

Ashley R. Carter

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EDUCATION

University of Colorado, Boulder, CO;	
Ph.D. in Physics	2008
Certificate in Optical Science and Engineering	2008
M.S. in Physics	2006
University of Michigan, Ann Arbor, MI;	
B.S. Physics – with highest honors	2002
Math minor	
B.S.E. Engineering Physics – summa cum laude	2002

TEACHING EXPERIENCE

Amherst College, Department of Physics	2010-present
Associate Professor 2018-present	
Assistant Professor 2011-2018	
Visiting Assistant Professor 2010-2011	

Course responsibilities include design, execution, and grading for course. Courses use a blended learning environment with online and in-class work along with active learning lectures.

- Electronics (PHYS 114) – General science laboratory course on electronics. Course is for science and non-science majors and focuses on the building electronics for use in the community. Course has a cap at 20 students and meets for two 1.5-hour sessions per week. (F2018)
- Waves (PHYS 125) – Sophomore course on waves for physics majors. Course contains 15 students per term and meets for three 1-hour lectures, one 1-hour discussion, and one 3-hour laboratory per week. (F2018)
- Maker Optics (PHYS 147) – General science laboratory course on optics. Course is for science majors and focuses on building optical systems in a learn-as-you go manner. Course has a cap at 12 students and meets for two 1.5-hour sessions per week. (S2018)
- Electromagnetism and Optics (PHYS 117) – Calculus-based introductory course on electromagnetism, circuits, and optics. Course is for premedical students, scientists, and biophysics majors. Course contains 35 students per term and meets for 3 one-hour lectures and a three-hour lab per week. Sometimes includes a one hour discussion section. (F2015, S2016, F2016, F2017)
- Molecular and Cellular Biophysics (PHYS/BIO/CHEM/BCBP 400) – Senior capstone course for the Biochemistry and Biophysics major. Sometimes co-taught. Course contains 10-20 students per term and meets for two 1.5-hour lectures per week. (F2011, F2012, F2013, S2016, S2018)
- Maxwellian Synthesis (PHYS 124) - Calculus-based introductory course on electricity and magnetism, circuits and optics for majors. Course contains 20 students per term and meets for 3 one-hour lectures, a one-hour discussion, and a three-hour lab per week. (S2012, S2013, S2014)
- Dynamics (PHYS 343) – Classical dynamics for upper-division physics majors. Course contains 10 students per term and meets for 3 one-hour lectures. Labs are infused into lecture curriculum. (F2011, F2012, F2013)

- Mechanics (PHYS 116) – Calculus-based introductory mechanics course for non-majors. This is a large course (60 students per term) aimed at students looking to fulfill their pre-medical school requirements. Course meets for 3 one-hour lectures and a three-hour lab per week. (F2010, S2011)

Devry University Online, *College of Liberal Arts & Sciences* 2009-2011
Adjunct Professor

Courses at Devry are taught in an online, asynchronous format requiring students to turn in weekly assignments. Responsible for course management and for students meeting prescribed learning objectives.

- College Physics II with Lab (PHYS 320) – Calculus-based introductory physics course on thermodynamics, electromagnetism, and waves for engineering students. Course contains 20 students per term.
- Applied Physics (PHYS 214) – Algebra-based, introductory physics course on mechanics for pre-medical students. Course contains 20 students per term.

Harvard University, *Department of Physics* 2009-2010
Teaching Fellow, Instructor

- Cocktail Party Physics – January term course for 15 undergraduates, graduates, and faculty. Responsible for course development and implementation. Course is on topics that are interesting to talk about at a cocktail party. (J2010)
- Life Sciences 100 research (LS100r) – Course is for upper division undergraduates. Course contains 20 students per term. Responsible for mentoring students through a research project on planaria phototaxis. (F2009)

RESEARCH EXPERIENCE

Associate Professor, *Department of Physics* 2010-present
Assistant Professor 2011-2018
Visiting Assistant Professor 2010-2011
Amherst College, Amherst, MA

Current Projects

- Investigating the molecular packaging of DNA within sperm, especially the process by which protamine proteins replace histone proteins, using video microscopy, optical trapping, and atomic force microscopy.
- Developing biophysical teaching laboratories, “plug and play” laboratories, for interdisciplinary courses
- Probing the local mechanical properties of the cytoplasm *in vivo* within zebrafish embryos using video microscopy. (Collaboration)
- Tracking zebrafish startle behavior in physiology experiments using video microscopy and machine vision. (Collaboration)

Finished Projects

- Measured movements of the RecBCD helicase along DNA to 1 bp precision. (Collaboration)
- Assessed the quality of back-scattered laser detection for use in optical trapping, particle tracking, or atomic force microscopy experiments.

