

JOHN B. SHUMWAY, JR.

Curriculum Vita—last revision September, 2009

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I. Background

A. Synopsis

I work in computational physics and specialize in the development of quantum Monte Carlo algorithms for nanoelectronics applications. This research merges advanced quantum theory and high-performance computing to address problems that are important to the semiconductor industry. I enjoy teaching and mentoring students, and I have experience working with students from sophomore undergraduates through postdoctoral researches, in physics and electrical engineering. I enjoy adapting research and teaching to meet the individual needs of students. I have expertise in computer technologies (web-based applications, high-performance computation, and visual presentation of scientific data), which I integrate into my teaching and research.

B. Education

- 1999 Ph. D., Physics, Univ. of Illinois at Urbana-Champaign
Dissertation: *Quantum Monte Carlo Simulations of Electrons and Holes*
Dissertation Committee: David Ceperley (chair), Richard Martin, Jim Wolfe, John Stack
- 1995 M. S., Physics, Univ. of Missouri-Columbia
Thesis: *Simulation of Vortex Motion with Pinning and Surfaces*
Thesis Committee: Sashi Satpathy (chair), David Cowen, John Bauman
- 1993 B. S., Physics, Univ. of Missouri-Columbia

C. Professional Employment

- Fall 2007 – present Associate Professor, Department of Physics,
Arizona State University
- Fall 2008 – Summer 2009 LASSP Fellow, Laboratory of Atomic and Solid State Physics,
Cornell University, Ithaca, NY
- Fall 2001 – Summer 2007 Assistant Professor, Department of Physics and Astronomy,
Arizona State University
- Fall 1999 – Summer 2001 Post-doctoral Researcher, Solid State Theory Group (with Dr. Alex Zunger),
National Renewable Energy Laboratory, Golden, CO

II. Teaching

A. Courses Taught

Arizona State University

- | | | | |
|---------|---------------|-------------------------------------|----------------------------------|
| PHY 121 | Undergraduate | “University Physics I” | Fall 2009 |
| PHY 416 | Undergraduate | “Quantum Physics III” | Fall 2004, F 2005, F 2006 |
| PHY 501 | Graduate | “Methods of Theoretical Physics I” | F 2001, F 2002, F 2003 |
| PHY 502 | Graduate | “Methods of Theoretical Physics II” | Spring 2002 |
| PHY 531 | Graduate | “Electricity & Magnetism I” | Fall 2007 |
| PHY 541 | Graduate | “Statistical Physics” | S '03, S'04, S '06, S '07, S '08 |
| PHY 598 | Graduate | “Advanced Statistical Physics” | Spring 2008 |

B. Post-Doc Mentoring

Raghu Chatanathody, Jan. 2002–Dec. 2003.

C. Graduate Student Mentoring

C. 1. As Research Advisor

Jianheng Liu, Ph. D., Research Advisor/Committee Chair, Dec. 2007–present
Lei Zhang, Ph. D., Research Advisor/Committee Chair, May 2006–present
Sourab Sinha, Ph. D., Research Advisor/Committee Chair, May 2006–present
Daejin Shin, Ph. D., Research Advisor/Committee Chair, graduated May. 2007
Matthew Harowitz, M. S., Research Advisor, graduated May 2005

D. As Research Rotation Advisor

Jianheng Liu, Fall 2007
Natalie Hinkel (**Astronomy**), Fall 2007–Spring 2008
Sebastian Sandersius, Spring 2008

