JORDAN MITCHELL GERTON

Applied Physics
Caltech 128-95
Pasadena, CA 91125

lab: 626-395-2762
office: 626-395-4823
jgerton@caltech.edu

EDUCATION

Rice University, Houston, Texas
Ph.D., Physics, May 2001
Thesis Advisor: Prof. Randall G. Hulet
Thesis Title: Molecular Spectroscopy of a Bose-Einstein Condensate with Attractive Interactions

M.A., Physics, May 1998
Thesis Advisor: Prof. Randall G. Hulet
Thesis Title: Laserless Slow Atom Source for Loading Atom Traps

University of Arizona, Tucson, Arizona
B.S., Engineering Physics, May 1994
Graduated Cum Laude

PROFESSIONAL EXPERIENCE

California Institute of Technology, Pasadena, California
Beckman Senior Research Fellow, May 2003 – present
Collaborators: Prof. Stephen Quake (Applied Physics); Prof. Scott Fraser (Biology); Prof. David Chan (Biology).

Postdoctoral Scholar, July 2001 – April 2003
Supervisor: Prof. Stephen Quake.

Smith College, Northampton, Massachusetts
Participant, Molecular Biology Summer Workshop, July 2003
Program Director: Prof. Steven Williams.

Pomona College, Claremont, California
Visiting Physics Instructor, August 2002 - December 2002
Coordinator: Prof. David Tannenbaum.

Rice University, Houston, Texas
Welch Fellow and Graduate Research Assistant, August 1995 – May 2001
Supervisor: Prof. Randall G. Hulet.

Graduate Teaching Assistant, January 1995 – May 1997
Supervisor: Prof. Stanley Dodds.

HONORS AND AWARDS

Beckman Senior Research Fellowship: Funded research proposal, Caltech (2003)

Wilson Thesis Prize: Award for most outstanding physics doctoral thesis, Rice University (2001)

Chuoke Award: Award for most outstanding physics graduate student, Rice University (1997)

Outstanding Male Student Athlete: Award for best combined athletic and academic record, University of Arizona (1993)

NCAA Division I All-American: Member of 4×50 yard freestyle relay team at Swimming National Championships, University of Arizona (1991)

RESEARCH ACCOMPLISHMENTS

***Dynamic protein interactions*:** I wrote a research proposal which initiated collaborative research between myself and faculty members in Applied Physics and Biology at Caltech. The proposal was one of only two funded by the Beckman Institute at Caltech in 2003 and entitles me to faculty status and an independent research budget of $50k per annum for up to three years. Research goals include using a fluorescence microscope with molecular-scale spatial resolution to study protein-mediated membrane fusion between HIV virion and their target cells, and stimulus-induced conformational changes in membrane-bound protein signal complexes.

***Tip-enhanced fluorescence microscopy*:** (With L. Wade, G. Lessard, Z. Ma, and S. Quake) We developed a novel instrument that combines a fluorescence microscope and an atomic force microscope (AFM) for spectroscopic imaging with molecular-scale resolution. The AFM probe strongly enhances the excitation-laser intensity, in analogy with a lightning rod, leading to fluorescence microscopy with spatial resolution below 10 nm. This work led to a patent (pending) and has potential in a wide array of applications including studies of dynamic interactions between the various biomolecules which constitute the sub-cellular machinery.

***Bose-Einstein condensation*:** (With C. Sackett, I. Prodan, D. Strekalov, M. Welling, and R. Hulet) We developed a novel spectroscopy technique that permitted the first direct measurement of the complex, non-equilibrium dynamics within a Bose-Einstein condensate (BEC) composed of atoms with attractive interactions. The underlying mechanism for the observed dynamics is analogous to the case of a star going supernova, even though these phenomena are separated by several orders of magnitude in both length and temperature scale. This work settled a long-standing dispute and touched off a flurry of activity in the BEC community.

***Atom guiding and trapping*:** (With B. Ghaffari, W. McAlexander, C. Bradley, S. Moss, and R. Hulet) We developed a novel technique to selectively remove the slow atoms from a thermal atomic beam and direct them to an atom trap for subsequent ultracold experiments. The method is based on the same principle employed in particle-accelerator storage rings, and is much more general and simple than other techniques that require laser manipulation of the atomic beam. This work led to a patent and has potential for use in space-based ultracold atom experiments including next-generation, satellite-borne atomic clocks.

