

Thaddeus D. Ladd

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EDUCATION

Stanford University, Palo Alto, CA
2005 PH.D. in Applied Physics
2000 M.S. in Applied Physics

Harvey Mudd College, Claremont, CA
1998 B.S. in Physics with high distinction
Honors in Physics
Honors in the Humanities and Social Sciences

DISSERTATION

Quantum Computing with Nuclear Spins in Semiconductors
Advisor: Yoshihisa Yamamoto

Theory of solid-state NMR quantum computing, with optical polarization and detection in both bulk semiconductors and semiconductor nanostructures; experimental study of nuclear coherence time in silicon and the slow noise processes limiting it as revealed by high-power NMR decoupling pulse sequences.

RESEARCH EXPERIENCE

- Dec 2009 – Present **HRL Laboratories, LLC**, Malibu, CA
Accepted position as staff researcher.
- July 2005 – Nov. 2009 **Stanford University**, Palo Alto, CA,
National Institute of Informatics, Tokyo, Japan,
and **The University of Tokyo**, Japan
– Post-doctoral research as subgroup leader (PI *Yoshihisa Yamamoto*).
– Managing experimental effort to measure and manipulate single semiconductor impurities in high- Q semiconductor microcavities.
– Developing theoretical approaches to hybrid and qubus quantum information processing based on semiconductor nanophotonics.
- Sept. 1998 – June 2005 **Stanford University**, Palo Alto, CA
Doctoral thesis research, including collaborative efforts with *Kohei Itoh* on silicon NMR and ESR, with *David Cory* on solid-state NMR quantum information processing, and with *Ian Fisher* on growth of fluorapatite single crystals.
- June – Sept. 2002 **IBM Corporation**, San Jose, CA
Internship at the Almaden Research Center with manager *Bruce Gurney*, advised by *Jeff Childress* and *Matt Carey*; built low-temperature cryostat for measurement of magnetoresistance and differential conductance of magnetic tunnel junction devices intended for hard-drive readhead applications.
- Sept. 1996 – May 1998 **Harvey Mudd College**, Claremont, CA
Undergraduate research, advised by *James Eckert* and *Patricia Sparks*; an effort to measure the spin diffusion length of carriers in doped silicon, involving photolithographic microfabrication and magnetoresistance measurements of cobalt/silicon heterostructures, intended for spintronics applications.
- June – Sept. 1997 **The University of Illinois**, Urbana-Champaign, IL
NSF-sponsored REU, advised by *Michael Weissman*; noise statistics measurements for investigating the domain dynamics of GMR field sensors.
- June – Sept. 1996 **Fermilab**, Batavia, IL
Internship in *Drasko Jovanovic's* program, advised by *Hogan Nguyen*; assembly and test of the electromagnetic calorimeter for KTeV (an experiment studying CP violation in K-mesons); upgrade of a photomultiplier-tube testing facility.

TEACHING EXPERIENCE

- 2005–2007 **Stanford University**, Palo Alto, CA
 Guest lecturer for graduate courses:
 – EE248, “Fundamentals of Noise Processes”
 – AP226, “Physics of Quantum Information”
- Jan. – Apr. 2004 Teaching assistant to *Mark Kasevich* and *Rick Pam* for Phys. 107,
 “Intermediate Physics Laboratory”
 – Advised undergraduate students in optics laboratory
 – Coached undergraduate students in technical writing
 – Co-authored current manual on technical writing for physics majors,
 T. D. Ladd and D. Ugolini, “Writing Guide for Stanford Physics 107,”
 available by request
- 2003 – 2004 Teaching assistant to *Mark Kasevich* for Phys. 70, “Modern Physics”
- Sep. – Dec. 2002 Graduate mentor for Freshman Academic Resources and Mentoring (FARM)
- Nov. 2003 **The University of California**, Berkeley, CA
 Guest lecturer for Phys. 191, “Quantum Information Science and Technology”
- 1996 – 1998 **Harvey Mudd College**, Claremont, CA
 – Teaching assistant to *James Eckert* for Phys. 53, “Electricity and Optics Laboratory”
 – Grader and tutor for assorted courses in physics and mathematics

