Kipp J. van Schooten, Ph.D.

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Research Interests

Investigating spin-dependent formation and recombination processes for excitations in material systems ranging from organic semiconductors to colloidal quantum dots. By coherently manipulating the spin identity of optically and electrically generated excited states via electron spin resonance (ESR), insight into the nature, interactions and possible technological usefulness of these excitations can be gained. Information obtained via time-resolved photo- and electroluminescence spectroscopy, from picoseconds to seconds time scales often proves complementary and extremely valuable.

Current projects involve pushing the boundaries of parameter space in electro-optical ESR methods in two significant ways. The first by moving to single spin sensitivity for combined magnetic resonance and optical spectroscopy. The second involves magnetic resonance at high field (12.5 Tesla) and high frequency (330 GHz) which enforces complete polarization with a Zeeman splitting above kT at liquid He temperatures.

Research Experience

Postdoctoral Researcher, University of Utah, Salt Lake City, Utah 2013–present
Materials Research, Science, and Engineering Center (MRSEC)

- Develop powerful excitation and detection methods for the Inverse Spin Hall Effect.
- Explore spin-current injection and spin- to charge-current conversion mechanisms in organic semiconductors.
- Design and implement a ~$1.4M, 12.5 Tesla, 330 GHz electro-optical spin resonance facility. [PDF] (*project shelved due to withdrawal of USTAR fund-matching*)
- Advisors: Profs. Christoph Boehme, Z. Valy Vardeny, Brian Saam, Joel S. Miller

The Spin Electronics Group

- Measuring spin-spin interaction energies within organic semiconductors via detection of Rabi oscillations under detuning.
- Correlating morphology and magnetic order/disorder in organic semiconductors.
- Advisor: Prof. Christoph Boehme

The Organic Semiconductors and Optical Nanostructures Group

- Spent 4 weeks at the University of Regensburg, Regensburg, Germany to retrofit a wide-field, optical microscopy setup with single-molecule spin-resonance capabilities.
- This work was sponsored by Prof. John M. Lupton, now Chair of the Institute of Experimental and Applied Physics at the University of Regensburg.

Education

University of Utah, Salt Lake City, Utah 2006–2012
Ph.D. in Condensed Matter Physics, Dept. of Physics & Astronomy

- Thesis: *Optically Active Charge Traps and Chemical Defects in Semiconducting Nanocrystals Probed by Pulsed Optically Detected Magnetic Resonance* [PDF]
- Advisor: Prof. John M. Lupton

Southern Polytechnic State University, Marietta, Georgia 2000–2005
B.Sc in Physics, Dept. of Physics

- Minor (non-traditional) in Electrical Engineering Technology
- Senior Project: *Development of a Wireless Geophone System for Subsurface Depth Seismology*
- Advisors: Dr. James B. Whitenton, Dr. Russel S. Patrick, Dr. Michael G. Thackston

Technical Proficiencies

Techniques

- Electron Spin Resonance (electrical, optical, and absorption detected ESR, both at high and low fields)
- Optical techniques (pulsed electrical/optical excitation for time-gated electroluminescence/photoluminescence spectroscopy)
- Electronic methods of small-signal detection and signal conditioning
- Organic semiconductor device fabrication, glovebox procedures, and thermal evaporation of metals
- Basic chemical handling, wetlab, and cleanroom procedures
- Basic analog/digital electronics, microcontroller programming/interfacing, RF electronics, and associated test equipment

Software

- OriginLab, Python, LabVIEW, Xepr/PulseSPEL, LaTeX
- Working experience in AutoCAD/Inventor, Assembly, MATLAB, C/C++

Refereed Journal Publications

[1] Malissa, H., Kavand, M., Waters, D. P., **van Schooten, K. J.**, Burn, P. L., Vardeny, Z. V., Saam, B., Lupton, J. M., Boehme, C., Room-temperature coupling between electrical current and nuclear spins in OLEDs. *Science* (2014) [*in press*]

[2] **van Schooten, K. J.**, Boehme, C. & Lupton, J. M. Coherent magnetic resonance of nanocrystal quantum-dot luminescence as a window to blinking mechanisms. *ChemPhysChem* **15**, 1737–46 (2014). doi:10.1002/cphc.201400081 [PDF]

[3] Her, J. H., Stephens, P. W., Davidson, R. A., Min, K. S., Bagnato, J. D., **van Schooten, K. J.**, Boehme, C. & Miller, J. S. Weak ferromagnetic ordering of the $Li^{+}[TCNE]^{\bullet -}$ (TCNE = tetracyanoethylene) organic magnet with an interpenetrating diamondoid structure. *J. Am. Chem. Soc.* **135**, 18060–3 (2013) doi:10.1021/ja410818e [PDF]

[4] **van Schooten, K. J.**, Huang, J., Talapin, D. V, Boehme, C. & Lupton, J. M. Spin-dependent electronic processes and long-lived spin coherence of deep-level trap sites in CdS nanocrystals. *Phys. Rev. B* **87**, 125412 (2013) doi:10.1103/PhysRevB.87.125412 [PDF]