Postdoctoral Researcher, *Department of Physics* 2009-2010
Harvard University, Cambridge, MA
Advisor: Dr. Aravinthan Samuel

- Determined the behavioral algorithm of *Drosophila* larva phototaxis and examined the role of various neurons in the implementation of that algorithm.

Graduate Research Assistant, Department of Physics 2003-2009
JILA/ University of Colorado, Boulder, CO
Advisor: Dr. Thomas Perkins
Dissertation: "Precision Measurement using a Stabilized Microscope: Motility of the *E. Coli* Helicase, RecBCD"

- Stabilized an optical microscope to 0.1 nm using a laser detection system.
- Created a stabilized optical tweezers system capable of resolving 1 base-pair (0.34-nm) motion along DNA
- Stabilized an atomic force microscope to 30 pm.

Graduate Engineering Intern 2007
Zygo Corporation, Middletown, CT
Manager: Dr. David Wilson

- Designed and performed reliability testing of fiber-collimator assemblies for use in precision stage positioning products (*e.g.* lithographic tools).

Graduate Research Assistant 2002-2003
Laboratory for Physical Sciences, College Park, MD
Principle Investigator: Dr. Keith Schwab

- Fabricated a microchip to act as an atom trap for Bose-Einstein Condensates using photolithography and electroplating techniques.

Undergraduate Research Assistant, Department of Physics 1999-2002
University of Michigan and Fermi National Accelerator Laboratory
Advisor: Dr. Myron Campbell
Honors Thesis: "Efficiency Study of the Collider Detector at Fermilab (CDF) Calorimeter Trigger"

- Involved in building the calorimeter trigger for CDF by assembling and testing hardware and creating a software suite to set the various triggering levels.
- Analyzed Run II CDF data to find the calorimeter triggering efficiency.
- Designed, built, and installed a fiber optical cable system to calibrate the time-of-flight detector for CDF.

AWARDS & GRANTS

NSF CAREER Grant, DMR, Biomaterials, Award #1653501, 2017-2022
Cottrell Scholar, Research Corporation, Class of 2015
Cottrell College Science Award, Research Corporation, 2015-2017
Class of 1952 Dean Eugene S. Wilson Faculty Development Fellowship,
Amherst College Sabbatical Fellowship, 2014
Milton L. Shifman Endowed Scholarship, Marine Biological Laboratory, 2009
Biophysical Society Student Travel Award, 2008
Physik Instrumente NanoInnovation Grant, 2006
National Physical Science Consortium Fellowship, 2002-2008
Optical Science and Engineering Program Fellowship, National Science Foundation's
Integrative Graduate Education and Research Traineeship Program, 2002-2007
Ralph B. Bodine Scholarship, University of Michigan Physics Department, 2000-2002
Wiley Book Award, Univ. of Mich. Physics Dept. Award for Achievement, 2002
Motorola Global Future Faculty Fellowship, 2001
Undergrad. Research Opportunities Program and General Electric Fellowship, 2000
Undergrad. Research Opportunities Program and NSF Fellowship, 1999
University of Michigan Awards
James B. Angell Scholar 2002
University or Class Honors 1999-2002

PROFESSIONAL ACTIVITIES

ALPhA, Secretary, 2018-present
SPIE Optical Trapping and Optical Micro., Program Committee, 2018-present
APS Reichert Award, Selection Committee, 2017-present
ALPhA, New England Regional Director, 2017-present

