

Alexander Schuckert – Theory of Quantum Simulation

Career

- 2024–cont. **Visiting Postdoc, Harvard (Yelin group)**
- 2024–cont. **Assistant Research Scientist (equiv. to fixed-term Assistant Professor), QuICS**
- 2022–2024 **Postdoc Fellow, Center for Quantum Information and Computer Science (QuICS)**
Theoretical Quantum Optics Fellowship, University of Maryland
A. Gorshkov, M. Gullans, M. Hafezi, C. Monroe
Collab.: I. Chuang (MIT), N. Wiebe (Toronto), S. Girvin (Yale), N. Navon (Yale), P. Roushan (Google)
- 2021–2023 **Quantum Computing Consultant, Quantinuum**

Education

- 2017–2021 **PhD Physics, TU Munich & Max Planck Institute for Quantum Optics (MPQ)**
Michael Knap, Summa Cum Laude, MPQ Fellowship
- 2016–2017 **M. Sc. Physics, University of Heidelberg**
J. Berges, Best mark possible (1.0 \approx GPA 4.0)
- 2015–2016 **M. Sc. Physics, University and King's College London, Exchange (Erasmus)**
Best of year
- 2014 **Internship, Centre for Quantum Technologies Singapore, 3 months**
K. Dieckmann, Ultracold dipolar molecules (experiment)
- 2012–2015 **B. Sc. Physics, University of Heidelberg**
M. Bartelmann, M. Weidemüller, Top 5% of year (Grade: 1.2 \approx GPA 3.8)

Selected Publications

- ⊙ **A. Schuckert**, E. Crane, M. Hafezi, A. V. Gorshkov, M. J. Gullans
Fermion-qubit fault-tolerant quantum computing
arXiv:2411.08955, in Review in Nature
- ⊙ E. Crane, K. C. Smith, T. Tomesh, A. Eickbusch, J. M. Martyn, S. Kühn, L. Funcke, M. A. DeMarco, I. L. Chuang, N. Wiebe, **A. Schuckert**, S. M. Girvin
Hybrid Oscillator-Qubit Quantum Processors: Simulating Fermions, Bosons, and Gauge Fields
arXiv:2409.03747, in Review in Physical Review X
- ⊙ K. Hemery, K. Ghanem, E. Crane, S. L. Campbell, J. M. Dreiling, C. Figgatt, C. Foltz, J. P. Gaebler, J. Johansen, M. Mills, S. A. Moses, J. M. Pino, A. Ransford, M. Rowe, P. Siegfried, R. P. Stutz, H. Dreyer, **A. Schuckert**, and R. Nigmatullin,
Measuring the Loschmidt Amplitude for Finite-Energy Properties of the Fermi-Hubbard Model on an Ion-Trap Quantum Computer
PRX Quantum **5**, **030323** (2024), arXiv:2309.10552, [Press release by Quantinuum](#)
- ⊙ **A. Schuckert***, O. Katz*, L. Feng, A. De, E. Crane, M. Hafezi, A. Gorshkov, C. Monroe
Observation of a finite-energy phase transition in a one-dimensional quantum simulator
Nature Physics (accepted), arXiv:2310.19869
- ⊙ T. Andersen, N. Astrakhantsev, A. H. Karamlou, J. Berndtsson, J. Motruk, A. Szasz, J. A. Gross, **A. Schuckert**,...(218 other authors)..., X. Mi (Google Quantum AI)
Thermalization and Criticality on an Analog-Digital Quantum Simulator
Nature (accepted), arXiv:2405.17385
- ⊙ F. Vivanco*, **A. Schuckert***, S. Huang*, G. L. Schumacher, G. G. T. Assumpcao, Y. Ji, Ji. Chen, M. Knap, N. Navon
The strongly driven Fermi polaron
Nature Physics (accepted), arXiv:2308.05746

