Edwin Miles Stoudenmire

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Research Experience

2017-Pres. Research Scientist, Flatiron Institute
Center for Computational Quantum Physics (CCQ)

2016-2017 Research Scientist, Univ. of California Irvine
Supported by the Simons Foundation, Many-Electron Collaboration

- Scalable "sliced basis" DMRG approach to quantum chemistry.
- Co-organized Quantum Machine Learning conference at the Perimeter Institute for Theoretical Physics.

2013-2016 Postdoctoral Researcher, Perimeter Institute for Theoretical Physics

- Proposed machine learning framework based on powerful tensor network methods developed in physics. Link to video.
- Performed highly cited research on non-abelian topological order in 2d lattice models and universal entanglement properties of critical systems
- Significantly expanded user base of ITensor software and developed ambitious new version 2.0 design.

2010-2013 Postdoctoral Researcher, UC Irvine
Supervisors: Steven R. White and Kieron Burke

- Discovered a method for parallelizing the density matrix renormalization group (DMRG) algorithm in real space.
- Extensively developed ITensor: an open-source C++ library for tensor network algorithms and DMRG. Website: http://itensor.org/

2005-2010 Graduate Research Assistant, UC Santa Barbara
Supervisor: Leon Balents

- Applied a variety of methods (bosonization, mean-field, spin wave high temperature series, Monte Carlo) to study frustrated magnets.
- Collaborated with Steven R. White on a new method for simulating finite temperature quantum systems (METTS algorithm).

Education

2010 PhD in Physics, UC Santa Barbara. Advisor: Leon Balents
2005 BS in Physics, Georgia Institute of Technology, highest honors
2005 BS in Mathematics, Georgia Institute of Technology, highest honors

Publications

2019 Mario Motta, Claudio Genovese, Fengjie Ma, Zhi-Hao Cui, Randy Sawaya, Garnet Kin-Lic Chan, Natalia Chepiga, Phillip Helms, Carlos Jimenez-Hoyos, Andrew J. Millis, Ushnish Ray, Enrico Ronca, Hao Shi, Sandro Sorella, **Edwin M. Stoudenmire**, Steven R. White, Shiwei Zhang,"Ground-state properties of the hydrogen chain: insulator-to-metal transition, dimerization, and magnetic phases", arxiv:1911.01618

2019 Jing Chen, **E.M. Stoudenmire**,"Hybrid Purification and Sampling Approach for Thermal Quantum Systems", *Phys. Rev. B* **101**, 195119

2019 Tai-Danae Bradley, **E.M. Stoudenmire**, John Terilla, "Modeling Sequences with Quantum States: A Look Under the Hood", arxiv:1910.07425

2019 Katharine Hyatt, **E.M. Stoudenmire**, "DMRG Approach to Optimizing Two-Dimensional Tensor Networks", arxiv:1908.08833

2018 Steven R. White, **E.M. Stoudenmire**, "Multisliced gausslet basis sets for electronic structure", *Phys. Rev. B* **99**, 081110(R)

2018 William Huggins, Piyush Patel, K. Birgitta Whaley, **E.M. Stoudenmire**, "Towards Quantum Machine Learning with Tensor Networks", *Quant. Sci. Tech.* **4**, 024001

2018 **E.M. Stoudenmire**, "Learning Relevant Features of Data with Multi-scale Tensor Networks", *Quant. Sci. Tech.* **3**, 034003

2017 William Huggins, C. Daniel Freeman, **E.M. Stoudenmire**, Norm M. Tubman, K. Birgitta Whaley, "Monte Carlo Tensor Network Renormalization", arxiv:1710.03757

2017 Benedikt Bruognolo, Zhenyue Zhu, Steven R. White, and **E.M. Stoudenmire**, "Matrix product state techniques for two-dimensional systems at finite temperature", arxiv:1705.05578

2017 Mario Motta, David M. Ceperley, **E.M. Stoudenmire**, et al., "Towards the solution of the many-electron problem in real materials: equation of state of the hydrogen chain with state-of-the-art many-body methods", *Phys. Rev. X* **7**, 031059

2017 **E.M. Stoudenmire** and Steven R. White, "Sliced Basis Density Matrix Renormalization Group for Electronic Structure", *Phys. Rev. Lett.* **119**: 046401

2016 **E.M. Stoudenmire** and D.J. Schwab, "Supervised Learning with Quantum-Inspired Tensor Networks", *Advances in Neural Information Processing Systems (NIPS)* **29**: 4799

