

Nicole Yunger Halpern

ITAMP Postdoctoral Fellow

December 5, 2020

BASIC INFORMATION	<p>Harvard-Smithsonian Institute for Theoretical Atomic, Molecular, and Optical Physics (ITAMP) 60 Garden St., MS 14 Cambridge, MA 02138, USA</p> <p>nicoleyh@g.harvard.edu +1-813-810-3300</p>
FUTURE POSITIONS	<p>Physicist Laser-Cooling and -Trapping Group, Quantum-Measurement Division, National Institute of Standards and Technology (NIST). Sept. 2021–.</p> <p>QuICS Fellow Joint Institute for Quantum Information and Computer Science (QuICS), NIST and U. of Maryland. Sept. 2021–.</p> <p>Adjunct Assistant Professor of Physics U. of Maryland Dept. of Physics. Sept. 2021–.</p> <p>Adjunct Assistant Professor of IPST Institute for Physical Science & Technology (IPST), U. of Maryland. Sept. 2021–.</p> <p>JQI Affiliate Joint Quantum Institute (JQI), NIST and U. of Maryland. Sept. 2021–.</p>
CURRENT POSITIONS	<p>ITAMP Postdoctoral Fellow Harvard-Smithsonian Institute for Theoretical Atomic, Molecular, and Optical Physics (ITAMP). Sept. 2018–June 2021.</p> <ul style="list-style-type: none">• Mentors: Profs. Isaac Chuang, Aram Harrow, and Seth Lloyd. <p>Associate Harvard U. Dept. of Physics. Sept. 2018–June 2021.</p> <p>Visiting Scholar Massachusetts Institute of Technology. Sept. 2018–June 2021.</p>
EDUCATION	<p>PhD in Physics, California Institute of Technology Aug. 2013–June 2018.</p> <ul style="list-style-type: none">• Advisor: Prof. John Preskill.

- Affiliations: Institute for Quantum Information and Matter, Division of Physics, Mathematics, and Astronomy.
- Thesis: “Quantum Steampunk: Quantum Information, Thermodynamics, Their Intersection, and Applications Thereof Across Physics”
 - Recipient of the Ilya Prigogine Prize for Thermodynamics.
 - The subject of a *Scientific American* feature article, translated into Spanish and Hebrew and reported on in *Popular Mechanics*, *Nature Daily Briefing*, and *Fortune*.
 - Cited on Wikipedia.

MS in Physics and **Perimeter Scholars International (PSI)**,
Perimeter Institute for Theoretical Physics and U. of Waterloo
Aug. 2012–June 2013.

- Advisors: Prof. Robert W. Spekkens, Dr. Markus P. Müller.
- Specialization: Quantum information theory.

BA, Dartmouth College

Sept. 2007–June 2011.

- Major: Physics Modified.
- Co-valedictorian (top grade in college-wide graduating class).
- *Summa cum laude*, with Honors in the Major.
- Advisors: Miles Blencowe, Lorenza Viola, Marcelo Gleiser, and Chandrasekhar Ramanathan.

OTHER
RESEARCH
POSITIONS
HELD

Visiting Researcher

Oxford U. Dept. of Physics.

Hosts: Profs. Vlatko Vedral and Jonathan Barrett. Sept.–Dec. 2013.

Research Assistant

Lancaster U. Dept. of Physics.

Condensed-matter-and-quantum-optics theory group.

Advisor: Prof. Henning Schomerus. Nov. 2011–July 2012.

AWARDS AND
FELLOWSHIPS

International Quantum Technology Emerging Researcher Award

Institute of Physics, 2020.

***Journal of Physics A* Emerging Talent**

Journal of Physics A, Institute of Physics (IOP) Publishing (2020–2021).

Ilya Prigogine Prize for Thermodynamics

Joint European Thermodynamics Conference, 2018–2019.

ITAMP Postdoctoral Fellowship

Harvard-Smithsonian Institute for Theoretical Atomic, Molecular, and Optical Physics (ITAMP), Jan. 2018–Aug. 2021.

Miller Postdoctoral Fellowship

Miller Institute, U. California, Berkeley, Dec. 2018.

Declined for ITAMP Fellowship.

Hartree Postdoctoral Fellowship

Joint Center for Quantum Information and Computer Science (QuICS),
U. of Maryland and NIST, Dec. 2018.
Declined for ITAMP Fellowship.

Barbara Groce Graduate Fellowship

Division of Physics, Mathematics, and Astronomy (PMA), Caltech,
Oct.–Dec. 2017 and Mar.–June. 2018.
Competitively “awarded to [PMA’s] most talented students to allow them
freedom to focus totally on their research.”

KITP Graduate Fellowship

Kavli Institute for Theoretical Physics; U. of California, Santa Barbara;
July–Dec. 2017.

Burke Graduate Student Fellowship

Walter Burke Institute for Theoretical Physics, Caltech, Jan.–June 2017.

Institute for Quantum Information and Matter Graduate Fellowship

Caltech, NSF, and Gordon and Betty Moore Foundation,
Oct. 2014–Oct. 2015.

Virginia Gilloon Fellowship

Caltech, Oct. 2013–Oct. 2014.
Awarded to incoming graduate students selected from across the university.

Cambridge International Fellowship

University of Cambridge, 2013–2016.
Declined for Caltech graduate fellowships.

Purcell Fellowship

Harvard University, 2013–2014.
Declined for Caltech graduate fellowships.

Named MIT Fellowship

Massachusetts Institute of Technology, 2013–2014.
Declined for Caltech graduate fellowships.
Name would have been chosen upon acceptance of fellowship.