D. 1. As Committee Member

Kathrine Kelly Craig, Ph. D., Committee Member, Fall 2001
Yangting Zhang, Ph. D., Substitute Committee Member, Summer 2002
Sridhar Srinivasen, Ph. D., Committee Member, Fall 2003
Irena Knezivic, Ph. D. (**Electrical Engineering**), Committee Member, Summer 2004
Emily McDaniel, Ph. D., Committee Member, Fall 2005
Jin He, Ph. D., Committee Member, Summer 2005
Matthew Gilbert, Ph. D. (**Electrical Engineering**), Committee Member, Summer 2005
Sutharsan Ketharanathan, Ph. D., Committee Member, Fall 2006
Vijay d’Costa, Ph. D., Committee Member, Fall 2006
Jason Cook, Ph. D., (**Astronomy**) Committee Member, Summer 2007
Eric Dykeman, Ph. D., Committee Member, Spring 2008
Steven Finkelstein, Ph. D., (**Astronomy**) Committee Member, Summer 2008
Shahid Kumar, Ph. D., Committee Member, Spring 2009
Aron Cummings, Ph. D. (**Electrical Engineering**), Committee Member, Spring 2009
Theodore Vecchio, Ph. D., Committee Member
Daniel Barr, Ph. D., (**Chemistry**), Committee Member
Adam Burke, Ph. D. (**Electrical Engineering**), Committee Member
Allison Loll, Ph. D., (**Astronomy**) Committee Member
Tyler Glembo, Ph. D., Committee Member
Natalie Hinkel, Ph. D., (**Astronomy**) Committee Member

E. Undergraduate Mentoring

Richard Haynie, Physics Major (Aug 2007–present, currently a junior at ASU).
Hosam Yousif, Physics Major (May 2006–May 2008, ASU B. S. Physics, now Ph. D. student at UCSD).
Mark Sanger, Physics Major (May 2006–Dec. 2007, ASU B. S. Physics, Dec. 2007).
Paul Schmit, Physics Major (Dec. 2006–May 2007, ASU B. S. Physics, now Ph. D. student at Princeton)
Ming Ho, Physics Major (May 2005–May 2006, ASU B. S. Physics, now Ph. D. student at UCLA).
Ross Tucker, Physics and Math Major (Dec. 2004–May 2006, ASU B. S. Physics, May 2007).
Erick Smith, Summer Research (Summer 2004).
Josh Whitney, Research Experience for Undergraduate (REU) Student (Summer 2002).
Michael Wimmer, Visiting Diplom Student from Regensburg (2001-02, now Regensburg Ph. D. student).

F. Fellowships and Awards

- 2008 Outstanding Teaching Award, Department of Physics, Arizona State University.

- NSF CAREER Award (2003).
- Finalist, College of Liberal Arts and Sciences Dean’s Distinguished Teaching Award (2002).