SELECTED SKILLS

- Theory
 - Quantum information, specializing in design of quantum computers and quantum repeaters
 - Quantum optics, specializing in cavity QED
 - Solid-state magnetic resonance and spin dynamics, specializing in multi-pulse sequences
 - Monte-Carlo and master-equation simulations using OOP with C++ and Matlab
- Experiment
 - Optics at low temperatures (2 K) and high magnetic fields (10 T), specializing in microphotoluminescence and photoluminescence excitation in semiconductor nanostructures
 - Magnetic resonance, specializing in solid-state NMR
 - Magnetic transport
- Communication
 - Numerous conference presentations. Recent conference talks:
 - APS March Meeting, Pittsburgh, PA, 2009*
 - Eleventh Annual Southwest Quantum Information Technology Network Workshop, Seattle, WA, 2009*
 - Workshop on Topological Cluster State Computing in Optics, Tokyo, Japan, 2008*
 - First International Conference on Quantum Error Correction, Los Angeles, CA, 2007*
 - NEC Workshop on Quantum Computing, Princeton, NJ, 2007 (invited)*
 - Workshop on Linear Optical Quantum Information Processing, Baton Rouge, LA, 2006 (invited)*
 - Invited seminars delivered at U. Tokyo, U. Hokkaido, Harvard U., U. C. San Diego, U. C. Berkeley, U. British Columbia, Simon Fraser U.
 - Co-organized DOD-sponsored “International Workshop on Dynamical Decoupling,” Oct. 5–6, 2009, Boulder, CO
 - Organized NSF-sponsored workshop on “CQED-based Quantum Computation using Topological Fault Tolerance,” Feb. 5–6, 2009, Palo Alto, CA
 - Regular reviewer for *Physical Review Letters*, *Physical Review B*, *Physics Letters A*
 - Author of multiple grant proposals for NSF, ARO, IARPA, and DARPA