Leigh Page Prize

Yale University, 2013.
Declined for Caltech graduate fellowships.

Perimeter Scholars International (PSI) Scholarship

Perimeter Institute for Theoretical Physics, Aug. 2012–June 2013.

Fulbright Scholarship

April 2012.
Declined for PSI Scholarship.

Dartmouth General-Campbell Fellowship

Dartmouth College, Aug. 2011–Aug. 2012.

Co-Valedictorian

Dartmouth College, June 2011.
Top grade in college-wide graduating class.

Mina H. Warren Scholarship Award

Dartmouth College, June 2011.

Summa Cum Laude

Dartmouth College, June 2011.

Honors in the Major

Dartmouth College, June 2011.

Physics and Astronomy Faculty Prize

Dartmouth College, June 2011.

4-time Rufus Choate Scholar

Dartmouth College, 2007–2011.
Annual GPA in top $\sim 5\%$ of college-wide class.

Phi Beta Kappa Prize

Dartmouth College, Nov. 2009.

James O. Freedman Presidential Scholarship

Dartmouth College, June 2009–Mar. 2010.
Research advisor: Prof. Marcelo Gleiser.

8 Academic Citations

Dartmouth College, 2007–2011. For exceptional performance in courses, including Statistical Physics, Reading Course in Introductory Quantum Mechanics, Introductory Physics III, Problem Solving with Computer Science, and Understanding the Universe.

Dale Carnegie Training Student Scholarship

Mar. 2011. To attend Dale Carnegie “High-Impact Presentations” public-speaking workshop.

**RESEARCH
INTERESTS**

- Applications of quantum information theory to thermodynamics, and applications of the combination to other fields: nonequilibrium statistical mechanics; condensed matter; atomic, molecular, and optical physics; high-energy physics; chemical physics; etc.
- Thermalization, resistance to thermalization, many-body localization, the Eigenstate Thermalization Hypothesis, and quantum engines.
- Quantum information scrambling, quantum chaos, and out-of-time-ordered correlators.
- Fluctuation theorems for nonequilibrium statistical mechanics.
- Entropies, information theory beyond i.i.d., and resource theories.
- Weak measurements and quasiprobability distributions.

- [1] A. Bene Watts, N. Yunger Halpern, and A. Harrow, “Nonlinear Bell inequality for macroscopic measurements,” accepted by *Phys. Rev. A* as a Rapid Communication (in press) arXiv:1911.09122.
- [2] D. R. M. Arvidsson-Shukur, N. Yunger Halpern, H. V. Lepage, A. A. Lasek, C. H. W. Barnes, and S. Lloyd, “Quantum advantage in postselected metrology,” *Nat. Comms.* **11**, 3775 (2020).
 - Featured in news articles written by the *U. of Cambridge Research News* and *The Science Times* and picked up by 13 other news sites.
- [3] N. Yunger Halpern, M. E. Beverland, and A. Kaley, “Equilibration to the non-Abelian thermal state in quantum many-body physics,” *Phys. Rev. E* **101**, 042117 (2020).
- [4] N. Yunger Halpern and D. T. Limmer, “Fundamental limitations on photoisomerization from thermodynamic resource theories,” *Phys. Rev. A* **101**, 042116 (2020).
 - Selected for highlighting as an Editors’ Suggestion.
- [5] N. Yunger Halpern, A. Bartolotta, and J. Pollack, “Entropic uncertainty relations for quantum information scrambling,” *Comms. Phys.* **2**, 92 (2019).
- [6] N. Yunger Halpern and E. Crosson, “Quantum information in the Posner model of quantum cognition,” *Ann. Phys.* **407**, 92-147 (2019).
 - Selected, from across Elsevier Physics and Astronomy publications, for highlighting in an article by Elsevier News.
- [7] J. R. González Alonso, N. Yunger Halpern, and J. Dressel, “Out-of-time-ordered-correlator quasiprobabilities robustly witness scrambling,” *Phys. Rev. Lett.* **122**, 040404 (2019).
- [8] N. Yunger Halpern, C. D. White, S. Gopalakrishnan, and G. Refael, “Quantum engine based on many-body localization,” *Phys. Rev. B* **99**, 024203 (2019).
 - Selected for highlighting as an APS Physics Focus.
 - Selected for highlighting as an Editors’ Suggestion.
- [9] J. Dressel, J. R. González Alonso, M. Waegell, and N. Yunger Halpern, “Strengthening weak measurement of qubit out-of-time-order correlators,” *Phys. Rev. A* **98**, 012132 (2018).
- [10] N. Yunger Halpern, A. J. P. Garner, O. C. O. Dahlsten, and V. Vedral, “Maximum one-shot dissipated work from Rényi divergences,” *Phys. Rev. E* **97**, 052135 (2018).
- [11] B. Swingle and N. Yunger Halpern, “Resilience of scrambling measurements,” *Phys. Rev. A* **97**, 062113 (2018).
- [12] N. Yunger Halpern, B. Swingle, and J. Dressel, “Quasiprobability behind the out-of-time-ordered correlator,” *Phys. Rev. A* **97**, 042105 (2018).