III. Research

A. Publications

Refereed Articles

22. M. J. Gilbert and J. Shumway, “Probing quantum coherent states in bilayer graphene,” *J. Comput. Electron.* *in press* (2009).
21. Sutharsan Ketharanathan, Sourabh Sinha, John Shumway, and Jeff Drucker, “Electron charging in epitaxial Ge quantum dots on Si (100),” *J. Appl. Phys.* **105**, 044312 (2009).
20. Stefan K. Baur, J. Shumway, and Erich J. Mueller, “FFLO vs Bose-Fermi mixture in polarized 1D Fermi gas on a Feshbach resonance: a 3-body study,” submitted to *Phys. Rev. A* (arXiv:0902.4653).
19. Lei Zhang, Jesper Pedersen, Matthew J. Gilbert, and J. Shumway, “Path integral study of the role of correlation in exchange coupling of spins in double quantum dots and optical lattices,” in preparation for resubmission. (arXiv:0809.0038).
18. Daejin Shin, Ming-Chak Ho, and J. Shumway, “Ab initio path integral techniques for molecules,” in preparation for resubmission (quant-ph/0611105).
17. Michael McKay, John Shumway, and Jeff Drucker, “Real-time coarsening dynamics of Ge/Si(100) nanostructures,” *J. Appl. Phys.* **99**, 094305 (2006).
16. J. Shumway, “Quantum Monte Carlo Simulation of Exciton-Exciton Scattering in a GaAs/AlGaAs Quantum Well,” *Physica E* **32**, 273–276 (2006).
15. M. Wimmer, S. V. Nair, and J. Shumway, “Biexciton recombination rates in self-assembled quantum dots,” *Phys. Rev. B* **73**, 165305 (2006).
14. M. Harowitz, Daejin Shin, and J. Shumway, “Path-Integral Quantum Monte Carlo Techniques for Self-Assembled Quantum Dots,” *J. Low Temp. Phys.* **140**, 211–226 (2005).
13. G. Bester, A. Zunger, and J. Shumway, “Broken symmetry and quantum entanglement of an exciton in $\text{In}_x\text{Ga}_{1-x}\text{As}/\text{GaAs}$ quantum dot molecules,” *Phys. Rev. B* **71**, 075325 (2005).
12. J. Shumway, “A Quantum Monte Carlo Method for Non-Parabolic Electron Bands in Semiconductor Heterostructures,” *J. Phys.: Condens. Matter* **71**, 2563–2570 (2005).
11. J. Shumway and D. M. Ceperley, “Quantum Monte Carlo Simulations of Excitonic Condensates,” *Solid State Communications* **134**, 19–22 (2005).
10. G. Bester, J. Shumway, and A. Zunger, “Theory of excitonic spectra and entanglement engineering in dot molecules,” *Phys. Rev. Lett.* **93**, 047401 (2004).
9. J. Shumway, A. Franceschetti, and Alex Zunger, “Correlation versus mean-field contributions to excitons, multiexcitons, and charging energies in semiconductor quantum dots,” *Phys. Rev. B* **63**, 155316 (2001).
8. J. Shumway, A. J. Williamson, Alex Zunger, A. Passaseo, M. DeGiorgi, R. Cingolani, M. Catalano, P. Crozier, “Electronic structure consequences of In/Ga intermixing in self-assembled InGaAs/GaAs alloy quantum dots,” *Phys. Rev. B* **64**, 125302(2001).
7. D. V. Regelman, E. Dekel, D. Gershoni, E. Ehrenfreund, A. J. Williamson, J. Shumway, A. Zunger, W. V. Schoenfeld, and P. M. Petroff, “Optical spectroscopy of single quantum dots at positive, neutral, and negative charge states,” *Phys. Rev. B* **64**, 165301 (2001).
6. J. Shumway and D. M. Ceperley, “Exact calculation of exciton- exciton scattering cross sections within the effective mass approximation,” *Phys. Rev. B* **63**, 165209 (2001).

5. J. Shumway and D. M. Ceperley, “Path integral Monte Carlo simulations for fermion systems: pairing in the electron-hole plasma,” *J. Phys. IV France* **10**, Pr5-3–16 (2000).
4. J. Shumway, L. R. C. Fonseca, J. P. Leburton, Richard M. Martin, and D. M. Ceperley, “Electronic structure of self-assembled quantum dots: comparison between density functional theory and diffusion quantum Monte Carlo,” *Physica E* **8**, 260–268 (2000).
3. J. Shumway and S. Satpathy, “Dynamics of flux penetration and critical currents in type-II superconductors,” *Phys. Rev. B* **56**, 103–106 (1997).
2. J. Shumway, S. Chattopadhyay, and S. Satpathy, “Electron states and electron-phonon coupling in the BEDT-TTF-based organic superconductors,” *Phys. Rev. B* **53**, 6677–6681 (1996).
1. J. Shumway and S. Satpathy, “Polarization-dependent optical properties of C_{70} ,” *Chem. Phys. Lett.* **211**, 595–600 (1993).

Review Articles

1. J. Shumway and D. M. Ceperley, “Quantum Monte Carlo Methods in the Study of Nanostructures,” in: *Handbook of Theoretical and Computational Nanotechnology*, Edited by Michael Rieth and Wolfram Schommers, Volume 3: Pages 605–641, ISBN: 1-58883-045-4, (American Scientific Publishers, 2006).

Conference Papers

3. J. Shumway and Matthew J. Gilbert, “Path Integral Monte Carlo simulations of nanowires and quantum point contacts,” *J. Phys.: Conf. Series* **35**, 190–196 (2006).
2. M. Harowitz and J. Shumway, “Path Integral Simulations of Charged Multiexcitons in InGaAs/GaAs Quantum Dots,” pp. 697–698 in *Physics of Semiconductors: 27th International Conference on the Physics of Semiconductors*, edited by José Menéndez and Chris G. Van de Walle (AIP, 2005).
1. Michael R. McKay, Jeff Drucker, and John Shumway, “Real-Time Coarsening Dynamics of Ge/Si(100) Nanostructures Using Elevated Temperature Scanning Tunneling Microscopy, in *Stability of Thin Films and Nanostructures*, edited by R.P. Vinci, R. Schwaiger, A. Karim, and V. Shenoy (Mater. Res. Soc. Symp. Proc. 854E, Warrendale, PA, 2005), U4.6.