- ⊙ M. K. Joshi, F. Kranzl, **A. Schuckert**, I. Lovas, C. Maier, R. Blatt, M. Knap, C. F. Roos
Observing emergent hydrodynamics in a long-range quantum magnet
Science **376**, **720** (2022), [Perspective by Morningstar and Bakr](#)

Short-Term Visits

- 2023 **Duke Quantum Centre**, *Christopher Monroe* (1 month)
- 2021, 2022 **Yale University**, *Nir Navon* (2 and 1 month)

Invited Talks (recent, selection)

- Sept. 2024 Fault-tolerant fermionic quantum simulation
Quantum Information Processing group seminar
Massachusetts Institute of Technology, USA
- Feb. 2024 Learning quantum materials from quantum simulation
Institute for Quantum Physics
Hamburg University, Germany
- Nov. 2023 Finite-temperature and transport in quantum simulators
Quantum Innovators Workshop
IQC Waterloo, Canada
- Sept. 2023 Finite-temperature and transport in quantum simulators
Workshop on Thermalization
University of Washington, Seattle, USA
- Sep. 2023 Observation of an equilibrium phase transition in one-dimension
Workshop on long-range interactions
San Sebastian, Spain
- Sep. 2022 Quantum simulation of magnetism: finite temperature and transport
Lukin group seminar
Harvard University, USA

Supervision

- 2023–cont. Thomas Steckmann (PhD student), Joint Quantum Institute
- 2023–2024 Tianhao Liu (visiting undergrad. student, Beijing University), Joint Quantum Institute
- 2022–2024 Ali Rad (PhD student, co-supervision), Joint Quantum Institute
- 2022 Emily Haworth (Master’s intern), Quantinuum, Munich
- 2020–2021 Ansgar Burchards (Master’s student, co-supervision), TU Munich
- 2020 Michael Labenbacher (Bachelor student), TU Munich
- 2019–2020 Nepomuk Ritz (Master’s student, co-supervision), TU Munich

Teaching

- 2018 Quantum Mechanics (head tutor), TU Munich
- 2017 Quantum Many-Body Physics (tutor), TU Munich
- 2016 Theoretical Electrodynamics (tutor), University of Heidelberg

Grants and Awards

- 2023–2024 \$40k NSF seed grant (for supervising student Thomas Steckmann)
- 2023–2024 \$10k QuEra/AWS quantum computing grant from
- 2022–2023 \$10k NSF high-performance computing grants (1 million core hours)
- 2022–2025 \$300k Fellowship “Theoretical Quantum Optics Postdoc” at Joint Quantum Institute
- 2017–2020 \$200k Fellowship (PhD) at Max Planck Institute for Quantum Optics
- 2015 \$2.5k Erasmus scholarship for study at University College & King’s College London

2014 \$5k DAAD rise worldwide scholarship for research visit at CQT Singapore

Refereeing, Outreach, Community and Diversity

Refereeing 2x PRX Quantum, 3x PRL; 3x Physical Review A,B,E; 2x SciPost-Physics; 1x Quantum
2022–2023 Organizer of the Friday seminar at the Joint Quantum Institute
2017–2022 Science communication blog manybodyphysics.com
2020 Diversity in Leadership course participant, Munich Center for QST
2018–2021 PhD representative (elected) in Munich Center for QST
Member of executive committee, co-organization of conferences
2017–2021 Co-organizer of seminar series of IMPRS-QST
2017–2018 PhD representative (elected) of graduate school IMPRS-QST
Co-organization of yearly summer school, Vienna-Innsbruck-IMPRS workshop

