake City, Utah, (2/05).

"Ultracold Neutral Plasmas," University of Toronto Physics Department Colloquium, Toronto, Canada, (1/05).

"Ultracold Neutral Plasmas," University of Connecticut Physics Department Colloquium, Storrs, Connecticut, (11/04).

"Ultracold Neutral Plasmas," *12th International Congress on Plasma Physics*, Nice, France, (10/04).

"Imaging Ultracold Plasmas," *129th National Meeting of the American Association of Physics Teachers*, Sacramento, CA, (8/04).

"Optically Imaging an Ultracold Strontium Plasma," *19th International Conference on Atomic Physics*, Rio de Janero, Brazil, (7/04).

"Imaging an Ultracold Neutral Plasma," *2004 Annual Meeting of the Division of Atomic, Molecular, and Optical Physics of the American Physical Society*, Tucson, Arizona, (5/04).

"Ultracold Neutral Plasmas," Lectures at the *International Workshop and Seminar on Rydberg Physics*, Dresden, Germany, (4/04).

"Imaging an Ultracold Neutral Plasma," Harvard/MIT Center for Ultracold Atoms Seminar, Cambridge, MA (4/04).

"Experiments with Laser-Cooled Atomic Strontium," *Second Workshop on Cold Alkaline-Earth Atoms*, Copenhagen, Denmark (9/03).

"Collisions in Ultracold Neutral Plasmas," *XXIII International Conference on Photonic, Electronic, and Atomic Collisions*, Stockholm, Sweden (7/03).

"Experiments with Laser-Cooled Atomic Strontium," *2002 New Laser Scientist Conference*, satellite conference of the *2002 APS Division of Laser Science-XVIII/Optical Society of America Meeting*, Orlando, Florida

(9/02).

"Ultracold Neutral Plasmas: New Prospects with Laser-Cooled Strontium," *2002 International Conference on Strongly Coupled Coulomb Systems*, Santa Fe, New Mexico (9/02).

"Ultracold Neutral Plasmas: New Prospects with Laser-Cooled Strontium," *Resonances and Reflections: Profiles of Ugo Fano's Physics and Its Influences (Fano Memorial Symposium)*, Cambridge, Massachusetts, (7/02).

"Ultracold Neutral Plasmas," *2002 Topical Conference on Atomic Processes in Plasmas*, Gatlinburg, Tennessee, (4/02).

"Ultracold Neutral Plasmas," *2001 Workshop on Non-Neutral Plasmas*, San Diego, California, (9/01).

"From Laser-Cooled Atoms to an Ultracold Neutral Plasma," *Optical Society of America Annual Meeting and Exhibit 2000, ILS-XVI: 16th Interdisciplinary Laser Science Conference*, Providence, Rhode Island, (10/00).

"From Laser-Cooled Atoms to an Ultracold Neutral Plasma," *2000 Annual Meeting of the Division of Atomic, Molecular, and Optical Physics of the American Physical Society*, Storrs, Connecticut, (6/00).

"Bose-Einstein Condensation of Atomic Hydrogen: High Resolution Spectroscopy and the Cold collision Frequency Shift of the 1S-2S Transition," *Cold Atomic Collisions, Formation of Cold Molecules Workshop*, Les Houches, France, (3/99).

Publications

"Optical Probes of Ultracold Nuetral Plasmas," S. Laha, J. Castro, H. Gao, P. Gupta, C. E. Simien, and T. C. Killian, AIP Conf. Proc. **926**, 69 (2007).

"Experimental Realization of an Exact Solution to the Vlasov Equations for an Expanding Plasma," S. Laha, P. Gupta, C. E. Simien, H. Gao, J. Castro, T. Pohl, and T. C. Killian, Phys. Rev. Lett. **99**, 155001 (2007).

"Electron Temperature Evolution in Expanding Ultracold Neutral Plasmas," P. Gupta, S. Laha, C. E. Simien, H. Gao, J. Castro, T. C. Killian, and T. Pohl, Phys. Rev. Lett. **99**, 075005 (2007).

"Rotational Spectra of Vibrationally Excited CCH and CCD," T. C. Killian, C. A. Gottlieb, and P. Thaddeus, J. Chem. Phys. **127**, 114320 (2007).

"Ultracold Neutral Plasmas," T. C. Killian, T. Pattard, Thomas Pohl, and J. M. Rost, Phys. Rep., **449**, 77 (2007).

"Ultracold Neutral Plasmas," T. C. Killian, Science **316**, 705 (2007).