Book Chapters

1. J. Shumway, “All-Electron Path Integral Monte Carlo Simulations of Small Atoms and Molecules,” pages 181–195 in *Computer Simulations Studies in Condensed Matter Physics XVIII*, edited by D. P. Landau, S. P. Lewis, and H. B. Schütter, (Springer Verlag, Heidelberg, Berlin, 2006).

B. Presentations

B. 1. Invited Talks

18. “Path Integrals for Nanoelectronics,” Four-Corners Meeting of the American Physical Society, Northern Arizona University, Flagstaff, AZ (October 27, 2007).
17. “Path Integral Simulations of Molecules,” Symposium in Honor of William A. Lester, Jr.’s 70th Birthday, Berkeley, CA (March 30, 2007).
16. “Path Integral Simulations for Semiconductor Nanostructures,” NNIN/C: Synergy Between Experiment and Computation in Nanoscale Science, Harvard University, Cambridge, MA (May 31, 2006).
15. “Fixed Phase Path Integrals for Fermions, Magnetic Fields, and Spinors,” Workshop on New Developments in Quantum Monte Carlo, Tempe, AZ (May 16, 2006).
14. “Path Integral Monte Carlo simulation of semiconductor nanostructures,” 13th International Conference on Recent Progress in Many-Body Theories, **Buenos Aires, Argentina**, (December, 2005).
13. “Path Integral Monte Carlo Simulations of Nanowires and Quantum Point Contacts,” Progress in Nonequilibrium Green’s Functions III, **Kiel, Germany** (August 23, 2005).

12. "Path Integral Monte Carlo Simulations of Nanowires and Quantum Point Contacts," XIV International Materials Research Congress, **Cancún, Mexico** (August 24, 2005, presented by Matthew Gilbert due to schedule conflict).
11. "Path Integral Simulations of Quantum Dots," Advances in Computational Many-Body Physics, **Banff, Alberta, Canada** (January 15, 2005).
10. "Feynman Path Integrals for Atoms and Molecules," 17th Annual Workshop on Recent Developments in Computer Simulation Studies in Condensed Matter Physics, University of Georgia, Athens, GA (Feb. 19, 2004).
9. "Path Integrals and Simulations of Quantum Dots," DARPA Workshop on Computational Approaches Toward the Electronic Properties of Quantum Dots, Chicago, IL (Sept. 23, 2003).
8. "Path Integral Simulations for Quantum Dots," LLNL MRI Computational Summer School Lawrence Livermore National Laboratory, Livermore, CA (July 16, 2003).
7. "Quantum Monte Carlo for Nanostructures," LLNL MRI Computational Summer School, Lawrence Livermore National Laboratory, Livermore, CA (July 15, 2003).
6. "Modeling Self-Assembled Dot," LLNL MRI Computational Summer School, Lawrence Livermore National Laboratory, Livermore, CA (July 14, 2003).
5. "Path Integral Monte Carlo Methods for Quantum Dots," Workshop on Recent Developments in Electronic Structure Methods, Minneapolis, MN (May. 18, 2003).
4. "Quantum dots, modern material science, and prospects for future computing devices," American Association of Physics Teachers, Austin, TX, (Jan. 13, 2003).
3. "Spinors in quantum simulations and techniques for finite temperature," DARPA/ONR First Principles Design of Materials, Kickoff Meeting and Workshop, Arlington, VA (May 10, 2002).
2. "Quantum Dots: Building blocks for nano-scale semiconductor electronics," Lockheed-Martin, Goodyear, AZ, (February 22, 2002).
1. "Electron Correlation in Quantum Dots using Quantum Monte Carlo," 2000 March Meeting of the American Physical Society, Atlanta, (March, 2000).

