Michael Lindsey

quantumtative.github.io

POSITIONS

Applied Mathematics and Computational Research Division, Lawrence Berkeley National Laboratory
Faculty Scientist, 4/2023 - present

Department of Mathematics, University of California, Berkeley
Assistant Professor, 7/2022 - present

Courant Institute of Mathematical Sciences, New York University
NSF Postdoctoral Fellow, 9/2019 - 6/2022

EDUCATION

University of California, Berkeley, PhD in Applied Mathematics, 8/2019
Advisor: Lin Lin

Stanford University, BS in Mathematics (Honors), 6/2015

AWARDS

- Hellman Fellowship (2024)
- Sloan Research Fellowship (2024)
- John Todd Award, Oberwolfach Foundation (2022)
- NSF Mathematical Sciences Postdoctoral Research Fellowship (2019)
- SIAM Student Paper Prize (2019)
- Bernard Friedman Memorial Prize in Applied Mathematics, UC Berkeley (2018) [*top applied math graduate student*]
- NSF Graduate Research Fellowship (2016)
- National Defense Science and Engineering Graduate (NDSEG) Fellowship (declined) (2016)
- Kennedy Thesis Prize, Stanford University (2015) [*top undergraduate thesis in the natural sciences*]
- Firestone Medal for Excellence in Undergraduate Research, Stanford University (2015)
- J.E. Wallace Sterling Award for Scholastic Achievement, Stanford University (2015) [*awarded to top 25 graduating seniors in the School of Humanities and Sciences*]

RESEARCH INTERESTS

Numerical analysis, optimization, Monte Carlo methods, rank-structured approximation, semidefinite programming, electronic structure theory, quantum many-body physics

PREPRINTS

Michael Lindsey and Sandeep Sharma. **Fast and spectrally accurate construction of adaptive diagonal basis sets for electronic structure.** Preprint, arXiv: 2407.06171.

P. Michael Kielstra and Michael Lindsey. **Gaussian process regression with log-linear scaling for common non-stationary kernels.** Preprint, arXiv: 2407.03608.

Mark Fornace and Michael Lindsey. **Column and row subset selection using nuclear scores: algorithms and theory for Nyström approximation, CUR decomposition, and graph Laplacian reduction.** Preprint, arXiv: 2407.01698.

Yuhang Cai, Jingfeng Wu, Song Mei, Michael Lindsey, and Peter L. Bartlett. **Large stepsize gradient descent for non-homogeneous two-layer networks: margin improvement and fast optimization.** Preprint, arXiv: 2406.08654.

Jielun Chen and Michael Lindsey. **Direct interpolative construction of the discrete Fourier transform as a matrix product operator.** Preprint, arXiv:2404.03182.

Michael Lindsey. **Multiscale interpolative construction of quantized tensor trains.** Preprint, arXiv:2401.04176.

Michael Lindsey. **Fast entropically regularized semidefinite programming.** Preprint, arXiv:2303.12133.

PUBLICATIONS

Yian Chen, Yuehaw Khoo, and Michael Lindsey. **Multiscale semidefinite programming approach to positioning problems with pairwise structure.** *Journal of Scientific Computing*, accepted.

Yuehaw Khoo and Michael Lindsey. **Scalable semidefinite programming approach to variational embedding for quantum many-body problems.** *Journal of Computational Physics* 510, 113041 (2024).

Michael S. Albergo, Nicholas M. Boffi, Michael Lindsey, and Eric Vanden-Eijnden. **Multimarginal generative modeling with stochastic interpolants.** Accepted, *International Conference on Learning Representations 2024*.

Steven R. White and Michael Lindsey. **Nested gausslet basis sets.** *Journal of Chemical Physics* 159, 234112 (2023).

Huan Zhang, Robert J. Webber, Michael Lindsey, Timothy C. Berkelbach, and Jonathan Weare. **Understanding and eliminating spurious modes in variational Monte Carlo using collective variables.** *Physical Review Research* 5, 023101 (2023).

Peter Lunts, Michael Albergo, and Michael Lindsey. **Non-Hertz-Millis scaling of the antiferromagnetic quantum critical metal via scalable Hybrid Monte Carlo.** *Nature Communications* 14, 2547 (2023).

Yian Chen, Jeremy Hoskins, Yuehaw Khoo, and Michael Lindsey. **Committor functions via tensor networks.** *Journal of Computational Physics* 472, 111646 (2023).

Robert J. Webber and Michael Lindsey. **Rayleigh-Gauss-Newton optimization with enhanced sampling for variational Monte Carlo.** *Physical Review Research* 4, 033099 (2022).

Michael Lindsey, Jonathan Weare, and Anna Zhang. **Ensemble Markov chain Monte Carlo with teleporting walkers.** *SIAM/ASA Journal on Uncertainty Quantification* 10, 860 (2022).

Lin Lin and Michael Lindsey. **Variational embedding for quantum many-body problems.** *Communications on Pure and Applied Mathematics* 75, 2033 (2022).