- [13] N. Yunger Halpern, “Beyond heat baths II: Framework for generalized thermodynamic resource theories,” *J. Phys. A* **51**, 094001 (2018), in special issue “Shannon’s Information Theory, 70 years on.”
- Selected as a *J. Phys. A* Highlight of 2018.
- [14] N. Bao and N. Yunger Halpern, “Quantum voting system and violation of Arrow’s Impossibility Theorem,” *Phys. Rev. A* **95**, 062306-1–9 (2017).
- Selected for highlighting as an Editors’ Suggestion.
 - Covered in *Nature News*.
- [15] O. C. O. Dahlsten, A. J. P. Garner, M.-S. Choi, D. Braun, N. Yunger Halpern, and V. Vedral, “Entropic equality for worst-case work at any protocol speed,” *New J. Phys.* **19**, 043013-1–18 (2017).
- [16] N. Yunger Halpern, “Jarzynski-like equality for the out-of-time-ordered correlator,” *Phys. Rev. A* **95**, 012120-1–9 (2017).
- [17] N. Yunger Halpern, P. Faist, J. Oppenheim, and A. Winter, “Microcanonical and resource-theoretic derivations of the Non-Abelian Thermal State,” *Nat. Comms.* **7**, 12051-1–7 (2016).
- [18] N. Yunger Halpern and C. Jarzynski, “Number of trials required to estimate a free-energy difference, using fluctuation relations” *Phys. Rev. E* **93**, 052144-1–7 (2016).
- [19] N. Yunger Halpern and J. P. Renes, “Beyond heat baths: Generalized resource theories for small-scale thermodynamics,” *Phys. Rev. E* **93**, 022126-1–16 (2016).
- [20] N. Yunger Halpern, A. J. P. Garner, O. C. O. Dahlsten, and V. Vedral, “Introducing one-shot work into fluctuation relations,” *New. J. Phys.*, Focus Issue on Quantum Thermodynamics **17**, 095003-1–22 (2015).
- [21] G. Gour, M. P. Müller, V. Narasimhachar, R. W. Spekkens, and N. Yunger Halpern, “The resource theory of informational nonequilibrium in thermodynamics,” *Phys. Rep.* **583**, 1-58 (2015).
- [22] H. Schomerus and N. Yunger Halpern, “Uncompensated parity anomaly and Landau level lasing in strained photonic crystals,” *Phys. Rev. Lett.* **110**, 013903-1–5 (2013).

BOOK
CHAPTERS

- [23] N. Yunger Halpern, “Toward physical realizations of thermodynamic resource theories,” *Information and Interaction: Eddington, Wheeler, and the Limits of Knowledge*, Springer, FQXi subset of the *Frontiers* book collection (2017), p. 135–166.

PREPRINTS

- [24] D. Arvidsson-Shukur, J. Chevalier-Drori, and N. Yunger Halpern, “Conditions tighter than noncommutation needed for nonclassicality” (2020). [arXiv:2009.04468](https://arxiv.org/abs/2009.04468)
- [25] J. Monroe, N. Yunger Halpern, T. Lee, and K. Murch, “Weak measurement of superconducting qubit reconciles incompatible operators” (2020). [arXiv:2008.09131](https://arxiv.org/abs/2008.09131).

- [26] L. E. Hillberry, M. T. Jones, D. L. Vargas, P. Rall, N. Yunger Halpern, N. Bao, S. Notarnicola, S. Montangero, and L. D. Carr, “Entangled quantum cellular automata, physical complexity, and Goldilocks rules” (2020). arXiv:2005.01763.
- [27] W. Zhong, J. M. Gold, S. Marzen, J. England, and N. Yunger Halpern, “Learning about learning by many-body systems” (2020) arXiv:2004.03604.
- [1] “Noncommuting conserved quantities in thermalization,” *Asian Quantum Information Science 2020, Centre for Quantum Software and Information*, University of Technology Sydney, Sydney, Australia and online (Dec. 7–9, 2020).
- [2] “Noncommuting conserved quantities in quantum many-body thermalization,” *Scientific Quantum Computing and Simulation on Near-Term Devices*, Institute for Nuclear Theory, University of Washington, Seattle, Washington and online (Oct. 5–Nov. 13, 2020).
- [3] Dynamics, Criticality, and Universality in Random Quantum Circuits, Max Planck Institute for the Physics of Complex Systems, Dresden, Germany and online (Sept. 30–Oct. 2, 2020).
- [4] “Everything you wanted to know about resource theories and haven’t had the quantum information scientist to ask,” *Complexity from Quantum Information to Black Holes*, Lorentz Center, Leiden, Netherlands (June 2–5, 2020).
- [5] “Quantum information in the Posner model of quantum cognition”; *Coherent Spin Physics in Biology*; U. of California, Los Angeles; Los Angeles, CA, USA (Dec. 12–14, 2019).
- [6] “The Non-Abelian thermal state,” *Conference on Quantum Information and Quantum Control VIII*, Fields Institute, Toronto, ON, Canada (Aug. 26–30, 2019).
- [7] “How effectively can a molecular switch switch? A bound from thermodynamic resource theories,” *Algebraic and Statistical Ways into Quantum Resource Theories*, Banff International Research Station, Banff, AB, Canada (July 21–26, 2019).
- [8] “Quantum steampunk: Quantum information, thermodynamics, their intersection, and applications thereof across science,” Ilya Prigogine Prize Talk, *Joint European Thermodynamics Conference*, Barcelona, Spain (May 21–24, 2019).
- [9] “Simple Bounds on Far-from-Equilibrium Machines (Hat Tip to Quantum Information Theory),” *Exploring Open Quantum Systems in Quantum Simulators*, Kavli Institute for Theoretical Physics, Santa Barbara, CA, USA (Apr. 29–May 3, 2019).
- [10] “When quantum-information scrambling met quasiprobabilities,” *Quantum Matter 3: Emergence and Entanglement*, Perimeter Institute, Waterloo, ON, Canada (Apr. 22–26, 2019).