Colloquia and Seminars

19. "Path integral studies of quantized conductance and Luttinger liquid behavior in GaAs nanostructures," Condensed Matter Seminar, Heriot-Watt University, Edinburgh, Scotland, UK (August 7, 2009).
18. "Path integral studies of quantized conductance and Luttinger liquid behavior in GaAs nanostructures," Condensed Matter Seminar, Duke University, Durham, NC (February 12, 2009).
17. "Current fluctuations and quantized conductance," Applied Physics Seminar, University of Kansas, Lawrence, KS (October 9, 2008).
16. "Path integral studies of quantized conductance and Luttinger liquid behavior in GaAs nanostructures," Condensed Matter Seminar, University of Missouri, Columbia, MO (October 8, 2008).
15. "A Path Integral Approach to Computational Nanoscience," Physics Colloquium, University of Kansas, Lawrence, KS (October 6, 2008).
14. "A Path Integral Approach to Computational Nanoscience," LASSP Seminar, Cornell University, Ithaca, NY (September 16, 2008).
13. "Path Integrals for Nanoelectronics," Physics Colloquium, Brigham Young University, Provo, UT (January 16, 2008).
12. "Density Matrix Constraints for Quantum Monte Carlo," Lawrence Livermore National Laboratory, Livermore, CA (June 8, 2006).

11. "Fixed Phase Path Integrals for Fermions, Magnetic Fields, and Spinors," Quantum Information Seminar, Univ. of California at Berkeley, Berkeley, CA (June 6, 2006).
10. "Path Integral Tools for Nano-Electronics," Physics Department Colloquium, Virginia Tech., Blacksburg, VA (February 10th, 2006).
9. "Exciton-Exciton scattering in Quantum Wells," Condensed Matter and Biophysics Seminar, University of Missouri, Columbia, MO (March 9, 2005).
8. "Feynman Path Integrals and Nanostructures: Quantum Simulations without Schroedinger's Equation," O. M. Stewart Colloquium, Dept. of Physics and Astronomy, University of Missouri, Columbia, MO (March 7, 2005).
7. "Path Integrals for Quantum Simulations of Nanostructures," Physics Department Colloquium, Virginia Tech., Blacksburg, VA (February 4th, 2005).
6. "Entanglement and Quantum Computing in Coupled Quantum Dots," Physics Department Colloquium, Arizona State University, Tempe, AZ (September 16, 2004). Condensed Matter/Materials and Biological Physics Seminar, Washington University in St. Louis, St. Louis, MO (November 29, 2004).
5. "Feynman Path Integrals and Applied Quantum Mechanics," Physics Department Colloquium, University of Missouri-Rolla, Rolla, MO (Nov. 6, 2003).
4. "Feynman Path Integrals for Semiconductor Applications," Solid State Seminar, Ohio State University, Columbus, OH (April 28, 2003).
3. "Feynman Path Integrals for Semiconductor Applications," Physics Department Colloquium, Arizona State University, Tempe (April 11, 2002).
2. "Feynman Path Integrals and Applications to Quantum Dots," Physics Department Colloquium, Northern Arizona University, Flagstaff (Sept. 30, 2002).
1. "Quantum Monte Carlo Simulations of Electron-Hole Systems," Solid State Seminar, University of Missouri-Columbia, (September, 1999).