Complete Publication List

- [24] F. M. Surace, A. Lerose, O. Katz, E. R. Bennowitz, **A. Schuckert**, D. Luo, A. De, B. Ware, W. Morong, K. Collins, C. Monroe, Z. Davoudi, A. V. Gorshkov
String-Breaking Dynamics in Quantum Adiabatic and Diabatic Processes
arXiv:2411.10652 (2024)
- [23] **A. Schuckert**, E. Crane, M. Hafezi, A. V. Gorshkov, M. J. Gullans
Fermion-qubit fault-tolerant quantum computing
arXiv:2411.08955 (2024)
- [22] A. De, A. Lerose, D. Luo, F. M. Surace, **A. Schuckert**, E. R. Bennowitz, B. Ware, W. Morong, K. S. Collins, Z. Davoudi, A. V. Gorshkov, O. Katz, C. Monroe
Observation of string-breaking dynamics in a quantum simulator
arXiv:2410.13815 (2024)
- [21] E. Crane, K. C. Smith, T. Tomesh, A. Eickbusch, J. M. Martyn, S. Kühn, L. Funcke, N. Wiebe, M. A. DeMarco, I. L. Chuang, **A. Schuckert**, S. M. Girvin
Hybrid Oscillator-Qubit Quantum Processors: Simulating Fermions, Bosons, and Gauge Fields
arXiv:2409.03747 (2024)
- [20] Y. Liu, S. Singh, K. C. Smith, E. Crane, J. M. Martyn, A. Eickbusch, **A. Schuckert**, R. D. Li, J. Sinanan-Singh, M. B. Soley, T. Tsunoda, I. L. Chuang, N. Wiebe, and S. M. Girvin
Hybrid Oscillator-Qubit Quantum Processors: Instruction Set Architectures, Abstract Machine Models, and Applications
arXiv:2407.10381 (2024)
- [19] A. Rad, **A. Schuckert**, E. Crane, G. Nambiar, J. Wyrick, R. M. Silver, M. Hafezi, Z. Davoudi, M. J. Gullans
Simulating a quantum lattice field theory with donor spins in silicon
arXiv:2407.03419 (2024)
- [18] T. Andersen, N. Astrakhantsev, A. H. Karamlou, J. Berndtsson, J. Motruk, A. Szasz, J. A. Gross, **A. Schuckert**, (218 other authors) , X. Mi (Google Quantum AI)
Thermalization and Criticality on an Analog-Digital Quantum Simulator
arXiv:2405.17385 (2024)
- [17] E. R. Bennowitz, B. Ware, **A. Schuckert**, A. Lerose, F. M. Surace, R. Belyansky, W. Morong, D. Luo, A. De, K. S. Collins, O. Katz, C. Monroe, Z. Davoudi, A. V. Gorshkov
Simulating Meson Scattering on Spin Quantum Simulators
arXiv:2403.07061 (2024)
- [16] **A. Schuckert***, O. Katz*, L. Feng, A. De, E. Crane, M. Hafezi, A. Gorshkov, C. Monroe
Observation of a finite-energy phase transition in a one-dimensional quantum simulator
Nature Physics (accepted), arXiv:2310.19869

