

CATHERINE HIRSHFELD CROUCH, PH.D.

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PRESENT POSITION

Assistant Professor of Physics, Swarthmore College, 2003 – present.

Courses taught:

Electricity & magnetism for sophomore physics majors; seminar in classical electrodynamics for junior physics majors; seminar in quantum mechanics for junior physics majors; introductory physics for non-majors; introductory physics designed particularly for life science majors with extensive life science applications (new course developed by CHC for Swarthmore College); introductory, intermediate, and advanced laboratories.

EDUCATION

Postdoctoral Fellow in Applied Physics with Eric Mazur, Harvard University, 2000–2003.

Postdoctoral Fellow in Physics Education with Eric Mazur, Harvard University, 1996–2000,

Ph.D. in Physics with Robert M. Westervelt, Harvard University, September 1996.

B.A. in Physics *summa cum laude* with Highest Honors, Williams College, 1990.

FELLOWSHIPS and AWARDS

Argonne National Laboratory Center for Nanoscale Materials User proposal, “Quantum Rod Blinking and Fluorescence Lifetimes on Sub-Microsecond Timescales,” approved September 2007 (work in progress).

James A. Michener junior faculty research leave award, Swarthmore College, 2006-2007.

Materials Research Science & Engineering Center Postdoctoral Fellowship, Harvard University, 2001-2002.

Fellow, AT&T Graduate Research Program for Women, 1991–1996.

Graduate Fellow, National Science Foundation, 1991–1994.

RESEARCH PROJECTS IN PROGRESS

Excitation energy dependence of fluorescence intermittency in core-shell CdSe/ZnS nanocrystals. Work done at Swarthmore College with undergraduates Thomas Emmons '08, Robert Mohr '09, and Orion Sauter '11. Manuscript in preparation.

Intensity dependence of fluorescence intermittency in core-shell CdSe/ZnS nanocrystals. Work done at Swarthmore College in collaboration with University of Pennsylvania colleagues Siying Wang and Prof. Marija Drndic.

Measurements of semiconductor nanorod fluorescence intermittency and lifetimes on sub-microsecond timescales. Work in progress at Argonne National Laboratories in collaboration with Argonne staff scientist Matthew Pelton and postdoctoral fellow Xiaohua Wu, with samples supplied by the research group of Prof. Marija Drndic of the University of Pennsylvania.