- [11] “Resource-theory models for thermodynamics,” *APS March Meeting*, American Physical Society, Los Angeles, CA, USA (Mar. 5–9, 2018).
- [12] “This is your brain on quantum information,” *Physics of the Universe Summit (POTUS) 2018*, SpaceX and Caltech, Los Angeles, CA, USA (Jan. 12–14, 2018).
- [13] “The skeleton of information scrambling,” *Physics of Quantum Information Conference*, Kavli Institute for Theoretical Physics, Santa Barbara, CA, USA (Oct. 9–13, 2017).
- [14] “The skeleton of information scrambling,” *Quantum Information in Quantum Gravity III*, U. of British Columbia, Vancouver, CA (Aug. 14–18, 2017).
- [15] “How much is that density operator in the window? Quantifying resources,” *Power of Information Workshops: Information and Non-equilibrium Thermodynamics*, Beyond Center for Fundamental Concepts in Science, Arizona State U., Scottsdale, AZ, USA (Apr. 18–20, 2017).
- [16] “Quantum chaos: A Jarzynski-like equality,” *Fifth Quantum Thermodynamics Conference*, U. of Oxford, Oxford, UK (Mar. 13–17, 2017).
- [17] “Beyond heat baths: Generalized resource theories for small-scale thermodynamics,” *Beyond i.i.d. in Information Theory*, Banff International Research Station, Banff, Canada (July 5–10, 2015).
- [18] “Information as a resource in small-scale thermodynamics,” *Information and Interaction: Eddington, Wheeler, and the Limits of Knowledge* (FQXi workshop), U. of Cambridge, Cambridge, UK (March 20–24, 2014).
- [19] “Quantum steampunk: Quantum information meets thermodynamics,” *IQUIST Seminar*, Illinois Quantum Information Science and Technology Center (IQUIST), U. of Illinois at Urbana-Champaign, Urbana-Champaign, IL, USA, via Zoom (Sept. 1, 2020).
- [20] “Quantum steampunk: Quantum information meets thermodynamics,” *IQC Colloquium*, Institute for Quantum Computing (IQC), U. of Waterloo, Waterloo, ON, Canada (Mar. 3, 2020).
- [21] “Quantum steampunk: Quantum information meets thermodynamics,” Special Physics Colloquium, Carnegie Mellon, Pittsburgh, PA, USA (Feb. 24, 2020).
- [22] “Quantum steampunk: Quantum information meets thermodynamics,” Physics Colloquium, U. Massachusetts Boston, Boston, MA, USA (Oct. 3, 2019).
- [23] “Quantum steampunk: Quantum information meets thermodynamics,” Physics Colloquium, Clark U., Worcester, MA, USA (Oct. 2, 2019).
- [24] “Quantum steampunk: Quantum information meets thermodynamics,” *IQC Colloquium*, Institute for Quantum Computing (IQC), U. of Waterloo, Waterloo, ON, Canada (Apr. 15, 2019).

DEPARTMENT
COLLOQUIA

- [25] “Quantum steampunk: Quantum information meets thermodynamics,” Yale Quantum Institute Colloquium, Yale Quantum Institute, Yale U., New Haven, CT, USA (Feb. 22, 2019).
- [26] “Quantum steampunk: Quantum information meets thermodynamics,” Physics Colloquium, Colorado School of Mines, Golden, CO, USA (Jan. 29, 2019).
- [27] “Quantum steampunk: Quantum information applied to thermodynamics,” Physics and Astronomy Colloquium, Cal State LA, Los Angeles, CA, USA (May 26, 2016).
- INVITED
LECTURES
- [28] Mini Course on Quantum-Information Thermodynamics, University of São Paulo, São Paulo, Brazil and online (Nov. 23–Dec. 4, 2020).
 - Enrollment: 420, from across the globe.
 - Presented 5 of 9 lectures.
- [29] “Quantum information in quantum cognition,” Quantum-biology course, Koç University, Istanbul, Turkey, via Zoom (Sept. 2, 2020).
- [30] “Introduction to quantum thermodynamics” and “Jarzynski-like equality for the out-of-time-ordered correlator,” *Quantum Entanglement 2017*, Fudan U. and National Taiwan U., Shanghai, China and Taipei, Taiwan (Jan. 3–9, 2017).
- ACCEPTED
CONFERENCE
TALKS
- [31] “Putting resource theories to work: Using thermomajorization to bound a molecular switch’s probability of switching,” Beyond i.i.d. in Information Theory 8, Stanford, CA, USA and online (Sept. 9–13, 2020).
- [32] “Learning about learning by many-body systems”; *Machine-Learning Interpretability for Scientific Discovery @ICML*; with W. Zhong, J. M. Gold, S. Marzen, and J. England (talk presented by W. Zhong) (Jul. 17, 2020).
- [33] “MBL-mobile: Many-body-localized engine,” *50th Annual Meeting of the APS Division of Atomic, Molecular, and Optical Physics*, American Physical Society, Milwaukee, WI, USA (May 27–31, 2019).
- [34] “MBL-mobile: Many-body-localized engine,” *Quantum Thermodynamics Conference*, Kavli Institute for Theoretical Physics, Santa Barbara, CA, USA (June 25–29, 2018).
- [35] “Quantum steampunk: Quantum information and thermodynamics,” *Rising Stars in Physics*, Dept. of Physics, MIT, Cambridge, MA, USA (Apr. 24–25, 2018).
- SEMINARS
- [36] “Noncommuting conserved quantities in quantum many-body thermalization,” *Cavendish QI Seminar*, Quantum Information Group, Cavendish Laboratory, University of Cambridge, Cambridge, UK and online (Sept. 18, 2020).
- [37] “Noncommuting conserved quantities in quantum many-body thermalization,” *QICI Online Seminar*, Quantum Information and Computation Initiative (QICI), University of Hong Kong, Hong Kong, China and online (Sept. 11, 2020).