CURRENT RESEARCH

***Probing intracellular feedback networks*:** In collaboration with Prof. Pat Collier in the Chemistry department at Caltech, we have produced single-wall carbon nanotube probes for tip-enhanced fluorescence microscopy at the molecular length scale. We are also developing techniques to biochemically functionalize these nanotube probes specifically at their ends. I plan to use these novel probes to identify specific receptors on a cell membrane and induce a local stimulus there. This will help map the logical organization of intracellular feedback networks, in analogy with electronic circuits, in order to optimize control over the activities of a cell.

***Imaging signal transduction*:** In collaboration with Prof. Scott Fraser in the Biology department at Caltech, I am investigating appropriate model systems and sample preparation methods for studying membrane-bound protein complexes involved in signal transduction. I plan to exploit the molecular-scale spatial resolution of our tip-enhanced fluorescence microscope to image the dynamic conformational response of these complexes to biochemical signals. This will help illuminate the mechanistic details of the first stage of signal transduction occurring at the cellular interface.

***Reading a self-assembled DNA nanoarray*:** In collaboration with Prof. Angelika Niemz at the Keck Graduate Institute (Claremont, CA), I am developing a technique to simultaneously screen and decode a self-assembled DNA nanoarray using the tip-enhanced fluorescence microscope. Self-assembled nanoarrays are attractive platforms for probing gene expression because of their high target density, but require an extra decoding step following screening. I plan to utilize the topographical imaging capability of our microscope to screen the novel nanoarray while simultaneously decoding using the nanoscale optical imaging capability.

PUBLICATIONS

"Tip-Enhanced Fluorescence Microscopy at 10 nm Resolution," J. M. Gerton, L. A. Wade, Z. Ma, G. A. Lessard, and S. R. Quake, submitted to *Physical Review Letters*.

"Macroscopic Quantum Tunneling in Bose-Einstein Condensates," C. A. Sackett, J. M. Gerton, M. Welling, and R. G. Hulet, in *Exploring the Quantum/Classical Frontier: Recent Advances in Macroscopic and Mesoscopic Quantum Phenomena*, J.R. Friedman and S. Ham, eds. (Nova Science, 2003).

"Quantum Degeneracy in Lithium Gases," R. G. Hulet & J. M. Gerton, in *Trapped Particles and Fundamental Physics*, S. N. Atutov, R. Calabrese, and L. Moi, eds. (Kluwer, 2002).

"Photoassociative Frequency Shift in a Quantum Degenerate Gas," J. M. Gerton, B. J. Frew, & R. G. Hulet, *Physical Review A* **64** 053410 (2001).

"Direct Observation of Growth and Collapse of a Bose-Einstein Condensate with Attractive Interactions," J. M. Gerton, D. Strekalov, I. Prodan & R. G. Hulet, *Nature* **408** 692 (2000).

"Laser-Free Slow Atom Source," B. Ghaffari, J. M. Gerton, W. I. McAlexander, K. E. Strecker, D. M. Homan, & R. G. Hulet, *Physical Review A* **60** 3878 (1999).

"Dipolar Relaxation Collisions in Magnetically Trapped ^{7}Li," J. M. Gerton, C. A. Sackett, B. J. Frew, & R. G. Hulet, *Physical Review A* **59** 1514 (1999).

"Measurements of Collective Collapse in a Bose-Einstein Condensate with Attractive Interactions," C. A. Sackett, J. M. Gerton, M. Welling, & R. G. Hulet, *Physical Review Letters* **82** 876 (1999).

"Probing a Bose-Einstein Condensate by Near-Resonant Light Scattering," C. A. Sackett, J. M. Gerton, M. Welling, & R. G. Hulet, *Spectral Lineshapes: Proceedings of the Fourteenth International Conference on Spectral Lineshapes*, R. Herman, ed., Volume 10 (1999).

"Collective Collapse of a Bose-Einstein Condensate with Attractive Interactions," C. A. Sackett, J. M. Gerton, M. Welling, & R. G. Hulet, in *Atomic Physics 16*, W. E. Baylis and G. W. F. Drake, eds. (1999).

"Triplet *s*-Wave Resonance in ^{6}Li Collisions and Scattering Lengths of ^{6}Li and ^{7}Li," E. R. I. Abraham, W. I. McAlexander, J. M. Gerton, R. G. Hulet, R. Côté, & A. Dalgarno, *Physical Review A* **55** R3299 (1997).

"Singlet *s*-Wave Scattering Lengths of ^{6}Li and ^{7}Li," E. R. I. Abraham, W. I. McAlexander, J. M. Gerton, R. G. Hulet, R. Côté, & A. Dalgarno, *Physical Review A* **53** R3713 (1996).

