

RAFAEL JARAMILLO

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EDUCATION

The University of Chicago Ph. D. / Physics (Thomas F. Rosenbaum, advisor) National Science Foundation Graduate Research Fellow Thesis: "Antiferromagnetism in Chromium"	Chicago, IL 2008
Cornell University M. Eng. / Applied and Engineering Physics Cornell Masters of Engineering Fellow Thesis: "Gasdynamic Shocks and Expansion Waves: Special Relativity and Stability"	Ithaca, NY 2003
Cornell University B.S. / Applied and Engineering Physics Summa Cum Laude	Ithaca, NY 2002

AWARDS AND HONORS

• Energy Efficiency and Renewable Energy Postdoctoral Research Fellowship, US Department of Energy	2013-2014
• Ziff Postdoctoral Fellowship, Harvard University Center for the Environment	2009-2011
• Rosalind Franklin Young Investigator Award, Advanced Photon Source, Argonne National Laboratory	2010
• Yodh Award in Experimental Physics, The University of Chicago	2007
• Lindau Nobel Laureate Meeting, Lindau, Germany	2005
• National Science Foundation Graduate Research Fellowship	2004-2007
• Cornell Masters of Engineering Fellowship	2002-2003
• Merrill Presidential Scholar, Cornell University	2002
• B. S. Summa Cum Laude	2002
• Cuykendall Award in Engineering Physics, Cornell University	2002

EXPERIENCE

Massachusetts Institute of Technology Toyota Career Development Assistant Professor Department of Materials Science & Engineering	Cambridge, MA 2015-present
Postdoctoral Fellow Laboratory of Manufacturing and Productivity	2013-2014
<ul style="list-style-type: none"> • Leading an inter-disciplinary team of 7 graduate students and 4 postdocs on research & development of SnS-based thin film solar cell technology • Synchrotron x-ray absorption studies of amorphous semiconductors and conducting oxides 	
Harvard University Postdoctoral Fellow School of Engineering and Applied Sciences	Cambridge, MA 2011-2012
<ul style="list-style-type: none"> • Developed process for synthesizing nickelate complex oxide films on silicon 	

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<ul style="list-style-type: none">• Studied metal-insulator transition and bad metallicity in nickelate complex oxide films• International School of Oxide Electronics, Cargèse, France (2011)	
Ziff Postdoctoral Fellow	2009-2011
Harvard University Center for the Environment	
<ul style="list-style-type: none">• Studied surface potential, band alignment and defect segregation in oxide electronic devices• Investigated grain boundary effects in oxide conductors using scanning probe techniques• LCLS Ultrafast X-Ray Summer School, Stanford, CA (2010)• Gordon Conference on Ceramics for Energy Applications, New London, NH (2010)	
The University of Chicago	Chicago, IL
Postdoctoral Scholar, The James Franck Institute	2008-2009
Graduate Student, Physics	2003-2008
<ul style="list-style-type: none">• Developed advanced techniques for high pressure condensed matter physics in collaboration with Argonne National Laboratory• Measured magnetic domain dynamics and quantum criticality in antiferromagnetic chromium using magnetotransport, cryogenic, and high pressure techniques• Used X-ray diffraction to study magnetism at the Advanced Photon Source, Argonne National Lab: (a) High pressure diffraction study of the antiferromagnetic quantum phase transition in Cr, (b) Coherent and micro-diffraction studies of antiferromagnetic domain structures and dynamics, (c) Diffraction study of magnetism across the pressure-induced metal-insulator transition in NiS₂, (d) Diffraction study of pressure-induced antiferromagnetism in CeFe₂• Studied pressure-induced magnetic quantum phase transition in Cr:V using neutron diffraction, Paul Scherrer Institute, Switzerland• ECRES Workshop on Electronic Crystals, Cargèse, France (2008)• NCNR Neutron Spectroscopy Summer School, NIST, Gaithersburg, MD (2007)	
Cornell University	Ithaca, NY
Graduate Research Fellow, Applied and Engineering Physics	2002-2003
<ul style="list-style-type: none">• Performed a numerical stability analysis of shocks and rarefactions in astrophysical flows	
<hr/> INVITED PRESENTATIONS	
<ul style="list-style-type: none">• Rensselaer Polytechnic Institute, Materials Science• University of Delaware, Materials Science and Engineering Lecture Series• Department of Energy, SunShot Seminar• Northwestern University, Materials Science Seminar• Harvard University, Materials Seminar• Massachusetts Institute of Technology, Materials Science Seminar• Pennsylvania State University, Condensed Matter Physics Seminar• The University of Colorado Boulder, Condensed Matter Physics Seminar• National Renewable Energy Laboratory• The University of Chicago, James Franck Institute Seminar• Columbia University, Applied Physics Seminar• University of Wisconsin, Materials Science Seminar• Harvard University, Applied Physics Seminar• American Physical Society March Meeting, Invited Symposium• Washington University, Physics Department Seminar• Duke University, Physics Department Colloquium• University of Michigan, Department of Physics, CM - AMO Seminar• Boston College, Physics Department Colloquium• Dartmouth College, Jones Seminar on Science, Technology, and Society	<ul style="list-style-type: none">2015201420142014201420142014201420142013201220122012201220122012201220112011

