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RESEARCH INTERESTS

Computational methods for out-of-equilibrium and dense field theories; Machine learning acceleration of lattice field theory; Sign problems in Monte Carlo studies of quantum systems; Applications of quantum computers to field theories

HISTORY

- 2023-present* Feynman fellow
Theoretical Division T-2, Los Alamos National Laboratory
Advisors: Tanmoy Bhattacharya, Duff Neill
- 2020-2023* Postdoctoral research
University of Colorado, Boulder
Advisor: Paul Romatschke
- 2017-2020* Ph.D., Physics
University of Maryland, College Park
Thesis advisor: Paulo F. Bedaque
- 2015-2017* Graduate research, Astronomy
University of Maryland, College Park
- 2011-2015* B.S., Physics and Computer Science
University of Maryland, College Park.

PAPERS

- [37] S. Lawrence, B. McPeak, and D. Neill, “Bootstrapping time-evolution in quantum mechanics,” Dec. 2024. arXiv: [2412.08721 \[hep-th\]](#).
- [36] S. Lawrence, “Model-free spectral reconstruction via Lagrange duality,” Aug. 2024. arXiv: [2408.11766 \[hep-lat\]](#).
- [35] A. Bärttschi et al., “Potential Applications of Quantum Computing at Los Alamos National Laboratory,” Jun. 2024. arXiv: [2406.06625 \[quant-ph\]](#).
- [34] S. Lawrence, A. Shelby, and Y. Yamauchi, “Quantum states from normalizing flows,” Jun. 2024. arXiv: [2406.02451 \[quant-ph\]](#).
- [33] S. Lawrence, “Schwinger-Dyson control variates for lattice fermions,” Apr. 2024. arXiv: [2404.10707 \[hep-lat\]](#).
- [32] S. Lawrence, S. Valgushev, J. Xiao, and Y. Yamauchi, “Contour deformations for nonholomorphic actions,” *Phys. Rev. D*, vol. 110, no. 7, p. 074512, 2024. DOI: [10.1103/PhysRevD.110.074512](#). arXiv: [2401.16733 \[hep-lat\]](#).