2016 Sharmistha Sahoo, **E.M. Stoudenmire**, Jean-Marie Stéphan, Trithep Devakul, Rajiv R. P. Singh, and Roger Melko, "Unusual Corrections to Scaling and Convergence of Universal Renyi Properties at Quantum Critical Points", *Phys. Rev. B* **93**: 085120

2015 Thomas E. Baker, **E.M. Stoudenmire**, Lucas O. Wagner, Kieron Burke, and Steven R. White, "One Dimensional Mimicking of Electronic Structure: The Case for Exponentials", *Phys. Rev. B* **91**: 235141

2015 **E.M. Stoudenmire**, David J. Clarke, Roger S. K. Mong, and Jason Alicea, "Assembling Fibonacci Anyons from a $\mathbb{Z}_3$ Parafermion Lattice Model", *Phys. Rev. B* **91**: 235112
[**Editor's suggestion**]

2014 **E.M. Stoudenmire**, Peter Gustainis, Ravi Johal, Stefan Wessel, and Roger G. Melko, "Corner Contribution to the Entanglement Entropy of Strongly-Interacting O(2) Quantum Critical Systems in 2+1 Dimensions", *Phys. Rev. B* **90**: 235106

2014 Lucas O. Wagner, Thomas E. Baker, **E.M. Stoudenmire**, Kieron Burke, and Steven R. White , "Kohn-Sham Calculations with the Exact Functional", *Phys. Rev. B* **90**: 045109
[**Editor's suggestion**]

2014 A.B. Kallin, **E.M. Stoudenmire**, P. Fendley, R.R.P. Singh and R.G. Melko , "Corner Contribution to the Entanglement Entropy of an O(3) Quantum Critical Point in 2+1 Dimensions", *J. Stat. Mech.* (2014) P06009

2013 Lucas O. Wagner, **E.M. Stoudenmire**, Kieron Burke, and Steven R. White , "Guaranteed Convergence of the Kohn-Sham Equations", *Phys. Rev. Lett.* **111**: 093003 [**Editor's suggestion**]

2013 **E.M. Stoudenmire** and Steven R. White, "Real-space parallel density matrix renormalization group", *Phys. Rev. B* **87**: 155137

2013 Salvatore R. Manmana, **E.M. Stoudenmire**, Kaden R.A. Hazzard, Ana Maria Rey and Alexey V. Gorshkov, "Topological phases in ultracold polar-molecule quantum magnets", *Phys. Rev. B* **87**: 081106(R)

2012 **E.M. Stoudenmire**, Lucas O. Wagner, Steven R. White and Kieron Burke, "One-dimensional continuum electronic structure with the density matrix renormalization group and its implications for density functional theory", *Phys. Rev. Lett.* **109**: 056402

2012 Lucas O. Wagner, **E.M. Stoudenmire**, Kieron Burke and Steven R. White, "Reference electronic structure calculations in one dimension", *Phys. Chem. Chem. Phys.* **14**: 8581

2012 **E.M. Stoudenmire** and Steven R. White, "Studying two dimensional systems with the density matrix renormalization group", *Annual Reviews of Condensed Matter Physics* **3**: 111

2011 **E.M. Stoudenmire,** Jason Alicea, Oleg A. Starykh and Matthew P.A. Fisher, "Interaction effects in topological superconducting wires supporting majorana fermions", *Phys. Rev. B* **84**: 014503 [**Editor's suggestion**, Synopsis Article]

2010 **E.M. Stoudenmire** and Steven R. White, "Minimally entangled typical thermal state algorithms" *New J. Phys.* **12**: 055026

2009 **E.M. Stoudenmire**, Simon Trebst and Leon Balents, "Quadrupolar correlations and spin freezing in S=1 triangular lattice antiferromagnets", *Phys. Rev. B* **79**: 214436

2008 **E.M. Stoudenmire** and Leon Balents, "Ordered phases of the anisotropic kagome lattice antiferromagnet in a field", *Phys. Rev. B* **77**: 174414

2005 **E.M. Stoudenmire** and C.A.R. Sá de Melo, "Magnetoresistive effects in ferromagnet-superconductor multilayers", *J. Appl. Phys.* **97**: 10J108

Invited Research Talks

Dec 2017 AI and Quantum Physics Workshop, *"Learning Relevant Features of Data with Tensor Networks"*. Nanjing, China.

Dec 2017 Simons Center for Geometry and Physics, *"Learning Relevant Features of Data with Tensor Networks"*. Stony Brook, NY.

Jul 2017 Kavli Inst. of Theor. Sci. (KITS), *"Machine Learning with Tensor Networks"*. Beijing, China.