- Washington University, Mechanical Engineering and Materials Science Colloquium 2011
- University of Minnesota, Chemical Engineering and Materials Science Seminar 2011
- Cornell University, Applied and Engineering Physics Seminar 2010
- Advanced Photon Source Users' Meeting, Franklin Award Presentation 2010
- Joint MMM/Intermag Conference 2010
- The University of Chicago, Computations in Science Seminar 2009
- Princeton University, Condensed Matter Seminar 2009
- Columbia University, Nanoscale Science Seminar 2009
- Johns Hopkins University, Condensed Matter Physics Seminar 2009

PUBLICATIONS

- Vera Steinmann, Riley E. Brandt, Rupak Chakraborty, **R. Jaramillo**, Matthew Young, Benjamin K. Ofori-Okai, Chuanxi Yang, J. Alexander Polizzotti, Keith A. Nelson, Roy G. Gordon & Tonio Buonassisi. The impact of sodium contamination on tin sulfide thin-film solar cells. (submitted)
- **R. Jaramillo**, Amanda Youssef, Austin Akey, Frank Schoofs, Shriram Ramanathan & Tonio Buonassisi. Using atom probe tomography to understand Schottky barrier height pinning at the ZnO:Al / SiO₂ / Si interface. (submitted). arXiv: 1510.08794.
- **R. Jaramillo**, Meng-Ju Sher, B. K. Ofori-Okai, V. Steinmann, Chuanxi Yang, Katy Hartman, K. Nelson, Aaron M. Lindenberg, Roy G. Gordon & T. Buonassisi. Transient terahertz photoconductivity measurements of minority-carrier lifetime in tin sulfide thin films: Advanced metrology for an early-stage photovoltaic material. *J. Appl. Phys.* (accepted). arXiv: 1511.07887.
- A. Palmer, D. Silevitch, Y. Feng, Y. Wang, **R. Jaramillo**, A. Banerjee, Y. Ren & T. F. Rosenbaum. Sub-Kelvin magnetic and electrical measurements in a diamond anvil cell with in situ tunability. *Rev. Sci. Instrum.* **86**, 093901 (2015). *Editors' Suggestion*
- N. Mangan, R. E. Brandt, V. Steinmann, **R. Jaramillo**, C. Yang, J. Poindexter, R. Chakraborty, H. H. Park, X. Zhao, R. Gordon & T. Buonassisi. Framework to predict optimal buffer layer pairing for thin film solar cell absorbers: A case study for tin sulfide/zinc oxysulfide. *J. Appl. Phys.* **118**, 115102 (2015).
- S. C. Siah, R. E. Brandt, K. Lim, L. T. Schelhas, **R. Jaramillo**, M. D. Heinemann, D. Chua, J. Wright, C. U. Segre, R. G. Gordon, M. F. Toney & T. Buonassisi. Dopant activation in Sn-doped Ga₂O₃ investigated by X-ray absorption spectroscopy. *Appl. Phys. Lett.* **107**, 252103 (2015).
- R. Chakraborty, V. Steinmann, N. M. Mangan, R. E. Brandt, J. R. Poindexter, **R. Jaramillo**, J. P. Mailoa, K. Hartman, A. Polizzotti, C. Yang, R. G. Gordon & Tonio Buonassisi. Non-monotonic effect of growth temperature on carrier collection in SnS solar cells. *Appl. Phys. Lett.* **106**, 203901 (2015).
- **R. Jaramillo**, Vera Steinmann, Chuanxi Yang, Katy Hartman, Rupak Chakraborty, Jeremy Poindexter, Mariela Castillo, Roy Gordon & Tonio Buonassisi. Making record-efficiency SnS solar cells by thermal evaporation and atomic layer deposition. *J. Vis. Exp.* **99**, e52705 (2015).
- Sin Cheng Siah, **R. Jaramillo**, Peter T. Erslev, Tsu-Chien Weng, Michael F. Toney, Glenn Teeter & Tonio Buonassisi. X-Ray Absorption Spectroscopy Study of Structure and Stability of Disordered (Cu₂SnS₃)_{1-x}(ZnS)_x Alloys *IEEE J. Photovolt.* **5**, 372 (2015).
- H. H. Park, R. Heasley, L. Sun, V. Steinmann, **R. Jaramillo**, K. Hartman, R. Chakraborty, P. Sinsermuksakul, D. Chua, T. Buonassisi & R. G. Gordon. Co-optimization of SnS absorber and Zn(O,S) buffer materials for improved solar cells. *Prog. Photovoltaics* **23**, 901 (2015).
- Vera Steinmann, **R. Jaramillo**, Katy Hartman, Rupak Chakraborty, Riley E. Brandt, Jeremy R. Poindexter, Yun Seog Lee, Leizhi Sun, Alexander Polizzotti, Helen Hejin Park, Roy G. Goron & Tonio Buonassisi. 3.88% efficient tin sulfide solar cells based on congruent evaporation. *Adv. Mater.* **26**, 7488 (2014).
- Vladan Stevanovic, Katy Hartman, **R. Jaramillo**, Shriram Ramanathan, Tonio Buonassisi & Peter Graf. Variations of ionization potential and electron affinity as a function of surface orientation: the case of orthorhombic SnS. *Appl. Phys. Lett.* **104**, 211603 (2014).
- Feng Yan, Frank Schoofs, Jian Shi, Sieu D. Ha, **R. Jaramillo** & Shriram Ramanathan. Local