Contributed Talks

13. "Path integral simulations of quantized conductance in nanowires," 2007 March Meeting of the American Physical Society, Denver, CO (March, 2007).
12. "Density Matrix Constraints for Quantum Monte Carlo," 2006 March Meeting of the American Physical Society, Baltimore, MD (March 16, 2006).
11. "Quantum Monte Carlo Simulations of Exciton-Exciton Scattering in Quantum Wells," 2005 March Meeting of the American Physical Society, Los Angeles, CA (March 21, 2005).
10. "Quantum Monte Carlo Simulations of Excitonic Condensates," International Conference on Spontaneous Coherence in Excitonic Systems, Seven Springs Resort, Pennsylvania (May 25, 2004).
9. "Fixed-Node Fermion Path Integral Methods for Atoms and Molecules," 2004 March Meeting of the American Physical Society, Montreal, Quebec, Canada (March 25, 2004).
8. "Biexciton recombination rates in self-assembled quantum dots," 2003 March Meeting of the American Physical Society, Austin, TX (March 2003).
7. "Electronic structure and excitations in Ge/Si self-assembled dots," 2002 March Meeting of the American Physical Society, Indianapolis, IN, (March, 2002).
6. "Band mixing in isolated and coupled InGaAs/GaAs self-assembled quantum dots," 2001 March Meeting of the American Physical Society, Seattle, WA, (March, 2001).
5. "Effect of Indium/Gallium Intermixing within $\text{In}_{0.5}\text{Ga}_{0.5}\text{As}$ Self-Assembled Dots," 2000 March Meeting of the American Physical Society, Minneapolis, MN, (March, 2000).

4. “Optical Properties in Quantum Dots: Role of CI and QMC Calculations” DOE Workshop on Excited State Properties, Minneapolis, MN, (November, 2000).
3. “Exact Calculation of Elastic Exciton-Exciton Scattering within the Effective Mass Approximation,” 1999 March Meeting of the American Physical Society, Atlanta, GA, (March, 1999).
2. “Including Anisotropic Masses into Diffusion Monte Carlo Calculations of Exciton Binding Energies,” 1997 March Meeting of the American Physical Society, Kansas City, MO, (March, 1997).
1. “Langevin Dynamics Study of Flux Penetration and Critical Currents in Type II Superconductors,” 1996 March Meeting of the American Physical Society, St. Louis, MO (March, 1996).

IV. Service

A. Professional Service

- Chaired “Workshop on New Developments in Quantum Monte Carlo,” May 14–18, 2006, in Tempe, AZ. Brought together eighteen leading researchers in quantum Monte Carlo from the United States, Canada, and Europe who work in a wide range of application fields. Also arranged travel for graduate students and postdocs to participate in three days of seminars, posters, and discussions.
- Participant in the Nanoelectronics Research Initiative (NRI) of the Semiconductor Research Initiative (SRI) through the South West Academy of Nanoelectronics (SWAN) in University of Texas-Austin.
- Participating in National Nanotechnology Infrastructure Network (NNIN) through computational division of Harvard’s Center for Nanoscale Systems (CNS) and collaborations with the Cornell Nanoscale Facility (CNF). Invited presenter at workshop, NNIN/C: Synergy Between Experiment and Computation in Nanoscale Science, May 31–June 3, 2006.
- Served on NSF Review Panels (Arlington, VA, April 2005, February 2008).
- Contributor to the NSF sponsored NCN nanoHUB at Purdue University and the Materials Computation Center (MCC) code archive at Univ. of Illinois at Urbana-Champaign.
- Served on organizing committee for 2003 Four Corners Sectional Meeting of the American Physical Society (Tempe, AZ, October 24–25 2003).
- Referee for Physical Review, Journal of Physics, and NSF.

B. University Service

- Faculty Mentor for ASU President Barack Obama Scholars Program, 2009.
- Academic Program Review Committee (Dept. of Physics and Astronomy), 2002–2005.
- ASU Faculty Ambassador for review of science curriculum at Wickenburg High School, 2006.

C. Department Service

- Computer Committee Chair, 2001–2004.
- Graduate Exam Committee, 2001–2003.
- Growth and Development Committee, 2001–2002.
- Committee on Committees, 2002–2004 (recorder in 2003–2004).
- Graduate Recruiting Committee (“Tiger Team”), 2004–2005
- Graduate Program Committee, 2004–2008.
- Faculty Representative on Information Technology Search Committee, 2005–2006.
- Personnel Committee, 2005–2007.

- Ad-hoc Graduate Curriculum and Evaluation Committee, 2005–2007.
- Member of “Future electronics” search committee, 2007-2008.
- Recorder for physics faculty meetings, 2006–2008.
- Organizer of the Nanoscience Seminar Series, 2007–2008.