Apr 2017 Perimeter Institute, *"Applying DMRG to Continuous Systems in 1D and 3D"*. Waterloo, Canada.

Mar 2017 RIKEN AICS, *"Machine Learning with Quantum-Inspired Tensor Networks"*. Kobe, Japan.

Feb 2017 UC Irvine AI/ML Seminar, *"Learning with Tensor Networks"*. Irvine, CA.

Jan 2017 UBC, *"Sliced Basis Set Approach to Quantum Chemistry with DMRG"*. Vancouver, BC.

Dec 2016 "Tensor Network States: Algorithms and Applications" Conference, *"Machine Learning with Quantum-Inspired Tensor Networks"*. Hsinchu, Taiwan.

Nov 2016 CUNY Graduate Center Symposium, *"Machine Learning with Quantum-Inspired Tensor Networks"*. New York, NY.

Oct 2016 Berkeley Chemistry Seminar, *"Quantum Chemistry by a Thousand Cuts"*. Berkeley, CA.

Apr 2015 MIT Condensed Matter Seminar, *"Uncovering the Fibonacci Phase in Z3 Parafermion Systems"*. Cambridge, Massachusetts.

Apr 2015 Univ. of Illinois Condensed Matter Seminar, *"Uncovering the Fibonacci Phase in Z3 Parafermion Systems"*. Urbana-Champaign, Illinois.

Feb 2015 Conference on Advanced Numerical Algorithms for Strongly Correlated Quantum Systems, *"Uncovering the Fibonacci Phase in Z3 Parafermion Systems"*. Würzburg, Germany.

Sep 2012 LMU München, *"Parallelizing DMRG in Real Space"*. Munich, Germany.

Aug 2012 JILA and CU Dept. of Physics, *"Simulating Realistic Systems with DMRG"*. Boulder, CO.

May 2012 UC Merced Dept. of Chemistry, *"Exact Electronic Structure in 1d"*. Merced, CA.

Mar 2012 APS March Meeting, Symposium on DFT, *"Exact Density Functional Calculations with DMRG"*. Boston, MA.

Jun 2011 Microsoft Station Q Seminar, *"Interaction Effects in Topological Superconducting Wires"*. Santa Barbara, CA.

Invited Pedagogical Talks

Jun 2017 & 2016 Simons Summer School on the Many-Electron Problem and Coding School, *"Design"*, *"Optimization"*, *"Intro to Julia"* and *"ITensor Hands-on"*. Stony Brook, New York.

Jun 2016 & 2014 International School on Computational Methods for Quantum Materials, *"Hands-on with the ITensor Library"* (2 lectures and hands-on tutorials). Sherbrooke, Québec.

Jun 2014 Simons Summer School on the Many-Electron Problem, *"Matrix Product States and DMRG"* and *"ITensor Hands-on"* (3 lectures and hands-on tutorials). Stony Brook, New York.

Dec 2012 National Taiwan University, Winter School: DMRG 101. *"Studying Density Functional Theory and One-Dimensional Electronic Structure with DMRG"*. Taipei, Taiwan. Video and Slides

Dec 2012 Northeastern University, *"Introduction to MPS with the ITensor Library"* (2 lectures and hands-on tutorials). Boston, MA.

Mar 2012 IMSC Chennai, K.S. Krishnan Meeting on Tensor Network States
"From DMRG to Tensor Network States" (2 Lectures, Delivered Online). Chennai, India.

Teaching Experience

Mar 2015 **Master's Course**, Perimeter Institute PSI Program: *"Condensed Matter Explorations"*
(14 lectures; I created and taught all the lectures)

2012-13 Guest Lecturer. UCI advanced undergraduate quantum mechanics and condensed matter physics (6 Lectures).

2008 Guest Lecturer. UCSB graduate condensed matter physics (4 Lectures).

Selected Activities and Contributed Talks

Jan-Mar 2019 **Organizer**. KITP Program on *Machine Learning for Quantum Many-Body Physics*.

Dec 2016 Neural Information Processing (NIPS) Conference, Barcelona. Poster: *"Learning with Quantum-Inspired Tensor Networks"*.

Aug 2016 **Organizer**. Quantum Machine Learning, Perimeter Institute.
Talk: *"Learning with Quantum-Inspired Tensor Networks"*. Talk video and slides.

Jan 2016 Physics Informed Machine Learning, Santa Fe. Poster: *"Supervised Learning with Quantum-Inspired Tensor Networks"*.

Aug 2014 Conference on Computational Physics, CCP2014, Boston University.
Talk title: *"Corner Contributions to Entanglement Entropy in Critical Systems"*

References available upon request