- [31] S. Lawrence and Y. Yamauchi, “Mitigating a discrete sign problem with extreme learning machines,” Dec. 2023. arXiv: [2312.12636 \[hep-lat\]](#).
- [30] S. Lawrence and Y. Yamauchi, “Convex optimization of contour deformations,” *Phys. Rev. D*, vol. 110, no. 1, p. 014508, 2024. DOI: [10.1103/PhysRevD.110.014508](#). arXiv: [2311.13002 \[hep-lat\]](#).
- [29] T. Bhattacharya, S. Lawrence, and J.-S. Yoo, “Control variates for lattice field theory,” *Phys. Rev. D*, vol. 109, no. 3, p. L031505, 2024. DOI: [10.1103/PhysRevD.109.L031505](#). arXiv: [2307.14950 \[hep-lat\]](#).
- [28] S. Lawrence, R. Weller, C. Peterson, and P. Romatschke, “Instantons, analytic continuation, and PT-symmetric field theory,” *Phys. Rev. D*, vol. 108, no. 8, p. 085013, 2023. DOI: [10.1103/PhysRevD.108.085013](#). arXiv: [2303.01470 \[hep-th\]](#).
- [27] S. Lawrence and Y. Yamauchi, “Deep learning of fermion sign fluctuations,” *Phys. Rev. D*, vol. 107, no. 11, p. 114505, 2023. DOI: [10.1103/PhysRevD.107.114505](#). arXiv: [2212.14606 \[hep-lat\]](#).
- [26] S. Lawrence, “Semidefinite programs at finite fermion density,” *Phys. Rev. D*, vol. 107, no. 9, p. 094511, 2023. DOI: [10.1103/PhysRevD.107.094511](#). arXiv: [2211.08874 \[hep-lat\]](#).
- [25] S. Lawrence and P. Romatschke, “Gravitational-wave-to-matter coupling of superfluid Fermi gases near unitarity,” *Phys. Rev. A*, vol. 107, no. 3, p. 033327, 2023. DOI: [10.1103/PhysRevA.107.033327](#). arXiv: [2206.04765 \[cond-mat.str-el\]](#).
- [24] S. Lawrence, H. Oh, and Y. Yamauchi, “Lattice scalar field theory at complex coupling,” *Phys. Rev. D*, vol. 106, no. 11, p. 114503, 2022. DOI: [10.1103/PhysRevD.106.114503](#). arXiv: [2205.12303 \[hep-lat\]](#).
- [23] S. Lawrence, “Bootstrapping Lattice Vacua,” Nov. 2021. arXiv: [2111.13007 \[hep-lat\]](#).
- [22] S. Lawrence, “Resurrecting the Strong KSS Conjecture,” Nov. 2021. arXiv: [2111.08158 \[hep-th\]](#).
- [21] T. D. Cohen, H. Lamm, S. Lawrence, and Y. Yamauchi, “Quantum algorithms for transport coefficients in gauge theories,” *Phys. Rev. D*, vol. 104, no. 9, p. 094514, 2021. DOI: [10.1103/PhysRevD.104.094514](#). arXiv: [2104.02024 \[hep-lat\]](#).
- [20] S. Lawrence and Y. Yamauchi, “Normalizing Flows and the Real-Time Sign Problem,” *Phys. Rev. D*, vol. 103, no. 11, p. 114509, 2021. DOI: [10.1103/PhysRevD.103.114509](#). arXiv: [2101.05755 \[hep-lat\]](#).
- [19] S. Lawrence, “Perturbative Removal of a Sign Problem,” *Phys. Rev. D*, vol. 102, no. 9, p. 094504, 2020. DOI: [10.1103/PhysRevD.102.094504](#). arXiv: [2009.10901 \[hep-lat\]](#).
- [18] T. D. Cohen, S. Lawrence, and Y. Yamauchi, “Thermodynamics of large- N QCD and the nature of metastable phases,” *Phys. Rev. C*, vol. 102, no. 6, p. 065206, 2020. DOI: [10.1103/PhysRevC.102.065206](#). arXiv: [2006.14545 \[hep-ph\]](#).
- [17] S. Lawrence, “Sign Problems in Quantum Field Theory: Classical and Quantum Approaches,” Ph.D. dissertation, Maryland U., 2020. arXiv: [2006.03683 \[hep-lat\]](#).
- [16] H. Lamm, S. Lawrence, and Y. Yamauchi, “Suppressing Coherent Gauge Drift in Quantum Simulations,” May 2020. arXiv: [2005.12688 \[quant-ph\]](#).