- [38] “Entropic uncertainty relations for quantum information scrambling,” QChaos2020 (international online seminar series) (Aug. 6, 2020).
- [39] “Learning about learning about many-body physics”; Complexity Sciences Center; U. of California, Davis; Davis, CA, USA (July 22, 2020).
- [40] “MBL-mobile: Many-body-localized engine,” Quantum Simulation and Technology Group, Universidade Federal do Rio Grande do Norte, Natal, Brazil (July 9, 2020).
- [41] “Learning about learning by many-body systems,” American Physical Society Topical Group on Data Science (May 29, 2020).
- [42] “Putting thermodynamic resource theories to work: Bounding a molecular switch’s probability of switching,” Quarantine Thermo (international online seminar series) (Apr. 7, 2020).
- [43] “Quantum steampunk: Quantum information meets thermodynamics,” Dept. of Physics, U. of Toronto, Toronto, ON, Canada (Mar. 17, 2020).
- [44] “Resource theories go to work: Bounding how effectively a molecular switch can switch, using quantum-information thermodynamics,” *QuICS Seminar*, Joint Center for Quantum Information and Computer Science (QuICS), U. of Maryland and NIST, College Park, MD, USA (Feb. 19, 2020).
- [45] “Learning about learning by many-body systems,” *Informal Statistical-Physics Seminar*, Institute for Physical Science and Technology, U. of Maryland, College Park, MD, USA (Feb. 18, 2020).
- [46] “Entropic uncertainty relations for quantum-information scrambling,” *Special CUA Seminar*, Center for Ultracold Atoms, MIT, Cambridge, MA, USA (Feb. 5, 2020).
- [47] “MBL-mobile: Many-body-localized quantum engine,” Dept. of Physics and Astronomy, U. of Southern California, Los Angeles, CA, USA (Dec. 12, 2019).
- [48] “Noncommuting conserved charges in quantum many-body thermalization,” *Quantum Information Processing Seminar*, Center for Theoretical Physics, MIT, Cambridge, MA, USA (Nov. 1, 2019).
- [49] “Noncommuting conserved charges in quantum many-body thermalization,” *Theoretical-Physics Seminar*, Dept. of Physics and Applied Physics, U. of Massachusetts Lowell, Lowell, MA, USA (Oct. 31, 2019).
- [50] “Entropic uncertainty relations for quantum-information scrambling,” Institute for Quantum Studies, Chapman University, Orange, CA, USA (Sept. 5, 2019).
- [51] “When quantum-information scrambling met quasiprobabilities,” *Joint Condensed-Matter and High-Energy-Theory Seminar*, Dept. of Physics, Brown U., Providence, RI, USA (May 9, 2019).

- [52] “Entropic uncertainty relations for quantum-information scrambling,” *Perimeter Institute Quantum Discussions*, Perimeter Institute, Waterloo, ON, Canada (Apr. 18, 2019).
- [53] “Quantum steampunk: Quantum information meets thermodynamics,” *Special Theoretical Physics Seminar*, Dept. of Physics, Yale U., New Haven, CT, USA (Apr. 3, 2019).
- [54] “Entropic uncertainty relations for quantum-information scrambling,” *ITAMP Seminar*, Institute for Theoretical Atomic, Molecular, and Optical Physics (TAMP), Harvard-Smithsonian Center for Astrophysics, Cambridge, MA, USA (Feb. 28, 2019).
- [55] “Quantum information in quantum cognition,” *MIT Quantum Information Processing Seminar*, Center for Theoretical Physics, MIT, Cambridge, MA, USA (Feb. 8, 2019).
- [56] “Quantum steampunk: Quantum information meets thermodynamics,” Special Kadanoff Seminar, Kadanoff Center for Theoretical Physics, U. of Chicago, Chicago, IL, USA (Jan. 31, 2019).
- [57] “When quantum-information scrambling met quasiprobabilities,” CTQM Seminar, Center for Theory of Quantum Matter (CTQM), U. of Colorado Boulder, Boulder, CO, USA (Jan. 25, 2019).
- [58] “Reconciling two notions of quantum operator disagreement: Uncertainty relations and information scrambling,” JILA, Boulder, CO, USA (Jan. 22, 2019).
- [59] “Reconciling two notions of quantum operator disagreement: Uncertainty relations and information scrambling,” Condensed-Matter Seminar, Dept. of Physics, Washington U. in St. Louis, St. Louis, MO, USA (Dec. 10, 2018).
- [60] “The non-Abelian thermal state,” CAMP Seminar, Dept. of Physics, Penn State University, State College, PA, USA (Dec. 5, 2018).
- [61] “When quantum-information scrambling met quasiprobabilities,” AP 483 Seminar, Dept. of Applied Physics, Stanford University, Palo Alto, CA, USA (Nov. 12, 2018).
- [62] “When quantum-information scrambling met quasiprobabilities,” Informal String-Theory Seminar, MIT, Cambridge, MA, USA (Oct. 15, 2018).
- [63] “Quantum information in quantum cognition,” Quantum Artificial Intelligence Lab, Google, Venice, CA, USA (July 20, 2018).
- [64] “Resource-theory models for thermodynamics”; College of Chemistry; U. of California, Berkeley; Berkeley, CA, USA (July 9, 2018).
- [65] “Quantum information in quantum cognition,” Ming Hsieh Institute Seminar on Quantum Information, Ming Hsieh Institute, Dept. of Electrical Engineering, U. of Southern California, Los Angeles, CA, USA (Apr. 13, 2018).