NSF Advance Project on eAlliances, Advisory Board Member, 2016-present
Biophysical Society, Education Committee Member, 2015-present
AWIS local affiliate chapter, Faculty Advisor, Amherst College 2014-present
Sigma Xi, Chapter Vice President, Amherst College 2012-present
ALPhA, Board of Directors, 2016-2017
Neurobiology Course, Marine Biological Laboratory, 2009
Physics Graduate Student Search Committee Member, Univ. of Colorado, 2005-2006
Optical Society of America Student Chapter, Univ. of Colorado, President, 2002-2005
Physics Graduate Student Association, Univ. of Colorado, Vice President, 2003-2004
Graduate Research Opportunity Seminar Series, Univ. of Colorado, Chair, 2002-2003
Society of Physics Students, University of Michigan, Secretary, 1998-2002

Professional Associations

SPIE	American Physical Society (APS)
Biophysical Society	American Association of Physics Teachers (AAPT)
Sigma Xi	Association of Women in Science (AWIS)
Advanced Laboratory Physics Association (ALPhA)	

COMMUNITY ACTIVITIES

Amherst College Women's Track and Cross Country, Faculty Liaison, 2013-present
Elm Street Homeowners Association, Trustee, 2009-present
Cambridge Running Club, 2009-2012
Wimbledon Home Owners Association, President, 2004-2006
University of Colorado Women's Soccer, Captain 2002-2003
University of Michigan Women's Soccer, Captain and Member 1999-2001

GRANT APPLICATIONS

NSF Career, PI, July 2012 and July 2016 – funded Jan. 2017
NSF MRI, Co-PI, October 2013 and October 2014
Research Corp., Co-PI July 2013 and PI July 2014 – funded June 2015

THESES SUPERVISED

Hilary Bediako (Amherst College, BCBP, 2019)
“Measuring toroid formation by protamine.”

Peter Cho (Amherst College, BCBP, 2019)
“Ablating lateral line neurons affects zebrafish startle behavior.”

Ashwin Balaji (Amherst College, BCBP, 2019)
“DNA loop formation by positively charge ions.”

Bishop Grimm (Amherst College, Astronomy and Physics, 2018)
“Toward force characterization of protamine-condensed DNA.”

Adam Smith (Amherst College, BCBP, 2017)
“Measuring protamine-induced DNA folding using a tethered particle motion assay.”

Luka Devenica (Amherst College, BCBP and Physics, 2017)
“Construction of optical tweezers for measuring DNA folding by protamine.”

Marco Catipovic (Amherst College, BCBP, 2014)
“Measuring the viscoelastic properties of zebrafish embryos.”

Clay Contee (Hampshire College, Physics, 2014)
“Atomic force microscopy for undergraduate laboratories.”

Frederick Shipley (Amherst College, BCBP and Physics, 2013)
“Using backscattered detection to build an optical profilometer.”

Robert Schwab (Amherst College, BCBP, 2013)
“Stepwise mechanism of DNA condensation in sperm.”

SPECIAL TOPICS CLASSES

AFM Research (F2013)
Biophysics Research (F2013)
Microscope Development (S2013)
Mechanics of Biomolecules (S2011)

**Undergraduate or high school student authors are underlined. First author is the student with the largest contribution on the project. Last author is the principle investigator with the largest contribution on the project. Conference proceedings or invited papers that are not peer-reviewed are noted. All other publications are peer-reviewed.

PUBLICATIONS

Publications as a Professor

O. Ukogu, A. Smith, R. Schwab, R. McMillan, H. Bediako, S. Anwar, J. H. Lee, M. Woop, F. Feng, Y. Woody, M. Dasgupta, and **A. R. Carter**, “DNA looping by protamine occurs in a multi-step process.” (in preparation).

E. D. White, M. A. Catipovic, R. Flynn, M. Kilfoil, J. G. Trapani, and **A. R. Carter**, “Mechanical dynamics show local developmental differences in early zebrafish embryos.” (in preparation).

A. Boskovic, K. M. Jones, M. Viklund, and **A. R. Carter**, “Simple acoustic trapping.” *American Journal of Physics*, (in preparation).

A. R. Carter, “Case study on how to develop 3D labs with theoretical, experimental, and computational goals.” *Proceedings of BFY*, (submitted 2018).

L. M. Devenica, B. S. Grimm, T. Hultum, and **A. R. Carter**, “Progress on an optical trapping assay to measure DNA folding pathways in sperm.” *Proceedings of SPIE*, **10347** (2017).