- [15] K. Hemery, K. Ghanem, E. Crane, S. L. Campbell, J. M. Dreiling, C. Figgatt, C. Foltz, J. P. Gaebler, J. Johansen, M. Mills, S. A. Moses, J. M. Pino, A. Ransford, M. Rowe, P. Siegfried, R. P. Stutz, H. Dreyer, **A. Schuckert**, and R. Nigmatullin,
Measuring the Loschmidt Amplitude for Finite-Energy Properties of the Fermi-Hubbard Model on an Ion-Trap Quantum Computer
PRX Quantum **5**, **030323** (2024), arXiv:2309.10552, [Press release by Quantinuum](#)
- [14] F. Vivanco*, **A. Schuckert***, S. Huang*, G. L. Schumacher, G. G. T. Assumpcao, Y. Ji, Ji. Chen, M. Knap, N. Navon
The strongly driven Fermi polaron
Nature Physics (accepted), arXiv:2308.05746
- [13] K. Ghanem, **A. Schuckert**, H. Dreyer
Robust Extraction of Thermal Observables from State Sampling and Real-Time Dynamics on Quantum Computers
Quantum **7**, **1163** (2023)
- [12] E. Kozlikin, R. Lilow, M. Pauly, **A. Schuckert**, A. Salzinger, M. Bartelmann, M. Weidemüller
Ultracold plasmas from strongly anti-correlated Rydberg gases in the Kinetic Field Theory formalism
arXiv:2302.01807 (2023)
- [11] **A. Schuckert**, A. Bohrdt, E. Crane, M. Knap
Probing finite-temperature observables in quantum simulators with short-time dynamics
Phys. Rev. B **107**, **L140410** (2023)
- [10] M. K. Joshi, F. Kranzl, **A. Schuckert**, I. Lovas, C. Maier, R. Blatt, M. Knap, C. F. Roos
Observing emergent hydrodynamics in a long-range quantum magnet
Science **376**, **720** (2022), [Perspective by Morningstar and Bakr](#)
- [9] A. G. Burchards, J. Feldmeier, **A. Schuckert**, and M. Knap
Coupled Hydrodynamics in Dipole-Conserving Quantum Systems
Phys. Rev. B **105**, **205127** (2022)
- [8] J. F. Rodriguez-Nieva, **A. Schuckert**, D. Sels, M. Knap, E. Demler
Transverse instability and universal decay of spiral order in the Heisenberg model
Phys. Rev. B **105**, **L060302** (2022)
- [7] **A. Schuckert**, A. Bohrdt, E. Crane, F. Grusdt
Visualizing spinon Fermi surfaces with time-dependent spectroscopy
Phys. Rev. B **104**, **235107** (2021)
- [6] E. Crane, **A. Schuckert**, N. H. Le, A. J. Fisher
Rydberg Blockade Entangling Gates in Silicon
Phys. Rev. Research **3**, **033086** (2021)
- [5] **A. Schuckert**, and M. Knap
Probing eigenstate thermalization in quantum simulators via fluctuation-dissipation relations
Phys. Rev. Research **2**, **043315** (2020)
- [4] **A. Schuckert**, I. Lovas, and M. Knap
Non-local emergent hydrodynamics in a long-range quantum spin system
Phys. Rev. B **101**, **020416 (R)** (2020)
- [3] **A. Schuckert** and M. Knap
Many-body chaos near a thermal phase transition
SciPost Physics **7(2)**, **022** (2019)
- [2] E. Crane, T. Crane, **A. Schuckert**, N. H. Le, K. Stockbridge, S. Chick, and A. J. Fisher
Optically controlled entangling gates in randomly doped silicon
Phys. Rev. B **100**, **064201** (2019)

- [1] **A. Schuckert**, A. Piñeiro Orioli, and J. Berges
Nonequilibrium quantum spin dynamics from two-particle irreducible functional integral techniques in the schwinger boson representation
Phys. Rev. B **98**, **224304** (2018)

Talks, conferences and schools

2024

- October Invited Talk: Fermion-qubit fault-tolerant quantum computation
JQI Seminar, University of Maryland, USA
- September Invited Talk: Fault-tolerant fermionic quantum simulation
Quantum Information Processing group seminar, MIT, USA
- May Invited Talk: Quantum simulation of fermions with quantum computers
IQM, Munich, Germany
- May Invited Talk: Quantum simulation of condensed matter physics
Sussex Centre for Quantum Technologies, Sussex, UK
- April Invited Talk: Learning quantum materials from quantum simulation
CNRS, Paris, France
- February Invited Talk: Learning quantum materials from quantum simulation
Institute for Quantum Physics, Hamburg University, Germany