[5] **van Schooten, K. J.**, Huang, J., Baker, W. J., Talapin, D. V, Boehme, C. & Lupton, J. M. Spin-dependent exciton quenching and spin coherence in CdSe/CdS nanocrystals. *Nano Lett.* **13**, 65–71 (2013) doi:10.1021/nl303459a [PDF]

[6] Baker, W. J., Ambal, K., Waters, D. P., Baarda, R., Morishita, H., **van Schooten, K. J.**, McCamey, D. R., Lupton, J. M. & Boehme, C. Robust absolute magnetometry with organic thin-film devices. *Nat. Commun.* **3**, 898 (2012) doi:10.1038/ncomms1895 [PDF]

[7] Baker, W. J., McCamey, D. R., **van Schooten, K. J.**, Lupton, J. M. & Boehme, C. Differentiation between polaron-pair and triplet-exciton polaron spin-dependent mechanisms in organic light-emitting diodes by coherent spin beating. *Phys. Rev. B* **84**, 165205 (2011) doi:10.1103/PhysRevB.84.165205 [PDF]

[8] Chaudhuri, D., Wettach, H., **van Schooten, K. J.**, Liu, S., Sigmund, E., Höger, S. & Lupton, J. M. Tuning the singlet-triplet gap in metal-free phosphorescent π–conjugated polymers. *Angew. Chem.* **49**, 7714–17 (2010) doi:10.1002/anie.201003291 [PDF]

[9] McCamey, D. R., **van Schooten, K. J.**, Baker, W. J., Lee, S.-Y., Paik, S.-Y., Lupton, J. M. & Boehme, C. Hyperfine-Field-Mediated Spin Beating in Electrostatically Bound Charge Carrier Pairs. *Phys. Rev. Lett.* **104**, 017601 (2010) doi:10.1103/PhysRevLett.104.017601 [PDF]

[10] Boehme, C., McCamey, D. R., **van Schooten, K. J.**, Baker, W. J., Lee, S.-Y., Paik, S.-Y. & Lupton, J. M. Pulsed electrically detected magnetic resonance in organic semiconductors. *Phys. Status Solidi B* **246**, 2750–2755 (2009) doi:10.1002/pssb.200982357 [PDF]

[11] Walter, M. J., Borys, N. J., **van Schooten, K. J.** & Lupton, J. M. Light-Harvesting Action Spectroscopy of Single Conjugated Polymer Nanowires. *Nano Lett.* **8**, 3330–3335 (2008) doi:10.1021/nl801757p [PDF]

Conference Talks

[12] **van Schooten, K. J.**, Sun, D., Vardeny, Z. V., & Boehme, C. Artifact free Inverse Spin Hall Effect Measurements in Organic Semiconductor Devices by Pulsed Ferromagnetic-Resonant Spin-Pumping. *Rocky Mountain Conference on Magnetic Resonance* (RMCAC 2014). Copper Mountain, Colorado, USA, July 13–17, 2014.

[13] **van Schooten, K. J.**, Huang, J., Talapin, D. V., Boehme, C. & Lupton, J. M. Spin-Dependent Light-Harvesting in Nanotetrapods by Controlling Electronic Trap States with Optically Detected Magnetic Resonance. *Nanoscience with Nanocrystals* (NaNaX6). Bad Hofgastein, Austria, May 18–23, 2014.

[14] **van Schooten, K. J.**, Huang, J., Talapin, D. V., Boehme, C. & Lupton, J. M. Spin-Dependent Light-Harvesting in Nanotetrapods by Controlling Electronic Trap States with Optically Detected Magnetic Resonance. *International Conference on Quantum Dots* (QD2014). Pisa, Italy, May 11–16, 2014.

[15] **van Schooten, K. J.**, Huang, J., Talapin, D. V., Boehme, C. & Lupton, J. M. Spin-Dependent LightHarvesting in Colloidal Nanocrystals by Controlling Electronic Trap States with Optically Detected Magnetic Resonance. *American Physical Society March Meeting*. Baltimore, Maryland, USA, March 17–22, 2013.

[16] **van Schooten, K. J.**, Huang, J., Baker, W. J., Talapin, D. V., Boehme, C. & Lupton, J. M. Probing Electronic Trap States in Colloidal Nanocrystals with Optically Detected Magnetic Resonance. *Rocky Mountain Conference on Analytical Chemistry* (RMCAC 2012). Copper Mountain, Colorado, USA, June 16–21, 2012.

[17] **van Schooten, K. J.**, Baker, W. J., Huang, J., Talapin, D. V., Boehme, C. & Lupton, J. M. Observation of Long Spin Coherence Times in CdSe/CdS Colloidal Nanostructures. *American Physical Society March Meeting*. Dallas, TX, USA, March 22–25, 2011.