- [15] S. Lawrence and Z. Rogoszinski, “The Brute-Force Search for Planet Nine,” *arXiv e-prints*, arXiv:2004.14980, arXiv:2004.14980, Apr. 2020. DOI: [10.48550/arXiv.2004.14980](https://doi.org/10.48550/arXiv.2004.14980). arXiv: [2004.14980](https://arxiv.org/abs/2004.14980) [[astro-ph.EP](#)].
- [14] S. Harmalkar, H. Lamm, and S. Lawrence, “Quantum Simulation of Field Theories Without State Preparation,” Jan. 2020. arXiv: [2001.11490](https://arxiv.org/abs/2001.11490) [[hep-lat](#)].
- [13] A. Alexandru, P. F. Bedaque, and S. Lawrence, “Quantum algorithms for disordered physics,” *Phys. Rev. A*, vol. 101, no. 3, p. 032 325, 2020. DOI: [10.1103/PhysRevA.101.032325](https://doi.org/10.1103/PhysRevA.101.032325). arXiv: [1911.11117](https://arxiv.org/abs/1911.11117) [[cond-mat.dis-nn](#)].
- [12] H. Lamm, S. Lawrence, and Y. Yamauchi, “Parton physics on a quantum computer,” *Phys. Rev. Res.*, vol. 2, no. 1, p. 013 272, 2020. DOI: [10.1103/PhysRevResearch.2.013272](https://doi.org/10.1103/PhysRevResearch.2.013272). arXiv: [1908.10439](https://arxiv.org/abs/1908.10439) [[hep-lat](#)].
- [11] A. Alexandru, P. F. Bedaque, S. Harmalkar, H. Lamm, S. Lawrence, and N. C. Warrington, “Gluon Field Digitization for Quantum Computers,” *Phys. Rev. D*, vol. 100, no. 11, p. 114 501, 2019. DOI: [10.1103/PhysRevD.100.114501](https://doi.org/10.1103/PhysRevD.100.114501). arXiv: [1906.11213](https://arxiv.org/abs/1906.11213) [[hep-lat](#)].
- [10] H. Lamm, S. Lawrence, and Y. Yamauchi, “General Methods for Digital Quantum Simulation of Gauge Theories,” *Phys. Rev. D*, vol. 100, no. 3, p. 034 518, 2019. DOI: [10.1103/PhysRevD.100.034518](https://doi.org/10.1103/PhysRevD.100.034518). arXiv: [1903.08807](https://arxiv.org/abs/1903.08807) [[hep-lat](#)].
- [9] A. Alexandru, P. F. Bedaque, H. Lamm, and S. Lawrence, “ σ models on quantum computers,” *Phys. Rev. Lett.*, vol. 123, no. 9, p. 090 501, 2019. DOI: [10.1103/PhysRevLett.123.090501](https://doi.org/10.1103/PhysRevLett.123.090501). arXiv: [1903.06577](https://arxiv.org/abs/1903.06577) [[hep-lat](#)].
- [8] A. Alexandru, P. F. Bedaque, H. Lamm, S. Lawrence, and N. C. Warrington, “Fermions at Finite Density in 2+1 Dimensions with Sign-Optimized Manifolds,” *Phys. Rev. Lett.*, vol. 121, no. 19, p. 191 602, 2018. DOI: [10.1103/PhysRevLett.121.191602](https://doi.org/10.1103/PhysRevLett.121.191602). arXiv: [1808.09799](https://arxiv.org/abs/1808.09799) [[hep-lat](#)].
- [7] A. Alexandru, G. Başar, P. F. Bedaque, H. Lamm, and S. Lawrence, “Finite Density QED_{1+1} Near Lefschetz Thimbles,” *Phys. Rev. D*, vol. 98, no. 3, p. 034 506, 2018. DOI: [10.1103/PhysRevD.98.034506](https://doi.org/10.1103/PhysRevD.98.034506). arXiv: [1807.02027](https://arxiv.org/abs/1807.02027) [[hep-lat](#)].
- [6] H. Lamm and S. Lawrence, “Simulation of Nonequilibrium Dynamics on a Quantum Computer,” *Phys. Rev. Lett.*, vol. 121, no. 17, p. 170 501, 2018. DOI: [10.1103/PhysRevLett.121.170501](https://doi.org/10.1103/PhysRevLett.121.170501). arXiv: [1806.06649](https://arxiv.org/abs/1806.06649) [[quant-ph](#)].
- [5] A. Alexandru, P. F. Bedaque, H. Lamm, and S. Lawrence, “Finite-Density Monte Carlo Calculations on Sign-Optimized Manifolds,” *Phys. Rev. D*, vol. 97, no. 9, p. 094 510, 2018. DOI: [10.1103/PhysRevD.97.094510](https://doi.org/10.1103/PhysRevD.97.094510). arXiv: [1804.00697](https://arxiv.org/abs/1804.00697) [[hep-lat](#)].
- [4] A. Alexandru, P. F. Bedaque, H. Lamm, and S. Lawrence, “Deep Learning Beyond Lefschetz Thimbles,” *Phys. Rev. D*, vol. 96, no. 9, p. 094 505, 2017. DOI: [10.1103/PhysRevD.96.094505](https://doi.org/10.1103/PhysRevD.96.094505). arXiv: [1709.01971](https://arxiv.org/abs/1709.01971) [[hep-lat](#)].
- [3] S. Lawrence, J. G. Tervala, P. F. Bedaque, and M. C. Miller, “An Upper Bound on Neutron Star Masses from Models of Short Gamma-ray Bursts,” *Astrophys. J.*, vol. 808, p. 186, 2015. DOI: [10.1088/0004-637X/808/2/186](https://doi.org/10.1088/0004-637X/808/2/186). arXiv: [1505.00231](https://arxiv.org/abs/1505.00231) [[astro-ph.HE](#)].