- [66] “Resource-theory models for thermodynamics,” Beyond Center for Fundamental Concepts in Science, Arizona State U., Phoenix, AZ, USA (Jan. 29, 2018).
- [67] “Quantum information and the brain,” coffee@beyond seminar, Beyond Center for Fundamental Concepts in Science, Arizona State U., Phoenix, AZ, USA (Jan. 29, 2018).
- [68] “MBL-mobile: Many-body-localized engine”; Complexity Sciences Center; U. of California, Davis; Davis, CA, USA (Oct. 4, 2017).
- [69] “Quantum voting system and violation of Arrow’s Impossibility Theorem”; Dept. of Electrical Engineering and Computer Sciences; U. of California, Berkeley; Berkeley, CA, USA (Sept. 28, 2017).
- [70] “Go scramble yourself! Out-of-time-ordered correlators, the Second Law, and quasiprobabilities”; BQIC Seminar; Berkeley Quantum Information and Computation Center; U. of California, Berkeley; Berkeley, CA, USA (Sept. 27, 2017).
- [71] “A Jarzynski-like equality for quantum chaos, with a side of quasiprobabilities,” Statistical-Mechanics Group, U. of Maryland, College Park, MD, USA (June 8, 2017).
- [72] “Truly quantum Gibbs: Thermal state of a system whose charges don’t commute,” QuICS Seminar, Joint Center for Quantum Information and Computer Science (QuICS), U. of Maryland and NIST, College Park, MD, USA (June 7, 2017).
- [73] “A Jarzynski-like equality for quantum chaos, with a side of quasiprobabilities,” Quantum Seminar, U. of Massachusetts at Boston, Boston, MA, USA (May 30, 2017).
- [74] “Truly quantum Gibbs: Thermal state of a system whose charges don’t commute,” Quantum/Nano Seminar, Dartmouth College, Hanover, NH, USA (May 25, 2017).
- [75] “MBL-mobile: Many-body-localized engine,” Dept. of Chemistry and Chemical Biology, Harvard U., Cambridge, MA, USA (May 23, 2017).
- [76] “Truly quantum Gibbs: Thermal state of a system whose charges don’t commute,” Quantum-Information-Physics-Group Seminar, MIT, Cambridge, MA, USA (May 19, 2017).
- [77] “Go scramble yourself! Out-of-time-ordered correlators, fluctuation relations, and quasiprobabilities,” Condensed-Matter Seminar, Harvard U., Cambridge, MA, USA (May 16, 2017).
- [78] “Using many-body localization for thermodynamic advantage: MBL Otto engine,” U. College London, London, UK (Mar. 9, 2017).

- [79] “Bridging disciplines to comprehend chaos: Fluctuation theorem for the out-of-time-ordered correlator,” Stanford University, Palo Alto, CA, USA (Sept. 22, 2016).
- [80] “Truly quantum Gibbs: Thermal state of a system whose charges don’t commute,” Institute for Quantum Studies, Chapman University, Orange, CA, USA (Aug. 26, 2016).
- [81] “Toward physical realizations of information-theory models for small-scale thermodynamics,” Q+ Google hangout (online international quantum-information seminar) (Jan. 25, 2016).
- [82] “Toward physical realizations of information-theory models for small-scale thermodynamics,” IBM Watson, Yorktown Heights, NY, USA (Nov. 19, 2015).
- [83] “Toward physical realizations of information-theory models for small-scale thermodynamics,” IQIM Seminar, Inst. for Quantum Information and Matter, Caltech, Pasadena, CA, USA (Nov. 6, 2015).
- [84] “Beyond heat baths: Generalized resource theories for small-scale thermodynamics,” QuTech, TU Delft, Delft, Netherlands (Aug. 18, 2015).
- [85] “(One-shot) information theory and statistical mechanics,” Informal Statistical-Physics Seminar, Institute for Physical Science and Technology, U. of Maryland, College Park, MD, USA (Mar. 24, 2015).
- [86] “Quantum voting and violation of Arrow’s Impossibility Theorem,” Joint Center for Quantum Information and Computer Science (QuICS), U. of Maryland and NIST, College Park, MD, USA (Mar. 20, 2015).
- [87] “Beyond heat baths: Resource theories for small-scale thermodynamics,” MIT, Cambridge, MA, USA (May 22, 2014).
- [88] “Information as a resource in small-scale thermodynamics,” Centre for Mathematical Sciences, U. of Cambridge, Cambridge, UK (Mar. 24, 2015).
- [89] “Simple thermo, general tools: The resource theory of informational nonequilibrium,” Relativistic Quantum Information Seminar, U. of Nottingham, Nottingham, UK (Dec. 11, 2013).
- [90] “Simple thermo, general tools: The resource theory of informational nonequilibrium,” Lancaster U., Lancaster, UK (Nov. 28, 2013).
- [91] “Simple thermo, general tools: The resource theory of informational nonequilibrium,” U. of Oxford, Oxford, UK (Oct. 17, 2013).
- [92] “Single-shot entropies in the resource theory of nonuniformity,” ETH Zürich, Zürich, Switzerland (Aug. 2013).
- [93] “Single-shot entropies in the resource theory of nonuniformity,” Perimeter Institute for Theoretical Physics, Waterloo, Canada (June 2013).

