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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

- [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](https://doi.org/10.1103/PhysRevD.110.014508). arXiv: [2311.13002](https://arxiv.org/abs/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](https://doi.org/10.1103/PhysRevD.109.L031505). arXiv: [2307.14950](https://arxiv.org/abs/2307.14950) [[hep-lat](#)].
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- [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](https://doi.org/10.1103/PhysRevD.107.094511). arXiv: [2211.08874](https://arxiv.org/abs/2211.08874) [[hep-lat](#)].
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- [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](https://doi.org/10.1103/PhysRevD.106.114503). arXiv: [2205.12303](https://arxiv.org/abs/2205.12303) [[hep-lat](#)].
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- [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](https://doi.org/10.1103/PhysRevD.103.114509). arXiv: [2101.05755](https://arxiv.org/abs/2101.05755) [[hep-lat](#)].
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- [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](https://doi.org/10.1103/PhysRevC.102.065206). arXiv: [2006.14545](https://arxiv.org/abs/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](https://arxiv.org/abs/2006.03683) [[hep-lat](#)].
- [16] H. Lamm, S. Lawrence, and Y. Yamauchi, “Suppressing Coherent Gauge Drift in Quantum Simulations,” May 2020. arXiv: [2005.12688](https://arxiv.org/abs/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](#)].
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- [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. 191602, 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](#)].
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- [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. 094510, 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](#)].
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## PROCEEDINGS

- [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](#)].
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## 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.