Sriram Bharadwaj

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Education

University of California, Los Angeles — *Sept 2021 – June 2027 (anticipated)*
PhD in Theoretical Physics

- Awarded "UCLA Robert Finkelstein Fellowship in Theoretical Physics"
- Coursework: ML for Physics, AI and Quantum Information Theory, QFT, String Theory, core physics
- **PhD advisors**: Leo Zhou (Electrical/Computer Engineering), Eric D'Hoker (Physics)
- **Academic Mentor**: Di Luo (Electrical/Computer Engineering)

University of Oxford — *Oct 2020 – Sept 2021*
MSc in Mathematical and Theoretical Physics

- Graduated with distinction and completed a double-unit master's dissertation on string amplitudes

University of California, Los Angeles — *Sept 2017 – Sept 2020*
BS in Mathematics and Applied Science

- Graduated *summa cum laude* and was on Dean's honors list every quarter

Languages: Python (PyTorch, NumPy, SciPy, etc), MATLAB, Mathematica, C++, LaTeX

Research Interests

- **Quantum Algorithms.** Developing efficient quantum algorithms for optimization problems, and simulations of many-body systems on quantum hardware. (See work on CV-QAOA and VQE for lattice gauge theory).
- **Quantum Simulations of Many-Body Systems.** Studying many-body physics that is inaccessible via classical methods through quantum simulations (See work on quantum simulations of topological phases.)
- **Quantum State Learning.** Applying tools from machine learning to many-body systems including lattice gauge theories, using tools from physics to analyze representation power of neural networks. (See work on Scaling Laws for Neural Networks.)

Publications (in reverse chronological order)

Information-Theoretic Scaling Laws of Neural Quantum States — *Mar 2026*
with Y. Lu, D. Rathore, D. Luo arXiv:2603.23468, Phys. Rev. Lett. to appear

- Systematic study of the representation power of Transformer and RNNs applied to quantum state learning
- Prove superiority of NNs over tensor networks for states with (sub-)volume dephased mutual information
- Derive information theoretic scaling laws for a broad set of many-body systems which have (sub-)volume dephased mutual information and benchmark representation power of NNs
- Detailed examples studied include stabilizer states, Rokhsar–Kivelson states, Toric code, finite-temperature transverse-field Ising model

Hamiltonian Formulation of Lattice QED_3 with One and Two Flavors of Wilson Fermions: Topological Structure and Response — *Mar 2026*
with D. Luo, L. Funcke, et al, arXiv: 2603.05616, Phys. Rev. D to appear

- Non-trivially extends the analysis of arXiv: 2504.21828 to include dynamical U(1) gauge fields
- Investigates *classically non-simulable* regime via Hamiltonian formulation
- Groundwork for quantum simulations
- Analyze topological phase diagram at finite density with one and two fermion flavors; *cannot* be done via classical simulations due to sign problem
- Maps topological phase diagram at finite gauge coupling
- Identifies order-parameters for topological phase transitions in near-term quantum simulations via VQE

A Path to Quantum Simulations of Topological Phases: (2+1)D Quantum Electrodynamics with Wilson Fermions *April 2025*
with D. Luo, L. Funcke, et al, arXiv: 2504.21828, Phys. Rev. Lett. to appear

- Establish that "staggered fermion" classical/quantum simulations fail to simulate novel topological phases
- Propose an alternative formulation with Wilson fermions, which faithfully captures topological phases
- Proof of concept exact diagonalization to show feasibility of simulation on near-term quantum devices

Non-invertible defects on the worldsheet *Sept 2024*
with P. Niro and K. Roumpedakis, published in *JHEP* 03 (2025) 164

Approaching Argyres-Douglas Theories *June 2024*
with Eric D'Hoker, published in *JHEP* 06 (2024) 082

Selected ongoing research (in order of planned submission)

CV-QAOA: Efficient Low-depth Continuous Quantum Optimization *with Di Luo and Leo Zhou*

- CV-QAOA: novel low-overhead quantum optimization algorithm for tackling high-dimensional problems
- Versatility and ease of implementation inherited from the discrete QAOA
- Super-polynomial speed-ups in non-convex optimization relative to best known classical algorithms
- Provable instances of black-box query complexity separation between classical and quantum algorithms
- Semi-finalist: **XPrize Quantum Applications** (top 20 of 133 submissions)

Simulating Topological Phases on a Quantum Computer Using VQE *with Di Luo et al.*

- VQE simulation of topological phases using the Hamiltonian formulation developed in arXiv: 2504.21828
- Prepare the ground state of Wilson Fermions coupled to U(1) gauge fields using a QAOA-inspired ansatz
- Gives rigorous estimates of necessary gate-complexity
- Run simulation on real quantum device to experimentally check the phase diagram in arXiv: 2504.21828
- Demonstrate the ability of quantum computers to simulate novel topological phases of matter

List of presentations (in reverse chronological order)

- "Quantum Simulations of Topological Phases in (2+1)D Lattice Gauge Theory" (see arXiv: 2504.21828)
  1. Poster: "QuantHEP 2025", Lawrence Berkeley National Laboratory (Oct 2025).
  2. Contributed talk: NSF Institute for Artificial Intelligence and Fundamental Interactions (IAIFI) Summer School, Harvard (Aug 2025).
  3. Invited talk: "Probing the frontiers of nuclear physics with AI at the EIC (II)", Stony Brook (Mar 2025).
- Contributed talk: "2024 IHES Summer School - Symmetries and Anomalies: a Modern Take", IHES, France (June 2024) about "Non-invertible symmetries on the worldsheet" based on *JHEP* 03 (2025) 164.
- Pedagogical presentations in the High-Energy Theory Journal Club at UCLA.
  1. Anomalies and instantons in gauge theory (2024)
  2. Quantum information theory and entanglement entropy in gravity (2023)
  3. Aspects of confining strings in gauge theory (2022)

List of Summer/Winter schools (in reverse chronological order)

- Quantum Winter School 2026: Quantum Simulation at Institute for Pure and Applied Mathematics, UCLA
- IAIFI Summer School 2025, Harvard University
- 2024 Summer School on Symmetries and Anomalies, IHES, France

References

- Leo Zhou, Assistant Professor of Electrical and Computer Engineering, UCLA, ✉ leoxzhou@ucla.edu
- Di Luo, Associate Professor of Physics, Tsinghua (formerly Prof. at UCLA ECE), ✉ diluo@tsinghua.edu.cn
- Eric D'Hoker, Distinguished Research Professor in Theoretical Physics, UCLA, ✉ dhoker@physics.ucla.edu

Teaching Experience

- Was a teaching assistant for 10+ undergraduate courses, both elementary and advanced
- Appointed as lead teaching assistant to manage and update a course with over 900 students