ACADEMIC AND
PROFESSIONAL
ORGANIZATIONS

American Physical Society
Member Aug. 2010–Present.

Phi Beta Kappa
Member Nov. 2010–Present.
Inducted junior year of college.
Co-recipient of the Dartmouth College 2009 Phi Beta Kappa Prize.

SERVICE AND
LEADERSHIP

Alumni Advisory Board
Dartmouth College Dept. of Physics and Astronomy.
Member Sept. 2011–Present.

Refereeing for Academic Journals
New Journal of Physics, Optica, Physical Review E, Physical Review Letters, Physical Review X, Physics Letters A, Quantum Information Processing, Quantum Science and Technology, Studies in History and Philosophy of Modern Physics.

Session Chair
Beyond i.i.d. in Information Theory 8, Stanford, CA, USA and online (Nov. 9–13, 2020).

Dartmouth Physics Society
Dartmouth College.
Co-Founder, Co-President Jan.–June 2011.

See also “Diversity,” below.

TEACHING

See “Invited Lectures.”

Ph 219/CS 219c: Quantum Computation: Black Holes, Chaos, and Scrambling; and Topological Quantum Computation, Majoranas, and Anyons

Caltech. Instructor: Prof. Alexei Kitaev.
Teaching Assistant Mar.–Jun. 2016.

- Assisted with course design; answered questions and held weekly office hours; graded biweekly homework.
- In Teaching Quality Feedback Report, received scores of 4.50–5.00 in all categories, on a scale from 0 to 5.00. Report available upon request.

Ph 219/CS 219b: Quantum Computation: Quantum Error Correction and Quantum Shannon Theory

Caltech. Instructor: Prof. John Preskill.
Teaching Assistant Jan.–Mar. 2016.

- Answered questions and held weekly office hours; graded biweekly homework.
- In Teaching Quality Feedback Report, received scores of 4.67–5.00 in all categories, on a scale from 0 to 5.00. Report available upon request.

Ph 219/CS 219a: Quantum Computation: Formalism, Algorithms, and Complexity

Caltech. Instructor: Prof. Alexei Kitaev.

Teaching Assistant Sept.–Dec. 2015.

- Answered questions and held weekly office hours; graded biweekly homework; coordinated with fellow TA.
- In Teaching Quality Feedback Report, received scores of 4.80–5.00 in all categories, on a scale from 0 to 5.00. Report available upon request.

Perimeter Public-Speaking Group

Perimeter Institute for Theoretical Physics.

Group Founder and Leader Oct. 2012–June 2013.

- Led weekly meetings.
- Brainstormed, wrote, and presented speaking tips.
- Provided feedback for speech-givers. Guided other participants in providing feedback.

Berkeley Preparatory School

Philosophy-of-Physics Guest Teacher Sept. 2010.

Rocky VoxMasters Public-Speaking Group

Rockefeller Center for Public Policy at Dartmouth College.

Group Co-Leader Mar. 2008–June 2011.

- Co-led weekly meetings.
- Collaborated with co-leader and other campus organizations.
- Brainstormed, wrote, and presented speaking tips.
- Provided feedback for speech-givers. Guided other participants in providing feedback.

OUTREACH

***Quantum Frontiers* Blog**

Institute for Quantum Information and Matter, Caltech.

Blogger Apr. 2013–Present.

- Write monthly stories about science and how it gets under my skin.
- Number of times *QF* viewed per year: 200,000.
- Articles of mine have been featured in the *Scientific American* blog *Cocktail Party Physics*, in *Nature Briefing*, in *Physics World*, and in the *Physics World* blog.

National and Institutional Science Publications and Videos

Interviewee 2015–Present.

- **“‘Quantum negativity’ can power ultra-precise measurements,”** by Sarah Collins, *U. of Cambridge Research News* (2020).
- **“Does Time Really Flow? New Clues Come from a Century-Old Approach to Math,”** by Natalie Wolchover, *Quanta Magazine* (2020).
- **“The Universal Law That Aims Time’s Arrow,”** by Natalie Wolchover, *Quanta Magazine* (2019).
- **“What makes a great qubit? Diamonds and ions could hold the answer,”** by Allison Eck, *PBS NOVA* (2019).
- **“Here’s what the quantum internet has in store,”** by Davide Castelvecchi, *Nature* (2018).

- **“Break Through: The power of big ideas,”** *Caltech Academic Media Technologies* (2018).
- **“Quantum theory and our warm, wet, large brains,”** *The Caltech Effect*, Caltech Academic Media Technologies (2018).
- **“29 Smart Questions,”** *Amy Poehler’s Smart Girls, Legendary Entertainment* (2015).

National and Institutional Publications

Writer June 2006–Present.

- See “Selected Science Writing,” below.

“Einstein’s Quantum Riddle” Premier

NOVA and MIT.

Panelist Jan. 2019.

- Participated in public panel discussion at premier of NOVA film about quantum entanglement.

“Experimenting with Megan Amram” Webshow

Amy Poehler’s Smart Girls, Legendary Entertainment.

Guest-Scientist Interviewee Aug. 2015.

Hillel Academy Fifth-Grade Science Class

Guest Speaker Mar. 2014 and Feb. 2016.

“Famelab” Science-Communication Contest

NASA.

National Finalist Mar.–Apr. 2012.

- “I Love the Smell of Evolution in the Morning; It Smells Like Physics.”
- “Zombies Versus Evolution: How Physics Enables Complex Life to Form.”