- [1] Robert Mohr, Thomas Emmons, and Catherine H. Crouch, "Excitation energy dependence of fluorescence intermittency in CdSe/ZnS core-shell nanocrystals," in preparation.
- [2] Siying Wang, Claudia Querner, Michael D. Fischbein, Lauren Willis, Dmitry Novikov, Catherine H. Crouch and Marija Drndic, "Blinking statistics correlated with nanoparticle number," submitted to Nano Letters (September 2008).
- [3] Mengyan Shen, James E. Carey, Catherine H. Crouch, Maria Kandyla, Howard A. Stone, and Eric Mazur, "High-density regular arrays of nanometer-scale rods formed on silicon surfaces via femtosecond laser irradiation in water," *Nano Letters* **8**, 2087 (2008).
- [4] Siying Wang, Claudia Querner, Thomas Emmons, Marija Drndic, and Catherine H. Crouch, "Fluorescence blinking statistics from CdSe core and core-shell nanorods," *Journal of Physical Chemistry B* **110**, 23221 (2006).
- [5] James E. Carey, Catherine H. Crouch, Mengyan Shen, and Eric Mazur, "Visible and near-infrared responsivity of femtosecond laser-structured photodiodes," *Optics Letters* **30** (14), 1773 (2005).
- [6] C. H. Crouch, J. E. Carey, M. Y. Shen, E. Mazur, and F. Y. Génin, "Infrared absorption by sulfur-doped silicon formed by femtosecond laser irradiation," *Applied Physics A* **79**, 1635 (2004).
- [7] C. H. Crouch, J. E. Carey, J. M. Warrender, M. J. Aziz, and E. Mazur, "Comparison of structure and properties of femtosecond and nanosecond laser-structured silicon," *Applied Physics Letters* **84**, 1850 (2004).
- [8] M. Y. Shen, C. H. Crouch, J. E. Carey, and E. Mazur, "Femtosecond laser-induced formation of submicrometer spikes on silicon in water," *Applied Physics Letters* **85**, 5694 (2004).
- [9] M. Y. Shen, C. H. Crouch, J. E. Carey, R. Younkin, M. Sheehy, C. M. Friend, and E. Mazur, "Formation of ordered silicon microspikes by femtosecond laser irradiation through a mask," *Applied Physics Letters* **82**, 1715 (2003).
- [10] C. Wu, C. H. Crouch, L. Zhao, and E. Mazur, "Visible luminescence from silicon surfaces microstructured in air," *Applied Physics Letters* **81**, 1999 (2002).
- [11] C. Wu, C. H. Crouch, L. Zhao, J. E. Carey, R. Younkin, J. A. Levinson, E. Mazur, R. M. Farrell, P. Gothoskar, and A. Karger, "Near-unity below-band gap absorption by microstructured silicon," *Applied Physics Letters* **78**, 1850 (2001).
- [12] C. H. Crouch, C. Livermore, F. R. Waugh, R. M. Westervelt, K. L. Campman, and A. C. Gossard, "Evolution of the Coulomb gap in tunnel-coupled quantum dots," *Appl. Phys. Lett.* **71**, 817 (1997).
- [13] C. H. Crouch, C. Livermore, F. R. Waugh, R. M. Westervelt, K. L. Campman, and A. C. Gossard, "Coulomb gap of coupled quantum dots," *Surface Science* **361/362**, 631 (1996).
- [14] C. H. Crouch, C. Livermore, R. M. Westervelt, K. L. Campman, and A. C. Gossard, "Coulomb oscillations in partially open quantum dots," *Superlattices & Microstructures* **20**, 377 (1996).
- [15] C. Livermore, C. H. Crouch, R. M. Westervelt, K. L. Campman, and A. C. Gossard, "The Coulomb blockade in coupled quantum dots," *Science* **274**, 1332 (1996).
- [16] C. Livermore, C. H. Crouch, R. M. Westervelt, K. L. Campman, and A. C. Gossard, "Conductance peak splitting in charge-polarized coupled quantum dots," *Superlattices & Microstructures* **20**, 633 (1996).
- [17] F. R. Waugh, M. J. Berry, C. H. Crouch, C. Livermore, D. J. Mar, R. M. Westervelt, K. L. Campman, and A. C. Gossard, "Measuring interactions between tunnel-coupled quantum dots," *Phys. Rev. B* **53** 1413 (1996).
- [18] F. H. Stillinger, T. Head-Gordon, and C. L. Hirshfeld, "Toy model for protein folding," *Phys. Rev. E* **48** (1993), 1469-1477.
- [19] C. L. Hirshfeld and M. Seul, "Critical mixing in monomolecular films: pressure-composition phase diagram of a two-dimensional binary mixture," *J. Phys. France* **51** (1990), 1537-1552.

PUBLICATIONS: PHYSICS EDUCATION

- [1] Catherine H. Crouch, Jessica Watkins, Adam P. Fagen, and Eric Mazur, "Peer Instruction: Engaging students one-on-one, all at once," in *Research-Based Reforms in University Physics*, Edward F. Redish, editor (American Association of Physics Teachers, available online at <http://www.compadre.org/PER/items/detail.cfm?ID=4990>).
- [2] Mercedes Lorenzo, Catherine H. Crouch, and Eric Mazur, "Reducing the gender gap in the physics classroom," *American Journal of Physics* **74**, 118 (2006).
- [3] Catherine H. Crouch, Adam P. Fagen, J. Paul Callan, and Eric Mazur, "Classroom demonstrations: learning tools or entertainment?" *American Journal of Physics* **72**, 835 (2004).
- [4] K. Kelvin Cheng, BethAnn Thacker, Richard L. Cardenas, and Catherine H. Crouch, "Using an online homework system enhances students' learning of physics concepts in an introductory physics course," *American Journal of Physics* **72**, 1447 (2004).
- [5] Adam P. Fagen, Catherine H. Crouch, and Eric Mazur, "Peer Instruction: results from a range of classrooms," *The Physics Teacher* **40**, 206-209 (2002).
- [6] Catherine H. Crouch and Eric Mazur, "Peer Instruction: Ten Years of Experience and Results," *American Journal of Physics* **69**, 970 (2001).