A. D. Smith, O. A. Ukogu, L. M. Devenica, E. D. White, and **A. R. Carter**, “Optical methods for measuring DNA folding,” *Modern Physics Letters B*, 31:1730001 (2017).

S. R. Okoniewski, **A. R. Carter**, and T. T. Perkins, “A Surface-Coupled Optical Trap with 1-bp Precision via Active Stabilization.” *Methods in Molecular Biology*, **1486**:77-107 (2017).

E. L. Troconis, A. J. Ordoobadi, T. F. Sommers, R. Aziz-Bose, **A. R. Carter**, and J. G. Trapani, “Intensity-dependent timing and precision of startle response latency in larval zebrafish.” *Journal of Physiology*, **595**(1):265-282, DOI: 10.1113/JP272466 (2017).

A. R. Carter, M. H. Seaberg, H. Fan, G. Sun, C. J. Wilds, H. Li, and T. T. Perkins, “Sequence-dependent nanometer-scale conformational dynamics of individual RecBCD-DNA complexes.” *Nucleic Acids Research*, **44**(12):5849-60, DOI: 10.1093/nar/gkw445 (2016).

L. M. Devenica, C. Contee, R. Cabrejo, M. Kurek, E. F. Deveney, and **A. R. Carter**, "Biophysical Measurements of Cells, Microtubules, and DNA with an Atomic Force Microscope." *American Journal of Physics*, **84**:301 (2016).

M. A. Catipovic, P. M. Tyler, J. G. Trapani, and **A. R. Carter**, "Improving the quantification of Brownian motion." *American Journal of Physics*, **81**:485 (2013).

E. A. Kane, M. Gershow, B. Afonso, I. Larderet, M. Klein, **A. R. Carter**, B. L. de Bivort, S. G. Sprecher, and A. D. T. Samuel, "Sensorimotor structure of Drosophila larva phototaxis." *Proceedings of the National Academy of Sciences USA*, DOI: 10.1073/pnas.1215295110 (2013).

A. R. Carter, "Evolution of the significant figure rules," *The Physics Teacher*, **51**:340 (2013).

F. B. Shipley and **A. R. Carter**. "Back-scattered detection yields viable signals in many conditions." *Optics Express*, **20**:9581 (2012).

Publications as a Graduate Student

T. T. Perkins, G. M. King, A. B. Churnside, and **A. R. Carter**, "Ultrastable Atomic Force Microscopy using Laser-Based, Active Noise Cancelation." Conference on Lasers and Electro-Optics, *OSA Technical Digest*, Optical Society of America, CTuOO3 (2010). Invited paper that was not peer-reviewed.

G. M. King, **A. R. Carter**, A. B. Churnside, L. Eberle, and T. T. Perkins, "An ultrastable atomic force microscope: atomic-scale stability and registration in ambient conditions." *Nano Letters*, **9**:1451 (2009).

A. R. Carter, Y. Seol, and T. T. Perkins, "Precision surface-coupled optical-trapping assay with 1 base-pair resolution." *Biophysical Journal*, **96**:2926 (2009).

A. B. Churnside, G. M. King, **A. R. Carter**, and T. T. Perkins, "Improved performance of an ultrastable measurement platform using a field programmable gate array for deterministic, real-time control." *Proceedings of SPIE* **7042**:704205 (2008). Invited paper that was not peer-reviewed.

A. R. Carter, G. M. King, and T. T. Perkins, "Back-scattered detection provides atomic-scale localization precision, stability, and registration in 3D." *Optics Express*, **15**: 13434 (2007).

A. R. Carter, G. M. King, T. A. Ulrich, W. Halsey, D. Alchenberger, and T. T. Perkins, "Stabilization of an optical microscope to 0.1 nm in 3D." *Applied Optics*, **46**:421 (2007).

PATENTS

"Laser guided tip approach with 3D registration to a surface" with G. M. King and T. T. Perkins, US Patent #: 8,387,158 (filed 2010, issued February 26, 2013).

"Real-time, active, picometer-scale alignment and stabilization in one, two, and three dimensions," with G. M. King and T. T. Perkins, US Patent #: 7,928,409 (filed 2006, issued April 19, 2011).