TEDx Dartmouth

Dartmouth College.

Speaker May 2010.

- “Once Upon a Time in Linear Algebra.”

XKCD Comes to Dartmouth!

Dartmouth College.

Principal Event Coordinator May–Nov. 2008 (event held in Oct.).

- Speech by, and festivities with, Randall Munroe, creator of the hit science webcomic xkcd.
- Conceived and planned the event; structured a \$4,500 budget; garnered funds from 12 organizations; coordinated 28 volunteers.

ADVISING OF STUDENT RESEARCH

- [1] **Jacob Chevalier-Drori** (Undergraduate in Physics, University of Cambridge)
Primary advisor: Prof. Crispin Barnes. Aug. 2020–Present.
- [2] **Adam Bene Watts** (PhD Student in Physics, MIT)
Primary advisor: Prof. Aram Harrow. Mar. 2019–Present.
- [3] **Jacob M. Gold** (PhD Student in Physics, MIT)
Primary advisors: Dr. Jeremy England, Prof. Jörn Dunkel.
Mar. 2019–Present.

- [4] **Weishun Zhong** (PhD Student in Physics, MIT)
Primary advisors: Dr. Jeremy England, Prof. Isaac Chuang.
Mar. 2019–Present.
- [5] **Jonathan Tyler Monroe**
(PhD Student in Physics, Washington U. in St. Louis)
Primary advisor: Prof. Kater Murch. Apr. 2019–Present.
- [6] **Taeho Lee** (PhD Student in Physics, Washington U. in St. Louis)
Primary advisor: Prof. Kater Murch. Apr. 2019–Present.
- [7] **Richard Zhu** (Undergraduate in Physics, Caltech)
Primary advisor: Prof. Gil Refael. June 2016–June 2017.
Current employment: [Whisper.ai](#).
- [8] **Patrick Rall** (Undergraduate in Physics, Caltech)
Primary advisor: Prof. John Preskill. Apr. 2015–Mar. 2016.
Current employment: Physics PhD student at the U. of Texas at Austin.
- [9] **Logan Hillberry** (Masters Student in Physics, Colorado School of Mines)
Primary advisor: Prof. Lincoln D. Carr. Apr. 2015–Mar. 2016.
Current employment: Physics PhD student at the U. of Texas at Austin.
- [10] **Timothy Maxwell** (Undergraduate in Physics, Caltech)
Primary advisor: Prof. John Preskill. Apr.–Sept. 2015.
Current employment: Software engineer at Stripe.

DIVERSITY

Rising Stars in Physics

Dept. of Physics, MIT.

Workshop participant. Apr. 24–25, 2018.

- Workshop for “top early career women” about “navigating the early stages of the academic career” and supporting women in physics.
- Selected as one of 24 participants from 150 nationwide applicants.

Stories of Women in Science

Quantum Frontiers Blog, Institute for Quantum Information and Matter, Caltech.

Blogger Apr. 2013–Present.

- Interview and blog about women in scientific and science-adjacent fields.
- 14 women featured to date.

Women-in-Physics Lunch

Kavli Institute for Theoretical Physics; U. of California, Santa Barbara.

Organizer Sept.–Dec. 2017.

- Coordinated weekly lunches for women and gender-diverse physicists.
- Advertised via email, Facebook, Twitter, and word of mouth and at weekly quantum-information-workshop organizational meetings.

“Alice” Women-in-quantum-information dinner

Fifth Conference on Quantum Thermodynamics, U. of Oxford.

Organizer Mar. 13, 2017.

- Organized a dinner for women and gender-diverse researchers in quantum information and thermodynamics.
- 18 participants, representing 12 countries.

“29 Smart Questions” Interview

Amy Poehler’s Smart Girls, Legendary Entertainment.
Guest-Scientist Interviewee Aug. 2015.

“Experimenting with Megan Amram” Webshow

Amy Poehler’s Smart Girls, Legendary Entertainment.
Guest-Scientist Interviewee Aug. 2015.

SELECTED
 SCIENCE
 WRITING

- [1] “Quantum steampunk,” *Scientific American* (2020).
 - Reported on in *Popular Mechanics*, *Nature Daily Briefing*, and *Fortune*.
 - Referred to on Wikipedia.
 - Translated into Spanish and Hebrew.
- [2] “What Makes Extraordinary Science Extraordinary,” Preposterous Universe (Sean Carroll’s blog) (2018).
- [3] “Several kinds of hairy mouldy spots,” Verso, Huntington Library (2014).
- [4] “Hermitian Conjugation,” *Mathematics Magazine* (2013).
- [5] “Quantum Information,” *Quantum Times* **7**, 2 (2013).
- [6] “Poetry for Physicists,” *Inside the Perimeter*, Perimeter Institute for Theoretical Physics (2013).
- [7] “Words about Numbers,” *Mathematical Intelligencer* **35**, 1 (2013).
- [8] “Fiddling Around with Physics,” *Physics World* **25** (2012).
- [9] “Perturbation Theory,” *Quantum Times* **6**, 2 (2011).
- [10] “What’s the Physics Du Jour?” *Tampa Tribune: Thinking Out Loud* (2011).
- [11] “Willebrord Snellius,” *APS Newsletter* **20**, 4 (2011).
- [12] “Statistics,” *Math Horizons*, *Mathematical Association of America* **25** (2011).
- [13] “Three Poems,” *College Mathematics Journal*, *Mathematical Association of America* **41**, 233 (2010).
- [14] “Schrödinger Manuscript Collection,” *Smithsonian Institution Libraries Blog* (2009).