INVITED PRESENTATIONS: PHYSICS

- [1] "Dynamics on the Nanoscale: Light Emission from Single Semiconductor Nanorods," Swarthmore College Physics Colloquium, February 2008.
- [2] "Fluorescence blinking statistics from CdSe core and core-shell nanorods," Workshop on Fluorescence Intermittency in Molecules, Quantum Dots, and Quantum Wires, Notre Dame University, April 2007.
- [3 - 5] "Intermittent fluorescence from semiconductor nanorods," Argonne National Laboratory Nanomaterials seminar, Argonne, IL, June 2007; Laboratory for Surface Modification Seminar, Rutgers University, October 2007; and Materials Science Graduate Student Seminar, Princeton University, December 2006.
- [6 - 8] "Light emission from single quantum rods," Physics Colloquium, Wheaton College, October 2007; Amherst College, November 2006, and St. Joseph's University, November 2006.
- [9] "Light emission from single quantum rods: Research as education and vocation," keynote address at Erickson Undergraduate Research Conference, Seattle Pacific University, Seattle, WA, May 2006.
- [10] "Black silicon: changing structure and properties with light," Physics Colloquium, Haverford College, Haverford, PA, March 2004.
- [11] "Black silicon: using lasers to make novel materials," Condensed Matter Physics colloquium, Harvard University, Cambridge, MA, April 2003.
- [12] "Black silicon: Microstructuring silicon with femtosecond lasers," Physics Colloquium, University of Massachusetts-Lowell, Lowell, MA, November 2001.
- [13] "The Coulomb Blockade in Coupled Quantum Dots," Condensed Matter Physics Seminar, University of Maryland-College Park, College Park, MD, December 1996.
- [14] "Quantum Charge Fluctuations in an Artificial Molecule," Physics Colloquium, Williams College, Williamstown, MA, September 1995.

CONTRIBUTED CONFERENCE PRESENTATIONS: PHYSICS

- [1] Nicholas Kattamis, Neal McDaniel, Ethan Deyle, Corey White, Catherine Crouch, Stefan Bernhard, and Craig Arnold, "Laser Direct Write Printing of Small Molecule Organic Materials for Light Harvesting and Emitting Applications", Spring Meeting of the Materials Research Society, San Francisco, CA, April 2008.
- [2] Nicholas Kattamis, Neal McDaniel, Ethan Deyle, Corey White, Catherine Crouch, Stefan Bernhard, and Craig Arnold, "Laser Direct Write Printing of Small Molecule Organic Materials for Organic Electronics", Photonics West, San Jose, CA, January 2008.
- [3] Siying Wang, Claudia Querner, Thomas Emmons, Marija Drndic, and Catherine H. Crouch, "Size dependence of fluorescence blinking statistics from single CdSe nanorods," APS March Meeting, Denver, CO (2007).
- [4] Thomas Emmons, Siying Wang, Claudia Querner, Marija Drndic, and Catherine H. Crouch, "Effect of experiment duration on power law fluorescence blinking from semiconductor nanorods," APS Division of Laser Science meeting, Rochester, NY (2006).
- [5] Siying Wang, Nathan Landy, Tara Finley, Hugo Romero, Marija Drndic, and Catherine H. Crouch, "Truncated power law fluorescence blinking from semiconductor nanorods," APS March Meeting, Baltimore, MD (2006).
- [6] Catherine H. Crouch, James E. Carey, Jeff Warrender, Michael J. Aziz, and Eric Mazur, "Comparing femtosecond and nanosecond laser structuring of silicon: properties and microcone structure," MRS Fall Meeting, Boston, MA (2002).
- [7] Catherine H. Crouch, Mengyan Shen, James E. Carey, and Eric Mazur, "Early stages of femtosecond-laser-induced formation of silicon microspikes," MRS Meeting, Boston, MA (2002).
- [8] Catherine H. Crouch, James E. Carey, Mengyan Shen, François Génin, and Eric Mazur, "Femtosecond laser-structured silicon: properties and structure," Gordon Research Conference on Laser Interactions with Materials, Andover, NH (2002).
- [9] Catherine H. Crouch, Claudia Wu, Li Zhao, James E. Carey, Rebecca Younkin, and Eric Mazur, "Near-unity below-band gap absorption of microstructured silicon surfaces," OSA Annual Meeting, Providence, RI (2000).
- [9] C. H. Crouch, C. Livermore, R. M. Westervelt, K. L. Campman, and A. C. Gossard, "Coulomb Oscillations in Partially Open Quantum Dots," NanoMes '96 (Third International Symposium on Nanostructures and Mesoscopic Systems), Santa Fe, NM (1996).
- [10] C. H. Crouch, C. Livermore, R. M. Westervelt, K. L. Campman, and A. C. Gossard, "Coulomb Oscillations in Partially Open Quantum Dots," APS March Meeting, St. Louis, MO (1996),
- [11] C. H. Crouch, C. Livermore, F. R. Waugh, R. M. Westervelt, K. L. Campman, and A. C. Gossard, "Coulomb Gap of Coupled Quantum Dots," Eleventh Conference on Electronic Properties of Two-Dimensional Systems, Nottingham, U.K. (1995) (poster).
- [12] C. H. Crouch, C. Livermore, F. R. Waugh, R. M. Westervelt, K. L. Campman, and A. C. Gossard, "Coulomb Gap of Coupled Quantum Dots," APS March Meeting, San Jose, CA (1995).