Dong An, Lin Lin, and Michael Lindsey. **Towards sharp error analysis of extended Lagrangian molecular dynamics.** *Journal of Computational Physics* 466 (2022).

Lin Lin and Michael Lindsey. **Bold Feynman diagrams and the Luttinger-Ward formalism via Gibbs measures. Part II: Non-perturbative analysis.** *Archive for Rational Mechanics and Analysis* 242, 527 (2021).

Lin Lin and Michael Lindsey. **Bold Feynman diagrams and the Luttinger-Ward formalism via Gibbs measures. Part I: Perturbative approach.** *Archive for Rational Mechanics and Analysis* 242, 581 (2021).

Yuehaw Khoo, Lin Lin, Michael Lindsey, and Lexing Ying. **Semidefinite relaxation of multi-marginal optimal transport for strictly correlated electrons in second quantization.** *SIAM Journal on Scientific Computing* 42, B1462 (2020).

Lin Lin and Michael Lindsey. **Sparsity pattern of the self-energy for classical and quantum impurity problems.** *Annales Henri Poincaré* 21, 2219 (2020).

Xiaojie Wu, Michael Lindsey, Tiangang Zhou, Yu Tong, and Lin Lin. **Enhancing robustness and efficiency of density matrix embedding theory via semidefinite programming and local correlation potential fitting.** *Physical Review B* 102, 085123 (2020). [Editor's Suggestion.]

Carlos Mejuto-Zaera, Leonardo Zepeda-Núñez, Michael Lindsey, Norm Tubman, Birgitta Whaley, and Lin Lin. **Efficient hybridization fitting for dynamical mean-field theory via semi-definite relaxation.** *Physical Review B* 101, 035143 (2020).

Xiaojie Wu, Zhi-Hao Cui, Yu Tong, Michael Lindsey, Garnet Kin-Lic Chan, and Lin Lin. **Projected density matrix embedding theory with applications to the two-dimensional Hubbard model.** *The Journal of Chemical Physics*, 151, 064108 (2019).

Lin Lin and Michael Lindsey. **Convergence of adaptive compression methods for Hartree-Fock-like equations.** *Communications on Pure and Applied Mathematics* 72, 451 (2019).

Lin Lin and Michael Lindsey. **Variational structure of Luttinger-Ward formalism and bold diagrammatic expansion for Euclidean lattice field theory.** *Proceedings of the National Academy of Sciences* 115, 2282 (2018).

Michael Lindsey and Yanir A. Rubinstein. **Optimal transport via a Monge-Ampère optimization problem.** *SIAM Journal on Mathematical Analysis* 49, 3073 (2017).

Otis Chodosh, Vishesh Jain, Michael Lindsey, Lyuboslav Panchev, and Yanir A. Rubinstein. **On discontinuity of planar optimal transport maps.** *Journal of Topology and Analysis* 7, 239 (2015).

Robert A. Handler, Ivan Savelyev, and Michael Lindsey. **Infrared imagery of streak formation in a breaking wave.** *Physics of Fluids* 24, 121701 (2012).

INVITED PRESENTATIONS

Adaptive diagonal basis sets for electronic structure
SIAM Conference on Mathematical Aspects of Materials Science, 5/2024

Adaptive diagonal basis sets for electronic structure
AMS Spring Western Sectional Meeting, 5/2024

Direct interpolative construction of quantized tensor trains
Tensor4All Meeting, 4/2024

Direct interpolative construction of quantized tensor trains
Copper Mountain Conference on Iterative Methods, 4/2024

Fast entropically regularized SDP
PACM Colloquium, Princeton, 4/2024

Adaptive diagonal basis sets for electronic structure
Machine Learning in Electronic Structure Theory, IMSI, 3/2024

Interacting ensemble MCMC and fast entropically regularized SDP
Mathematics of Data and Decisions Seminar, UC Davis, 11/2023

Adaptive diagonal basis sets for electronic structure
Analysis and Applied Math Seminar, University of Toronto, 9/2023

Efficient sampling for lattice QMC
JSF Workshop on the Fermion Sign Problem, Peyresq, 7/2023

Interacting ensemble MCMC and fast entropically regularized SDP
John Todd Award Lecture, MFO, Oberwolfach, 6/2023

A sampling of QMC methods
Sanibel Symposium, 2/2023

Thermal state sampling for numerical linear algebra
Sampling, Transport, and Diffusions, Flatiron Institute, 11/2022

Mathematical aspects of Green's function methods
Solid Math, SISSA, 9/2022

Thermal state sampling for numerical linear algebra
Youth in High Dimensions, SISSA, 6/2022

Thermal state sampling for numerical linear algebra
Tripods@Duke, Duke University, 6/2022

Two topics in Monte Carlo for scientific computing
SCAN Seminar, Cornell University, 5/2022

Quantum embedding with lower bounds
Multiscale Approaches in Quantum Mechanics, IPAM, 3/2022

Many-body perturbation theory and Green's function methods
Multiscale Approaches in Quantum Mechanics, IPAM, 3/2022