- charge writing in epitaxial SmNiO₃ thin films. *J. Mater. Chem. C* **2**, 3805 (2014).
- **R. Jaramillo**, S. D. Ha, D. Silevitch & S. Ramanathan. Origins of bad metal conductivity and the insulator-metal transition in the rare-earth nickelates. *Nat. Phys.* **10**, 304 (2014).
 - S. D. Ha, Y. Zhou, **R. Jaramillo** & S. Ramanathan. *Correlated Electrons: A Platform for Solid State Devices in Future Trends in Microelectronics*, S. Luryi, J. Xu & A. Zaslavsky (Eds.), 300-307, John Wiley & Sons, Inc. (2013).
 - S. D. Ha*, **R. Jaramillo***, D. M. Silevitch, F. Schoofs, K. Kerman, J. D. Baniecki & S. Ramanathan. The Hall coefficient of SmNiO₃ thin films: Sign crossover below T_N and implications for antiferromagnetism. *Phys. Rev. B* **87**, 125150 (2013). *Equally contributing co-authors.
 - **R. Jaramillo***, F. Schoofs*, S. D. Ha and Shriram Ramanathan. High pressure synthesis of SmNiO₃ thin films and implications for thermodynamics of the nickelates. *J. Mater. Chem. C*, **1**, 2455 (2013). *Equally contributing co-authors. Also see news item in *Nature* **495**, March 7, 2013.
 - **R. Jaramillo**, Y. Feng & T. F. Rosenbaum. Four-probe electrical measurements with a liquid pressure medium in a diamond anvil cell. *Rev. Sci. Instrum.* **83**, 103902 (2012).
 - J. Wang, Y. Feng, **R. Jaramillo**, J. van Wezel, P. C. Canfield & T. F. Rosenbaum. Pressure tuning of competing magnetic interactions in intermetallic CeFe₂. *Phys. Rev. B* **86**, 014422 (2012).
 - S. D. Ha, M. Ataki, **R. Jaramillo**, A. Podpirka & S. Ramanathan. Stable metal-insulator transition in epitaxial SmNiO₃ thin films. *J. Solid State Chem.* **190**, 233 (2012).
 - Y. Feng, J. Wang, **R. Jaramillo**, J. van Wezel, S. Haravifard, G. Srajer, Y. Liu, Z.-A. Xu, P. B. Littlewood & T. F. Rosenbaum. Order parameter fluctuations at a buried quantum critical point. *PNAS* **109**, 7224 (2012).
 - **R. Jaramillo** & S. Ramanathan. Electronic granularity and the work function of transparent conducting ZnO:Al thin films. *Adv. Funct. Mater.* **21**, 4068 (2011).
 - E. M. Likovich, **R. Jaramillo**, K. J. Russell, S. Ramanathan & V. Narayanamurti. Narrow band defect luminescence from Al-doped ZnO probed by scanning tunneling cathodoluminescence. *Appl. Phys. Lett.* **99**, 151910 (2011).
 - E. M. Likovich, **R. Jaramillo**, K. J. Russell, E. Hu, S. Ramanathan & V. Narayanamurti. High current density monolayer CdSe/ZnS quantum dot light emitting devices with oxide electronics. *Adv. Mater.* **23**, 4521 (2011).