INVITED PRESENTATIONS: PHYSICS EDUCATION

- [1] “Gender and student achievement with Peer Instruction,” 2008 Physics Education Research Conference, Edmonton, Alberta, Canada, July 2008. Also served as invited session organizer (the conference included only six invited sessions).
- [2 – 4] “Reducing the gender gap in introductory physics,” Physics Education Research Group seminar, Rutgers University, October 2007; University of Maryland, September 2007; University of Colorado, March 2007.
- [5] “Promise and pitfalls of reformed instruction for female students,” workshop at Physics Teacher Education Coalition 2007 conference, Boulder, CO, March 2007.
- [6] “Classroom demonstrations: Learning Tools or Entertainment?” 19th Biennial Conference on Chemical Education, August 2006.
- [7] “Demonstrations: More than just entertainment?” American Physical Society April Meeting, Philadelphia, PA, April 2003.
- [8 – 10] “Demonstrations: More than just entertainment?” Physics Colloquium, Swarthmore College, Swarthmore, PA, April 2002; Worcester Polytechnic Institute, Worcester, MA, November 2001; and Calvin College, Grand Rapids, MI, September 2001.
- [11 – 20] “Peer Instruction: Turning a Lecture Into a Seminar,” Physics Colloquia at Temple University (Philadelphia, PA, April 2001), University of Michigan (Ann Arbor, MI, February 2000), Wake Forest University (Winston-Salem, NC, January 2000), Wesleyan University (Middletown, CT, November 1999), Indiana University of Pennsylvania (Indiana, PA, July 1999), University of California-San Diego, (San Diego, CA, May 1999); talks at Optical Society of America Annual Meeting (Baltimore, MD, October 1998), American Association of Physics Teachers National Meeting (New Orleans, LA, January 1998), and New England Section Meeting of the American Association of Physics Teachers (Newburyport, MA, October 1997); and workshop at NSF Engineering Education Scholars’ Workshop (Carnegie-Mellon University, Pittsburgh, PA, July 1999).
- [21] “Teaching and Research: Inseparable Responsibilities of the Modern Physicist,” American Physical Society Centennial Meeting, March 1999 (co-presented with Eric Mazur).

CONTRIBUTED CONFERENCE PRESENTATIONS: PHYSICS EDUCATION

- [1] Catherine H. Crouch, Mercedes Lorenzo, and Eric Mazur, “Reducing the gender gap in the physics classroom,” American Physical Society March meeting, Boulder, CO (2007).
- [2] Catherine H. Crouch, “Electricity, Magnetism, and Optics for the Life Sciences,” Physics Education and Research Gordon Conference, Mt. Holyoke College, June 2006.
- [3] Catherine H. Crouch, Laura McCullough, Eric Mazur, and Daniel MacIsaac, “Gender, Educational Reform, and Instructional Assessment,” Winter Meeting of the AAPT, Philadelphia, PA (2002).
- [4] Catherine H. Crouch, J. Paul Callan, Nan Shen, and Eric Mazur, “ConceptTests: What Do Students Learn From Them?” Winter Meeting of the AAPT, Kissimmee, FL (2000).
- [5] Catherine H. Crouch and Eric Mazur, “How I Got to Know 200 Students (Almost) Overnight,” Winter Meeting of the AAPT, Kissimmee, FL (2000).
- [6] Catherine H. Crouch, Emily Fair Oster, and Eric Mazur, “Closing the Gender Gap in Introductory Physics,” Centennial Meeting of the APS, Atlanta, GA (1999).