Tools for multimodal sampling
Applied Math Seminar, Duke University, 12/2022

Tools for multimodal sampling
Applied Math Seminar, Stanford University, 12/2022

Tools for multimodal sampling
PDE-Applied Math Seminar, University of Maryland, 10/2022
Tools for multimodal sampling
Mathematics of Deep Learning Seminar, Flatiron Institute, 10/2021

Tools for multimodal sampling
CAM Colloquium, University of Chicago, 10/2021

Embedding approaches for classical and quantum statistical mechanics
Applied Mathematics Seminar, UC Berkeley, 9/2021

Scalable variational embedding for quantum many-body problems
SIAM Conference on Mathematical Aspects of Materials Science, 5/2021

Optimization for variational Monte Carlo with neural quantum states
Modeling and Simulation Group Seminar: Machine Learning in Science at NYU, Courant Institute, 4/2021

Quantum many-body physics and semidefinite programming
SIAM CSE, 3/2021

Variational embedding for quantum many-body problems
QMC Seminar, Flatiron Institute, 6/2020

Optimal transport via a Monge-Ampère optimization problem
SIAM Conference on the Mathematics of Data Science, 5/2020

Variational embedding for quantum many-body problems
"Revolutionary Advances in Correlated Electron Materials" MURI Group Meeting, 4/2020

Variational embedding for quantum many-body problems
Modeling and Simulation Group Seminar, Courant Institute, 10/2019

Toward sharp error analysis of extended Lagrangian molecular dynamics for polarizable force field simulation
Ki-Net Young Researchers Workshop, University of Maryland, 10/2019

Variational embedding for quantum many-body problems
Modeling and Simulation Group Meeting, Courant Institute, 10/2019

Toward sharp error analysis of extended Lagrangian molecular dynamics for polarizable force field simulation
Analysis Seminar, Courant Institute, 9/2019

Semidefinite relaxation of multi-marginal optimal transport, with application to strictly correlated electrons in second quantization
ICIAM, 7/2019

Strictly correlated electrons in second quantization at finite temperature
Workshop: Optimal Transport Methods in Density Functional Theory, BIRS, 2/2019

Adaptive compression for Hartree-Fock-like equations
SIAM Conference on Applied Linear Algebra, 5/2018

A classical statistical mechanics approach to understanding Green's function methods and the Luttinger-Ward formalism
Workshop: Mathematical Methods in Quantum Chemistry, MFO, Oberwolfach, 3/2018

Optimal transport via a Monge-Ampère optimization problem
Bay Area Differential Geometry Seminar, UC Davis, 4/2017

Optimal transport via a Monge-Ampère optimization problem
Applied Mathematics Seminar, UC Berkeley, 11/2016

Optimal transport via a Monge-Ampère optimization problem
Workshop: Computational Optimal Transportation, Centre de Recherches Mathématiques, 7/2016

TEACHING

University of California, Berkeley
- Spring 2024: Math 128B (Numerical Analysis)
- Fall 2023: Math 228A (Numerical Solution of Differential Equations)
- Spring 2023: Math 128B (Numerical Analysis)
- Fall 2022: Math 228A (Numerical Solution of Differential Equations)

New York University
- Spring 2022: Linear Algebra I (graduate)
- Fall 2021: Mathematical Statistics
- Spring 2021: Linear Algebra I (graduate)
- Fall 2020: Calculus I

University of California, Berkeley (Graduate Student Instructor)
- Spring 2018: Math 54 (Linear Algebra and Differential Equations)
- Spring 2016: Math 53 (Multivariable Calculus)
- Fall 2015: Math 1B (Calculus)

OTHER ACTIVITIES

Referee for *SIAM Journal on Scientific Computing, SIAM Journal on Optimization*, *Journal of Scientific Computing*, *Physical Review Letters*, *Physical Review B, Physical Review X Quantum*, *Physical Review Research*, *Foundations of Computational Mathematics*, *SIAM/ASA Journal on Uncertainty Quantification*, *Communications on Pure and Applied Mathematics*, *Research in the Mathematical Sciences*

Co-organizer for

- Minisymposium: Numerical methods for the quantum many-body problem, SIAM CSE, Fort Worth 3/2025 (with Fabian Faulstich, Yuehaw Khoo, and Siyao Yang)
- Minisymposium: Numerical Methods for Quantum Many-Body Problems, SciCADE, Singapore 7/2024 (with Yuehaw Khoo)
- Minisymposium: Algorithmic advances in computational quantum mechanics, ICIAM, Tokyo 8/2023 (with Jason Kaye)

Co-PI (Lead: Garnet Chan) for DE-FOA-0003265, "Quantum utility through advanced computational quantum algorithms (QUACQ)"

Co-Investigator (Lead: Uros Seljak) for NSF Award No. 2311559, "Elements: A new generation of samplers for astronomy and physics"

Senior personnel (Lead: Yuehaw Khoo) for NSF Award No. 2134467, "Divide-and-Conquer Approach for Strongly Interacting Systems via Convex Optimization"

CV current as of September 2024.