"Kinetic Energy Oscillations in Annular Regions of Ultracold Neutral Plasmas," S. Laha, Y. C. Chen, P. Gupta, C. E. Simien, Y. N. Martinez, P. G. Mickelson, S. B. Nagel, T. C. Killian, European Phys. J. D **40**, 51 (2006).

"Cool Vibes," T. C. Killian, Nature **441**, 297 (2006).

"Pumped Quantum Systems: Immersion Fluids of the Future," V. Anant, M. Radmark, A. F. Abouraddy, T. C. Killian, and K. K. Berggren, J. Vac. .Sci. and Technol. B **23**, 2662 (2005).

"Spectroscopic Determination of the s-Wave Scattering Lengths of ^{86}Sr and ^{88}Sr," P. G. Mickelson, Y. N. Martinez, A. D. Saenz, S. B. Nagel, Y. C. Chen, T. C. Killian, P. Pellegrini, and R. Côté, Phys. Rev. Lett. **95**, 223002 (2005).

"Absorption Imaging of Ultracold Neutral Plasmas," C. E. Simien, Y. C. Chen, P. Gupta, S. Laha, Y. N. Martinez, P. G. Mickelson, S. B. Nagel, and T. C. Killian, IEEE Transactions on Plasma Science **33**, 540 (2005).

"Photoassociative Spectroscopy at Long Range in Ultracold Strontium," S. B. Nagel, P. G. Mickelson, A. D. Saenz, Y. N. Martinez, Y. C. Chen, T. C. Killian, P. Pellegrini, and R. Côté, Phys. Rev. Lett. **94**, 083004 (2005).

"Ultracold Neutral Plasmas," T. C. Killian, Y. C. Chen, P. Gupta, S. Laha, Y. N. Martinez, P. G. Mickelson, S. B. Nagel, A. D. Saenz, and C. E. Simien, Plasma Phys. Control. Fusion. **47**, A297 (2005).

"Absorption Imaging and Spectroscopy of Ultracold Neutral Plasmas," T. C. Killian, Y. C. Chen, P. Gupta, S. Laha, Y. N. Martinez, P. G. Mickelson, S. B. Nagel, A. D. Saenz, and C. E. Simien, J. Phys. B. **38**, 351 (2005).

"Electron Screening and Kinetic Energy Oscillations in a Strongly Coupled Plasma," Y. C. Chen, C. E. Simien, P. Gupta, S. Laha, Y. N. Martinez, P. G. Mickelson, S. B. Nagel, and T. C. Killian, Phys. Rev. Lett. **93**, 265003 (2004).

"Plasmas Put in Order," T. C. Killian, Nature **429**, 815 (2004).

"Using Absorption Imaging to Study Ion Dynamics in an Ultracold Neutral Plasma," C. E. Simien, Y. C. Chen, P. Gupta, S. Laha, Y. N. Martinez, P. G. Mickelson, S. B. Nagel, and T. C. Killian, Phys. Rev. Lett. **92**, 143001 (2004).

"Ultracold Plasmas and Rydberg Gases," S. D. Bergeson and T. C. Killian, Phys. World, pp. 37-41, Feb. 2003.

"Ultracold Neutral Plasmas: Recent Experiments and New Prospects," T. C. Killian, V. S. Ashoka, P. Gupta, S. Laha, S. B. Nagel, C. E. Simien, S. Kulin, S. L. Rolston, and S. D. Bergeson, J. Phys. A: Math. Gen. **36**, 6077 (2003).

"Magnetic Trapping of Metastable $^3P_2$ Atomic Strontium," S. B. Nagel, C. E. Simien, S. Laha, P. Gupta, V. S. Ashoka, and T. C. Killian, Phys. Rev. A **67**, 011401(R) (2003).

"Sum Rule for the Optical Spectrum of a Trapped Gas," M. O. Oktel, T. C. Killian, D. Kleppner, and L. S. Levitov, Phys. Rev. A **65**, 033617 (2002).

"Formation of Rydberg Atoms in an Expanding Ultracold Neutral Plasma," T. C. Killian, M. J. Lim, S. Kulin, R. Dumke, S. D. Bergeson, and S. L. Rolston, Phys. Rev. Lett. **86**, 3759 (2001).

"Plasma Oscillations and Expansion of an Ultracold Neutral Plasma," S. Kulin, T. C. Killian, S. D. Bergeson, and S. L. Rolston, Phys. Rev. Lett. **85**, 318 (2000).