SELECTED PUBLICATIONS

- “Distributed Quantum Computer Architecture Using Semiconductor Nanophotonics,” R. Van Meter, T. D. Ladd, A. G. Fowler, and Y. Yamamoto, *International Journal of Quantum Information*, accepted. arXiv:0906.2686 (2009)
- “Indistinguishable photons from independent semiconductor nanostructures,” K. Sanaka, A. Pawlis, T. D. Ladd, K. Lischka, and Y. Yamamoto, *Physical Review Letters*, **103**, 053601 (2009)
- “Ultrafast optical spin echo for electron spins in semiconductors,” S. M. Clark, K.-M. C. Fu, Q. Zhang, T. D. Ladd, C. Stanley, and Y. Yamamoto, *Physical Review Letters*, **102**, 247601 (2009)
- “Simultaneous sub-second hyperpolarization of the nuclear and electron spins of phosphorus in silicon by optical pumping of exciton transitions,” A. Yang, M. Steger, T. Sekiguchi, M. L. W. Thewalt, T. D. Ladd, K. M. Itoh, H. Riemann, N. V. Abrosimov, P. Becker, and H.-J. Pohl, *Physical Review Letters*, **102** 257401 (2009)
- “Complete quantum control of a single quantum dot spin using ultrafast optical pulses,” D. Press, T. D. Ladd, B. Zhang, and Y. Yamamoto, *Nature* **456**, 218 (2008)
- “High-speed quantum repeaters and quantum computers with optically controlled spins in semiconductors,” T. D. Ladd, K. Sanaka, K. M. C. Fu, S. Koseki, D. Press, S. M. Clark, K. De Greve, and Y. Yamamoto, in *Semiconductor Quantum Bits*, Eds. O. Benson and F. Henneberger, p. 453 (2009)
- “System design for a long-line quantum repeater,” R. Van Meter, T. D. Ladd, W. J. Munro, and Kae Nemoto, *IEEE/ACM Transactions on Networking* **17**, 1002 (2009)
- “Lasing of donor-bound excitons in ZnSe microdisks,” A. Pawlis, M. Panfilova, D. J. As, K. Lischka, K. Sanaka, T. D. Ladd, and Y. Yamamoto, *Physical Review B* **77**, 153304 (2008)
- “Quantum computers based on electron spins controlled by ultrafast off-resonant single optical pulses,” S. M. Clark, K. M. C. Fu, T. D. Ladd, and Y. Yamamoto, *Physical Review Letters* **99**, 40501 (2007)
- “Hybrid quantum repeater based on dispersive CQED interactions between matter qubits and bright coherent light,” T. D. Ladd, P. van Loock, K. Nemoto, W. J. Munro, and Y. Yamamoto, *New Journal of Physics* **8**, 184 (2006)
- “Hybrid quantum repeater using bright coherent light,” P. van Loock, T. D. Ladd, K. Sanaka, F. Yamaguchi, Kae Nemoto, W. J. Munro, and Y. Yamamoto, *Physical Review Letters* **96**, 240501 (2006)
- “Photocurrent-modulated optical nuclear polarization in bulk GaAs,” A. K. Paravastu, P. J. Coles, J. A. Reimer, T. D. Ladd, and R. S. Maxwell, *Applied Physics Letters* **87**, 232109 (2005)
- “Multispin dynamics of the solid-state NMR free induction decay,” H. Cho, T. D. Ladd, J. Baugh, D. G. Cory, and C. Ramanathan, *Physical Review B* **72**, 54427 (2005)
- “Coherence time of decoupled nuclear spins in silicon,” T. D. Ladd, D. Maryenko, Y. Yamamoto, E. Abe, and K. M. Itoh, *Physical Review B* **71**, 014401 (2005)
- “Optical detection of the spin state of a single nucleus in silicon,” K. M. C. Fu, T. D. Ladd, C. Santori, and Y. Yamamoto, *Physical Review B* **69**, 125306 (2004)
- “All-silicon quantum computer,” T. D. Ladd, J. R. Goldman, F. Yamaguchi, Y. Yamamoto, E. Abe, and K. M. Itoh, *Physical Review Letters* **89**, 17901 (2002)
- “Solid-state crystal lattice NMR quantum computation,” T. D. Ladd, Y. Yamamoto, J. R. Goldman, and F. Yamaguchi, *Quantum Information and Computation* **1**, 56 (2001)
Also in *Experimental Quantum Computation and Information: Proceedings of the CXLVIII Course of the International School of Physics “Enrico Fermi,”* IOS Press, Amsterdam (2002)
- “Decoherence in crystal lattice quantum computation,” T. D. Ladd, J. R. Goldman, F. Yamaguchi, and Y. Yamamoto, *Appl. Phys. A* **71**, 27 (2000)
- “Nonlinear AC response and noise of a giant magnetoresistive sensor,” J. R. Petta, Thaddeus Ladd, and M. B. Weissman, *IEEE Transactions on Magnetics* **36**, 2057 (2000)
- “A model for arbitrary plane imaging, or the brain in pain falls mainly on the plane,” Jeff Miller, Dylan Helliwell, and Thaddeus Ladd, *The UMAP Journal* **19**(3), 223 (1998)

HONORS AND AWARDS

- Fellow of the Fannie and John Hertz Foundation
- National Science Foundation Graduate Fellowship (declined)
- 1998 Alfred B. Focke Award for outstanding senior research in experimental physics
- 1998 Mathematical Contest in Modeling, rated Outstanding (top 2%)
- 1996 Vladimir Rojansky Prize for outstanding writing in quantum physics

NEWS/HIGHLIGHTS

- “Breaking the Secret of the Quantum Computer,” *Stanford Scientific*, Winter 2008
- “Quantum computers get smarter,” *PC Magazine*, October 16, 2007
- “Ultrafast quantum computer uses optically controlled electrons,” *Physorg.com*, August 15, 2007
- “Silicon chips set to go atomic,” *Technology Resource News*, July 24, 2002
- “The future is silicon,” *Nature Research Highlights*, July 1, 2002

REFERENCES

Prof. Yoshihisa Yamamoto (Current advisor)
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