PATENTS

"Method and Apparatus for Magnetically Guiding Neutral Particles," R. G. Hulet, C. C. Bradley, J. M. Gerton, B. Ghaffari, W. I. McAlexander, S. C. Moss, C. A. Sackett, K. E. Strecker, & J. J. Tollett, (*issued October 2003*).

"Improved Method and System for Scanning Apertureless Fluorescence Microscope," S. R. Quake, G. A. Lessard, L. A. Wade, and J. M. Gerton, (*pending*).

SELECTED PROFESSIONAL PRESENTATIONS

Invited

"Fluorescence Apertureless Near-Field Optical Microscope for Biological Imaging," microscopy seminar, Max-Planck Institute for Biochemistry, Martinsried, Germany (September 2002).

"Bose-Einstein Condensation," physics colloquium, Pomona College, Claremont, CA (December 2001).

"Direct Observation of Growth and Collapse of a Bose-Einstein Condensate with Attractive Interactions," International Conference on Quantum Electronics and Laser Science (QELS), Baltimore, MD (May 2001).

"Production of Ultracold Li_2 by Photoassociation of a Quantum Degenerate Gas," Workshop on Trapping, Spectroscopy, and Collisions of Ultracold Molecules at the Harvard-Smithsonian Center for Astrophysics, Boston, MA (July 1999).

"Dynamics of BEC in a Gas with Attractive Interactions," physics seminar, Texas A&M University, College Station, TX (December 1998).

Contributed

"Fluorescence-Enhancement Microscopy at 10 nm Resolution," Frontiers in Optics: Optical Society of America Annual Meeting, Tucson, AZ (October 2003).

"Apertureless Near-Field Fluorescence Microscope for Biological Imaging," Quantum Electronics and Laser Science (QELS), Baltimore, MD (June 2003).

"Fluorescence Apertureless Near-Field Optical Microscope for Biological Imaging," 7th International Conference on Near-field Optics (NFO7), Rochester, NY (August 2002).

"Producing Ultracold Lithium Dimers," APS Division of Atomic, Molecular, and Optical Physics (DAMOP), Storrs, CT (June 2000).

"Vibrational Relaxation of Ultracold Lithium Dimers," Quantum Electronics and Laser Science (QELS), San Francisco, CA (May 2000).

"Producing Ultracold Lithium Dimers," Summer School on Fundamental Physics and Trapped Particles, Les Houches, France (May 2000).

"Photoassociation of Quantum Degenerate ^{7}Li and Induced Condensate Collapse," APS Centennial Meeting, Atlanta, GA (March 1999).

"Loading a MOT Using Passive Velocity Selection," APS Centennial Meeting, Atlanta, GA (March 1999).

"Dipolar Relaxation Collisions in Magnetically Trapped ^{7}Li," APS Centennial Meeting, Atlanta, GA (March 1999).

"Dynamics of a Bose Condensate with Attractive Interactions," DAMOP, Santa Fe, NM (May 1998).

ACTIVITIES

***Referee, Physical Review journals*:** (since 2000)

***Member, American Physical Society*:** Divisions of Laser Science; Atomic Molecular and Optical Physics; Biological Physics (since 1997)

***Member, Optical Society of America*:** (since 1997)

***Organizer, Physics graduate-student seminar series*:** Rice University (1995-97)

***University Court Justice*:** Rice University (1995-97)

***Physics Department representative to the Graduate Student Association*:** Rice University (1995-98)

***Intramural sports coordinator for the Graduate Student Association*:** Rice University (1995-97)

***Assistant men's and women's varsity swim coach*:** Rice University (1994-95)

***Elected Team Captain, men's varsity swim team*:** University of Arizona (1992-93)

***Elected liaison between varsity swim team and athletic director*:** University of Arizona (1990-92)

***Member, men's varsity swim team*:** University of Arizona (1989-93)

REFERENCES

Research

Stephen R. Quake
Associate Professor of Applied Physics and Physics
California Institute of Technology
1200 E. California Blvd.
Pasadena, CA 91125
(626) 395-3362
quake@caltech.edu

Randall G. Hulet
Fayez Sarofim Professor of Physics and Astronomy
Rice University
6100 Main St.
Houston, TX 77005
(713) 348-6087
randy@atomcool.rice.edu

Robert F. Curl
Pitzer-Schlumberger Professor of Natural Sciences and Chemistry
1996 Nobel Laureate in Chemistry
Rice University
6100 Main St.
Houston, TX 77005
(713) 348-4816
rfcurl@rice.edu

Teaching

David M. Tanenbaum
Associate Professor of Physics
Pomona College
610 North College Avenue
Claremont, CA 91711-6359
(909) 621-8722
dtanenbaum@pomona.edu