- [2] S. Lawrence, Q. Liu, and V. M. Yakovenko, “Global inequality in energy consumption from 1980 to 2010,” *Entropy*, vol. 15, pp. 5565–5579, 2013. DOI: [10.3390/e15125565](https://doi.org/10.3390/e15125565). arXiv: [1312.6443](https://arxiv.org/abs/1312.6443) [[physics.data-an](#)].
- [1] C. Brust, A. Katz, S. Lawrence, and R. Sundrum, “SUSY, the Third Generation and the LHC,” *JHEP*, vol. 03, p. 103, 2012. DOI: [10.1007/JHEP03\(2012\)103](https://doi.org/10.1007/JHEP03(2012)103). arXiv: [1110.6670](https://arxiv.org/abs/1110.6670) [[hep-ph](#)].

PROCEEDINGS

- [5] S. Lawrence, “Machine-learning approaches to accelerating lattice simulations,” *PoS*, vol. LATTICE2024, p. 010, 2025. DOI: [10.22323/1.466.0010](https://doi.org/10.22323/1.466.0010). arXiv: [2502.02670](https://arxiv.org/abs/2502.02670) [[hep-lat](#)].
- [4] S. Lawrence, “Real-time dynamics from convex geometry,” *PoS*, vol. LATTICE2024, p. 057, 2025. DOI: [10.22323/1.466.0057](https://doi.org/10.22323/1.466.0057). arXiv: [2502.01880](https://arxiv.org/abs/2502.01880) [[hep-lat](#)].
- [3] S. Lawrence, “Real-Time Dynamics At Large N ,” *PoS*, vol. LATTICE2021, p. 518, 2022. DOI: [10.22323/1.396.0518](https://doi.org/10.22323/1.396.0518). arXiv: [2112.15016](https://arxiv.org/abs/2112.15016) [[hep-lat](#)].
- [2] Y. Yamauchi and S. Lawrence, “Normalizing flows for the real-time sign problem,” *PoS*, vol. LATTICE2021, p. 621, 2022. DOI: [10.22323/1.396.0621](https://doi.org/10.22323/1.396.0621). arXiv: [2112.15035](https://arxiv.org/abs/2112.15035) [[hep-lat](#)].
- [1] S. Lawrence, “Beyond Thimbles: Sign-Optimized Manifolds for Finite Density,” *PoS*, vol. LATTICE2018, p. 149, 2018. DOI: [10.22323/1.334.0149](https://doi.org/10.22323/1.334.0149). arXiv: [1810.06529](https://arxiv.org/abs/1810.06529) [[hep-lat](#)].

TALKS

- [10] S. Lawrence, “Machine learning approaches to accelerating lattice simulations,” Plenary at Lattice 2024, Aug. 2024.
- [9] S. Lawrence, “Real-time dynamics from convex geometry,” Lattice 2024, Aug. 2024.
- [8] S. Lawrence, “Aspects of large- N_f quantum field theories,” Seminar at Keio University, Oct. 2023.
- [7] S. Lawrence, “Machine learning approaches for sign and signal-to-noise problems,” Santa Fe workshop on “Lattice QCD and Probes of New Physics”, Aug. 2023.
- [6] S. Lawrence, “Machines learning to solve sign problems,” SIGN’22 at Tel Aviv University, 2022.
- [5] S. Lawrence, “Sign problems, contour deformations, and computational complexity,” Seminar, CU Boulder, 2021.
- [4] S. Lawrence, “The quantum computer in the s-matrix,” YITP, 2021.
- [3] S. Lawrence, “Quantum simulation of gauge theory,” Seminar, the George Washington University, 2019.
- [2] S. Lawrence, “Beyond thimbles: Integration contours to solve a sign problem,” Nuclear theory seminar, University of Maryland, 2018.
- [1] S. Lawrence, “Approximating waveforms of rapidly rotating neutron stars,” 21st International Conference On General Relativity and Gravitation, 2016.