PRESENTATIONS

SPIE Optical Trapping and Optical Micromanipulation XV (August 19, 2018)
National Meeting
Invited talk on “Looping DNA with protamine requires multiple steps.”

AAPT Summer Meeting (July 31, 2018)
National Meeting
Selected talk on “Design and Redesign of Acoustic Experiments.”

AAPT NSF Advance Project eAlliances Summit (July 28-29, 2018)
Summit for members of eAlliances
Cohort Presentations Panel.

Third Conference on Laboratory Instruction Beyond the First Year (July 25-27, 2018)
National Meeting of the Advanced Laboratory Physics Association (ALPhA)
Workshop W07 on “Acoustic trapping.”
Invited talk on “Case study on how to develop 3D labs with theoretical, experimental, and computational goals.”

Gordon Research Conference (July 19, 2018)
Conference on Single-Molecule Approaches to Biology
Selected talk on “Protamine folds DNA before forming loops.”

Connecticut Valley Zebrafish Meeting (May 4, 2018)
Regional Conference.
“Particle tracking in zebrafish embryos, what can we learn?”

Boston University (April 23, 2018)
Biophysics Seminar
“Studying the dramatic looping of DNA in sperm using single molecule assays.”

Biophysical Society Annual Meeting (February 2, 2018)
National Meeting.
Poster on “Protamine-induced DNA looping.”

University of Massachusetts Amherst (February 9, 2018)
Department of Mechanical and Industrial Engineering Seminar
“DNA Folding on the Fly.”

Bates (February 2, 2018)
Physics Department Seminar
“DNA Folding on the Fly.”

SPIE Optical Trapping and Optical Micromanipulation XIV (Aug. 9, 2017)
National Meeting
Poster on “Progress on optical trapping assay to measure DNA folding pathways in sperm.”

AAPT Summer Meeting (Jul. 24, 2017)
National Meeting. Session: Optics Labs at All Levels: Rainbows to Raman Spectroscopy
“Simple Setup to Teach Optical Alignment.” AD03

Bridgewater State University (Apr. 14, 2017)
Department of Physics Colloquium
“Folding DNA on the Fly.”

American Physical Society March Meeting (Mar. 13-17, 2017)
National Meeting.

Session B40: Jonathan F. Reichert and Barbara Wolff-Reichert Award for Excellence in Advanced Laboratory Instruction, “Adding Interdisciplinary Exploration to Teaching Laboratories using AFM and Biophysical Samples.”

Wellesley College (Nov. 8, 2017)
Department of Physics Colloquium
“The Art of Reshaping DNA.”

Advanced Physics Laboratory Association, Immersion Workshop (June 7-9, 2016)
Led workshop at Harvard University on Biophysical Measurements.
“Imaging DNA with an Atomic Force Microscope.”

Clark University (Apr. 5, 2016)
Department of Physics Colloquium
“The Unexpected Individualism of the Developing Zebrafish Embryo.”

Biophysical Society Annual Meeting (Feb. 27- Mar. 2, 2016)
National Meeting.
Panel Speaker in Session: “Founding, Establishing, and Maintaining a Research Laboratory.”

American Association of Physics Teachers Summer Meeting (July 25-29, 2015)
National Meeting.
Workshop W42: Intermediate and Advanced Laboratories, “Make your own DNA or microtubule AFM samples.”
Contributed talk FH05, “Biophysical Measurements of Cells, Microtubules, and DNA with an AFM.”

Advanced Laboratory Physics Association, Beyond the First Year Laboratory Conference (July 22-24, 2015)
National Meeting that occurs every three years with the summer AAPT meeting.
Workshop W05, “Make your own DNA or microtubule AFM samples.”
Session XII: Plenary Leader on “Bio-related BFY labs in physics.”

Miami University, Ohio (Feb. 24-26, 2015)
Department of Physics Colloquium
Arfken Scholar Visit
“Reshaping our Genetic Future.”

Connecticut Valley Zebrafish Meeting (Jan. 8, 2015)
Regional Conference.
“Cytoskeleton formation generates a radial viscosity wave in zebrafish zygotes.”

American Association of Physics Teachers Summer Meeting (July 26-30, 2014)
National Meeting.
Session “Magnetism and Thermal Instructional Labs, Beyond the First Year.”