2023

- December Invited Talk: Observation of an equilibrium phase transition in one-dimension
Young Researcher's Convent, Heidelberg University, Germany
- December Invited Talk: Observation of an equilibrium phase transition in one-dimension
Center for Quantum Science, Tübingen University, Germany
- November Invited Talk: Observation of an equilibrium phase transition in one-dimension
Quantum Innovators Workshop, IQC Waterloo, USA
- November Invited Talk: Observation of an equilibrium phase transition in one-dimension
Brookhaven National Lab, Long Island, NY, USA
- September Invited Talk: Observation of an equilibrium phase transition in one-dimension
Workshop on Thermalization, Inqubator for quantum simulation, Seattle, USA
- September Talk: Observation of an equilibrium phase transition in one-dimension
Long-range meeting, San Sebastian, Spain
- July Poster: Observation of an equilibrium phase transition in one-dimension
Quantum Simulation, Telluride, USA
- July Talk: Observation of an equilibrium phase transition in one-dimension
Gorshov group seminar, Joint Quantum Institute
- July Poster: Observation of an equilibrium phase transition in one-dimension
Quantum Systems Accelerator workshop, Berkeley
- June Poster: The strongly driven Fermi polaron
Precision many body physics, College de France
- June Talk: The strongly driven Fermi polaron
Schmidt group seminar, Heidelberg University
- May Talk: Digital-analogue quantum simulation
NSF STAQ grant review meeting, Duke University
- February Talk: Quantum simulation of finite temperature and transport properties
Nuclear physics seminar, University of Maryland
- February Poster: The strongly driven Fermi polaron
MURI grant review meeting, Harvard University

- February Poster: The strongly driven Fermi polaron
Winter conference on quantum simulation, Aspen
[2022](#)
- September Talk: Quantum simulation of magnetism: Finite temperature and transport
Hafezi group seminar, Joint Quantum Institute
- September Talk: Quantum simulation of magnetism: Finite temperature and transport
Lukin group seminar, Harvard University
- July Poster: Probing finite temperature properties in quantum simulators
GRC Quantum Science, Stonehill College
- June Talk: Towards useful quantum simulation advantage: finite temperature and transport properties
Rydberg experiments seminar, Joint Quantum Institute
- June Talk: Observing emergent hydrodynamics in a long-range quantum magnet
DAMOP, Orlando
- May Talk: Probing thermalization in trapped ion quantum simulators
Gorshkov Group seminar, Joint Quantum Institute
- May Talk: Probing thermalization in trapped ion quantum simulators
Davoudi Group seminar, University of Maryland
- March Talk: Observing emergent hydrodynamics in a long-range quantum magnet
March Meeting, virtual
- January Talk: Thermal equilibrium properties from quantum computers
Honeywell quantum solutions, virtual
[2021](#)
- October Talk: Emergent hydrodynamics in a long-range quantum magnet
Quantum workshop in Zurich, virtual
- October Poster: Emergent hydrodynamics in a long-range quantum magnet
International Symposium on Correlated Electrons, Munich
- September Talk: Emergent hydrodynamics in a long-range quantum magnet
Navon group seminar, Yale University
- July School: Boulder school on Ultracold Matter (moved from 2020)
Virtual
- July School: IMPRS-Harvard-BeyondC summer school
Virtual
- May Invited Talk: Visualizing spinon Fermi surfaces with time-dependent spectroscopy
Grusdt group seminar, LMU Munich
- May Talk: Visualizing spinon Fermi surfaces with time-dependent spectroscopy
DAMOP, virtual
- March Talk: Identifying non-thermal excitations in experiment
ICFO-IMPRS Workshop, virtual
- March Talk: Theory-independent probes of eigenstate thermalization in quantum simulators
March Meeting, virtual
[2020](#)
- November Invited Talk: Observing fluctuation-dissipation relations in quantum simulators
Weidemüller group, Heidelberg, Germany
- November Talk: Probing quantum matter with two-time correlation functions
Center for Theory of Quantum Matter, Boulder, Colorado, USA
- November Poster: Probing eigenstate thermalization in quantum simulators via fluctuation-dissipation relations
Quantum alliance meeting, Germany