"Bose-Einstein Condensation in Atomic Hydrogen," T. J. Greytak, D. Kleppner, D. G. Fried, T. C. Killian, L. Willmann, D. Landhuis, and S. C. Moss, Physica B **280**, 20 (2000).

"1S-2S Spectrum of a Hydrogen Bose-Einstein Condensate," T. C. Killian, Phys. Rev. A **61**, 033611 (2000).

"Creation of an Ultracold Neutral Plasma," T. C. Killian, S. Kulin, S. D. Bergeson, L. A. Orozco, C. Orzel, and S. L. Rolston, Phys. Rev. Lett. **83**, 4776 (1999).

"Bose-Einstein Condensation of Atomic Hydrogen," D. Kleppner, T. J. Greytak, T. C. Killian, D. G. Fried, L. Willmann, D. Landhuis, and S. C. Moss, in *Proceedings of the International School of Physics "Enrico Fermi," Course CXL: Bose Einstein Condensation in Atomic Gases, 1998*, edited by M. Inguscio, S. Stringari, and C. E. Weiman, (IOS Press, Amsterdam, 1999), p. 177.

"Bose-Einstein Condensation of Atomic Hydrogen," D. G. Fried, T. C. Killian, L. Willmann, D. Landhuis, S. C. Moss, D. Kleppner, and T. J. Greytak, Phys. Rev. Lett. **81**, 3811 (1998).

"Cold Collision Frequency Shift of the 1S-2S Transition in Hydrogen," T. C. Killian, D. G. Fried, L. Willmann, D. Landhuis, S. C. Moss, T. J. Greytak, and D. Kleppner, Phys. Rev. Lett. **81**, 3807 (1998).

"Doppler-Free Spectroscopy of Trapped Atomic Hydrogen," T. C. Killian, D. G. Fried, C. L. Cesar, A. D. Polcyn, T. J. Greytak, and D. Kleppner, in *Atomic Physics 15; Fifteenth International Conference on Atomic Physics, Zeeman-Effect Centenary*, edited by H. B. Van Linden Van Den Heuvell, J. T. M. Walraven, and M. W. Reynolds, (World Scientific, Singapore, 1997), p. 158.

"Two-Photon Spectroscopy of Trapped Atomic Hydrogen," C. L. Cesar, D. G. Fried, T. C. Killian, A. D. Polcyn, J. C. Sandberg, I. A. Yu, T. J. Greytak, D. Kleppner, and J. M. Doyle, Phys. Rev. Lett. **77**, 255 (1996).

"Two-Photon Spectroscopy of Trapped Atomic Hydrogen," C. L. Cesar, D. G. Fried, T. C. Killian, A. D. Polcyn, J. C. Sandberg, J. M. Doyle, I. A. Yu, T. J. Greytak, and D. Kleppner, in *Proceedings of the Fifth Symposium on Frequency Standards and Metrology, 1995*, edited by J. C. Berquist, (World Scientific, Singapore, 1996), p. 365.

"Diode Laser Jet Spectroscopy of Hexafluorobenzene in the 10-μm Region," P. B. Davies, G. M. Hansford, and T. C. Killian, J. Mol. Spectrosc. **163**, 138 (1994).

"Structure of Propadienylidene, H_2CCC," C. A. Gottlieb, T. C. Killian, P. Thaddeus, P. Botschwina, J. Flugge, and M. Oswald, J. Chem. Phys. **98**, 4478 (1993).

"Astronomical Detection of H_2CCCC," J. Cernicharo, C. A. Gottlieb, M. Guelin, T. C. Killian, P. Thaddeus, and J. M. Vrtilek, Astrophys. J. (Letters) **368**, L43 (1991).

"Astronomical Detection of H_2CCC," J. Cernicharo, C. A. Gottlieb, M. Guelin, T. C. Killian, G. Paubert, P. Thaddeus, and J. M. Vrtilek, Astrophys. J. (Letters) **368**, L39 (1991).

"Laboratory Detection of a Second Carbon Chain Carbene: Butatrienylidene, H_2CCCC," T. C. Killian, J. M. Vrtilek, C. A. Gottlieb, E. W. Gottlieb, and P. Thaddeus, Astrophys. J. (Letters) **365**, L89 (1990).

"Laboratory Detection of Propadienylidene, H_2CCC," J. M. Vrtilek, C. A. Gottlieb, E. W. Gottlieb, T. C. Killian, and P. Thaddeus, Astrophys. J. (Letters) **364**, L53 (1990).