 - E. M. Likovich, **R. Jaramillo**, K. J. Russell, S. Ramanathan & V. Narayanamurti. Scanning tunneling microscope investigation of local density of states in Al-doped ZnO films. *Phys. Rev. B* **83**, 075430 (2011).
 - Y. Feng, **R. Jaramillo**, A. Banerjee, J. M. Honig & T. F. Rosenbaum. Magnetism, structure, and charge at a pressure-induced Mott-Hubbard insulator-metal transition. *Phys. Rev. B* **83**, 035106 (2011).
 - **R. Jaramillo** & S. Ramanathan. Kelvin force microscopy studies of work function of transparent conducting ZnO:Al electrodes synthesized under varying oxygen pressures. *Sol. Ener. Mat. Sol. C* **95**, 602 (2011).
 - **R. Jaramillo**, Y. Feng, J. Wang & T. F. Rosenbaum. Signatures of quantum criticality in Cr at high pressure. *PNAS* **107**, 13631 (2010). Also see news item in *Science* **329**, August 13, 2010.
 - **R. Jaramillo**, Y. Feng & T. F. Rosenbaum. Diffraction line-shapes, Fermi surface nesting, and quantum criticality in antiferromagnetic chromium at high pressure. *J. Appl. Phys.* **107**, 09E116 (2010). *Invited Manuscript*
 - Y. Feng, **R. Jaramillo**, J. Wang, Y. Ren & T. F. Rosenbaum. High pressure techniques for condensed matter physics at low temperature. *Rev. Sci. Instrum.* **81**, 041301 (2010). *Invited Manuscript*
 - **R. Jaramillo**, Y. Feng, J. C. Lang, Z. Islam, G. Srajer, P. B. Littlewood, D. B. McWhan & T. F. Rosenbaum. Breakdown of the BCS Ground State at a Quantum Phase Transition. *Nature* **459**, 405 (2009).
 - **R. Jaramillo**, Y. Feng, J. C. Lang, Z. Islam, G. Srajer, H. M. Rønnow, P. B. Littlewood & T. F. Rosenbaum. Chromium at High Pressures: Weak Coupling and Strong Fluctuations in an Itinerant Antiferromagnet. *Phys. Rev. B* **77**, 184418 (2008). *Editors' Suggestion*
 - Y. Feng, **R. Jaramillo**, G. Srajer, J. C. Lang, Z. Islam, M. S. Somayazulu, O. G. Shpyrko, J. J. Pluth, H.-k. Mao, E. D. Isaacs, G. Aeppli & T. F. Rosenbaum. Pressure-Tuned Spin and Charge Ordering in an Itinerant Antiferromagnet. *Phys. Rev. Lett.* **99**, 137201 (2007).
 - **R. Jaramillo**, T. F. Rosenbaum, E. D. Isaacs, O. G. Shpyrko, P. G. Evans, G. Aeppli & Z. Cai.

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 - S. W. Yuan, **R. Jaramillo**, T. F. Rosenbaum & L. Yu. Synthesis and characterization of conjugated polymers containing first row transition metal complexes. *Macromolecules* **39**, 8652 (2006).
 - Y. Feng, M. S. Somayazulu, **R. Jaramillo**, T. F. Rosenbaum, E. D. Isaacs, J. Hu & H.-k. Mao. Energy dispersive x-ray diffraction of charge density waves via chemical filtering. *Rev. Sci. Instrum.* **76**, 063913 (2005).