- October School: Tensor Network based approaches to Quantum Many-Body Systems
Bad Honnef, Germany
- July Poster: Probing eigenstate thermalization in quantum simulators via fluctuation-dissipation relations
MCQST 2020, Munich, Germany
- April Talk: Probing eigenstate thermalization in quantum simulators via fluctuation-dissipation relations
Blackboard seminar condensed matter theory, TU Munich, Germany
- March Talk and one week visit: Characterizing late-time thermalization in (trapped ion) quantum simulators: From the emergence of fluctuation-dissipation relations to Lévy flight spin transport
Rey group seminar, Boulder, Colorado, USA
- March Talk: Non-local emergent hydrodynamics in a long range quantum spin system
March Meeting, Denver, Colorado, USA
- 2019
- December Talk: What bees and trapped ion quantum simulators have in common
MCQST Colloquium, Munich, Germany
- November Poster: Non-local emergent hydrodynamics in a long range quantum spin system
Technion-MCQST Symposium, Munich, Germany
- October Poster: Non-local emergent hydrodynamics in a long range quantum spin system
Ordering and Dynamics of Correlated Quantum Systems, Evora, Portugal
- September Talk: Non-local emergent hydrodynamics in a long range quantum spin system
Quantum Systems in Extreme Conditions, Heidelberg, Germany
- September Poster: Non-local emergent hydrodynamics in a long range quantum spin system
Korrelationstage, MPI-PKS Dresden, Germany
- August School, short stay (1/4 weeks)
Dynamics and Disorder in QMB systems out of equilibrium, Les Houches, France
- July School and Poster: Emergent hydrodynamics in long range spin models
Harvard-IMPRS-QST summer school, Bad Aibling, Germany
- July Co-organizer and poster: Emergent hydrodynamics in long range spin models
(young) MCQST conference, Munich, Germany
- May Talk: Emergent hydrodynamics in long range spin models
Blackboard seminar condensed matter theory, TU Munich, Germany
- April Talk: Thermalization and emergent hydrodynamics in long range spin models
DPG spring meeting, Regensburg, Germany
- March Poster: Many body chaos near a thermal phase transition
Workshop on Constrained Many-body Dynamics, MPI-PKS Dresden, Germany
- March Poster: Many body chaos near a thermal phase transition
ICFO-IMPRS-QST Workshop, ICFO, Barcelona, Spain
- February Talk: Many body chaos near a thermal phase transition
Blackboard seminar condensed matter theory, TU Munich, Germany
- 2018
- December Invited talk: Many body chaos near a thermal phase transition
Cold quantum coffee seminar, Heidelberg University, Germany
- December Co-organizer, Poster: Many body chaos near a thermal phase transition
Workshop on Recent Advances in QST, Munich, Germany
- November Silicon Quantum Information Processing, University College London, UK
- June Co-organizer, poster: Many body chaos near a thermal phase transition
IMRPS-QST summer school on machine learning, Oetz, Austria

- April Poster: Out-of-time-ordered correlation functions in the $O(N)$ model
Student condensate, Max-Planck-Institute for Quantum Optics, Munich, Germany
- March Poster: Out-of-time-ordered correlation functions in the $O(N)$ model
Workshop Chaos in Correlated Quantum Matter, MPI-PKS Dresden, Germany
- March Talk: Out-of-time-ordered correlation functions in the $O(N)$ model
DPG spring meeting, Berlin, Germany

2017

- November Talk: Non-equilibrium quantum field theory for spin systems
Berges group seminar, Heidelberg University, Germany
- October Talk: Non-equilibrium quantum field theory for inhomogeneous spin systems
Blackboard seminar condensed matter theory, TU Munich, Germany
- September Talk: Non-equilibrium quantum field theory for spin systems
CoQuS-IMRPS summer school, TU Vienna, Austria
- September Talk: Quantum simulation of spin Hamiltonians with deep donors in silicon
COMPASSS away day, Surrey University, UK (joint talk with Eleanor Crane)
- June Review talk: The classical statistical limit of nonequilibrium quantum field theory
Theoretical astrophysics group seminar, Heidelberg, Germany
- June Talk: Non-equilibrium quantum field theory for spin systems
Interview Days, Max-Planck-Institute for Quantum Optics, Munich, Germany

2016

- June Talk: Classical field theory methods in dynamics of correlated Rydberg atoms
UCL+ICL Undergraduate Research Conference, Imperial College London, UK