Conference Posters

[18] **van Schooten, K. J.**, Baker, W. J., Huang, J., Talapin, D. V., Boehme, C. & Lupton, J. M. Long Spin Coherence Lifetimes of Optically Generated Excitations in Colloidal CdS Nanorods. *Optical Probes of Conjugated Polymers and Organic Nanostructures* (OP2011) & *Excited State Processes on Electronic and Bio Nanomaterials* (ESP2011). Santa Fe, NM, USA, June 19–24, 2011

[19] **van Schooten, K. J.**, Huang, J., Baker, W. J., Talapin, D. V., Boehme, C. & Lupton, J. M. Long Spin Coherence Lifetimes of Optically Generated Excitations in Colloidal CdS Nanorods. *Fundamental Optical Processes in Semiconductors* (FOPS2011). Lake Junaluska, NC, USA, August 1–5, 2011.

[20] **van Schooten, K. J.**, Liu, S., Walter, M. J., McCamey, D. R., Scherf, U., Boehme, C., & Lupton, J. M. Time-Resolved Measurements of Spin-Dependent Carrier Recombination in Charge Transfer States of pi-Conjugated Polymers. *237th American Chemical Society National Meeting*. Salt Lake City, UT, USA, March 22–26, 2009.

Colloquia & Seminars

[21] Making Use of Trapped-Carrier Spins in Colloidal Nanocrystals, *Institute of Experimental and Applied Physics Colloqium*, University of Regensburg, Regensburg, Germany, June, 23, 2014.

[22] Increasing Accessibility to the Inverse Spin Hall Effect by Pulsed Ferromagnetic-Resonant Spin-Pumping, *Materials Research, Science, and Engineering Center* (MRSEC) *Seminar*, University of Utah, Salt Lake City, UT, USA, April 8, 2014.

Books

[23] **K. J. van Schooten**, *Optically Active Charge Traps and Chemical Defects in Semiconducting Nanocrystals Probed by Pulsed Optically Detected Magnetic Resonance*, Springer, Cham, Switzerland, 2013. ISBN:9783319005898

Papers in Preparation

[24] **van Schooten, K. J.**, Baird, D. L., Limes, M. E., Lupton, J. M., Boehme, C. Probing spin-spin interactions in intermolecular electron-hole pairs of a conjugated polymer through electrically detected spin-beating (2014) [*under review*]

[25] Sun, D., **van Schooten, K. J.**, Malissa, H., Kavand, M., Boehme, C., Vardeny, Z. V. Spin-orbit dependence of spin-Hall angles in organic semiconductors [*in preparation*]

Teaching Experience

University of Utah, Salt Lake City, Utah 2006–2009
Graduate Teaching Assistant, Dept. of Physics & Astronomy
- Courses: Modern Physics (grading, office hours, class 1 day/week), Electronics I (grading, office hours, practical lab), Solid State II (grading, office hours)
- *Outstanding Teaching Assistant of the Year* award winner each year with TA duties

Southern Polytechnic State University, Marietta, Georgia 2003–2005
University Staff Tutor, Campus wide
- Courses: Physics (all levels), Calculus (I-III), Pre-Calculus
- Hired as the only staff Physics tutor for the University, and one of two Calculus tutors

Honors & Awards

Ph.D. dissertation published in Springer Theses Series SPRING 2013
Optically Active Charge Traps and Chemical Defects in Semiconducting Nanocrystals Probed by Pulsed Optically Detected Magnetic Resonance, ISBN:9783319005898

2nd Place Best Graduate Student Oral Presentation AUGUST 4, 2012
Probing Electronic Trap States in Colloidal Nanocrystals with Optically Detected Magnetic Resonance. Student Research Symposium, Dept. Physics & Astronomy, University of Utah

1st Place Best Graduate Student Oral Presentation AUGUST 13, 2011
Long Spin Coherence Lifetimes of Optically Generated Excitations in Colloidal CdS Nanorods. Student Research Symposium, Dept. Physics & Astronomy, University of Utah

Outstanding Teaching Assistant 2008-2009
Course: Solid State Physics II (PHYS 5520). Taught by: Prof. John Lupton. Dept. Physics & Astronomy, University of Utah

Outstanding Teaching Assistant 2007-2008
Course: Intro to Quantum and Relativity (PHYS 3740). Taught by: Prof. John Lupton. Dept. Physics & Astronomy, University of Utah

Outstanding Teaching Assistant 2006-2007
Course: Intro to Quantum and Relativity (PHYS 3740). Taught by: Prof. John Lupton. Dept. Physics & Astronomy, University of Utah

Outstanding Teaching Assistant 2005-2006
Course: Intro to Quantum and Relativity (PHYS 3740). Taught by: Prof. David Ailion. Dept. Physics & Astronomy, University of Utah

Professional Affiliations

American Physical Society, Member 2008–present
American Chemical Society, Member 2006-present