Gordon Research Conference (June 8-13, 2014)
Physics Research and Education - The Complex Intersection of Biology and Physics.
“Involving Undergraduates in Cutting Edge Biophysics Research and its Implications for Instruction.”

American Physical Society New England Section Conference (Oct. 11-12, 2013)
Fall Meeting of the New England Section of the American Physical Society.
“Optical Trapping: from Ultrastable Measurements to Simple Biophysical Experiments.”

Williams College (Oct. 4, 2013)
Department of Physics Colloquium
“Reshaping our Genetic Future.”

Mt. Holyoke College (March 13, 2012)
Department of Physics Colloquium
“Discovering the Viscosity of Living Cells.”

Southern Connecticut State University (May 6, 2011)
Department of Physics Colloquium
“Using Lasers to Observe the Mechanics of Cellular Life.”

Smith College (Dec. 9, 2010)
Department of Physics Colloquium
“A Physicist's Look at DNA Unwinding.”

COLLEGE SERVICE

Lecture Committee (2017-present)

Standing committee of the faculty
Served with Anston Brosnan and Kuree 2017-2018

Center for Biological Physics (2015-present)

Five College Group that promotes Biophysics across many Departments.
Attend weekly seminar series, workshops, and conferences. Give talks and help with plenary sessions.

Amherst AWIS (2014-present)

Amherst student, faculty, and staff group associated with the Association for Women in Science national organization.
Leader of group and on the Faculty Executive Board

Curriculum Committee, Physics Department (2013-present)

Responsible for evaluating current curriculum and proposing changes
Co-leader of group with Dave Hanneke

Faculty Liaison to Women's Track and Field and Cross Country (2013-present)

Advise students and coach on academic matters. Act as liaison between athletics and academics

Sigma Xi Research Honor Society, Amherst Chapter Vice President (2012-present)

Responsible for submitting the yearly chapter summary including finances and for inducting our seniors into the society just before graduation
Co-leader of group with Mark Marshall

Orientation Advisor (2012-2013, 2015-2017)

Advise first year students during orientation and then as a college advisor

Biochemistry and Biophysics Program (2011-present)

Group of faculty that run the Biochemistry and Biophysics major at Amherst

Five College Biophysics Group and Center for Biological Physics (2011-present)

Give biophysics research talks and journal club discussions to the group and attend meetings located at UMass

Amherst Summer Undergraduate Research Fellowship (SURF) Program (2011-present)

Mentor 1-2 undergraduates per summer.
Give yearly lab tours and lunch talks to all SURF participants.

Comprehensive Exam Committee, Physics Department (2012-2014, 2015-2018)

Responsible for administering the department's comprehensive exam

New Faculty Social Hour (2014-2018)

Social group with a goal of fostering community amongst new faculty
Co-leader of group with Joe Trapani

Advising Network (2016-2017)

New pilot program to do intensive advising of Summer Science students

Committee on Academic Standing and Special Majors (2015-2017)

Standing committee of the faculty
Served with Ted Melilo and Ingrid Nelson 2015-2016
Served with Kristin Bumiller and Stanislav Rabinovich 2016-2017

Five College new-STEM Network (2011- 2016)

Give informal research talks to the group and attend meetings

Ask Big Questions (2014)

Group lead by the Provost to encourage community amongst faculty, staff, and students

Technology Committee (2013-2014)

Sub-committee of the strategic planning committees through the Provost's office

Served with Matt Schulkind, Sam Morse

Active Learning Classroom Working Group (2013-2014)

Ad hoc working group lead by Gayle Barton to establish an active learning classroom

Served with Caroline Goutte, Julia Emerson, Pat O'Hara, Nick Horton

Education and Athletics Committee (2012-2014)

Standing Committee of the Faculty

Served with Frank Couvares and Austin Sarat, 2012-2013

Served with Paul Rockwell and Catherine Sanderson, 2013-2014

Amherst College Orientation (August 29, 2013) My Amherst Too! Program

"Recipe for a Scientific Life: One Part Hard Work, One Part Curiosity and a Pinch of Creativity."

Annual Faculty Workshop Series (Sept. 20, 2013)

"Finding a way to package DNA."

Seminar Committee, Physics Department (2011-2012)

Organized weekly colloquium