

Leo Shaposhnik

replicawormhole.github.io | github.com/ReplicaWormhole | linkedin.com/in/leo-shaposhnik

Professional Experience

PhD Researcher in Theoretical Physics with Alexander Jahn and Jens Eisert

Berlin, Germany

Freie Universität Berlin

04/2023 – present

Quantitative Research and Scientific Computing

- Conduct research at the intersection of quantum information theory, quantum computing, tensor networks and high-energy physics.
- Developed a formalism for stabilizer quantum error correction in infinite-dimensional Hilbert spaces.
- Discovered an extension of the toric code applicable to the study of quantum gravity.
- Estimate magic-resource requirements for quantum simulation of relativistic vacuum states.
- Used the ZX-calculus to understand the relevance of magic in quantum many-body systems.
- Discovered a framework to study emergence in holographic quantum-error correcting codes.
- Proved that in certain systems low-energy observers cannot measure the emergence of spacetime.
- Use advanced mathematics, numerical methods, and proof-based research methods in theoretical physics.

AI and Computation

- Extensive use of AI agents for theoretical research (proof generation, exploration, adversarial review, coding).
- More than three years of experience reviewing AI-generated theoretical work and identifying errors.
- Design multi-agent systems that coordinate specialist agents for autonomous research on open-ended scientific problems.
- Build multi-agent systems for human-machine research collaborations.
- Use AI agents (Codex, Aristotle) to formalize my work in Lean 4.
- Implement high-performance code for the simulation of many-body systems on HPC clusters.

Leadership and Teaching

- Lead distributed collaborations from the initial idea through publication.
- Co-organize a weekly seminar on quantum many-body physics.
- Teach courses on quantum information, quantum mechanics and gravity.

IT Consultant

Berlin, Germany

d-fine GmbH

11/2021 – 03/2023

- Owned a core software component of a production-grade IFRS 17 reporting backend for an international reinsurer.
- Worked remotely in an agile environment with a large distributed team (50+ team members).
- Coordinated feature planning and implementation with client stakeholders.
- Managed databases using SQL Server.
- Performed regression and release testing.
- Project organization, version control, and CI/CD with Git and Azure DevOps.

Working Student — Mathematical Modeling, Numerical Simulation, and Data Analysis

Berlin, Germany

Physikalisch-Technische Bundesanstalt (PTB)

07/2020 – 10/2021

- Research on numerical effects in classical chaotic systems.
- Collaborated with senior postdocs on problems in theoretical physics.
- Discovered theoretical models that explain roundoff-induced effects in classical chaotic systems.
- Implemented code for the high-precision long-time simulations of chaotic systems on an HPC cluster.

Working Student

Zeuthen, Germany

DESY

03/2017 – 06/2020

- Designed and set up optical experiments to measure radiation damage in optical components for a linear accelerator.
- Analyzed the concentration of radioactive material in accelerator components with MATLAB.

Education

Master's Degree — Physics (Avg. Grade: 1.0 / GPA: 4.0)

Berlin, Germany

Humboldt-Universität zu Berlin / Albert Einstein Institute

10/2019 – 02/2022

Thesis on entanglement entropy in curved spacetime, including analytical derivations and numerical validation using tensor network techniques.

Bachelor's Degree — Physics (Avg. Grade: 1.7 / GPA: 3.3)

Berlin, Germany

Humboldt-Universität zu Berlin

10/2016 – 09/2019

Thesis on Hopf-algebraic structures underlying perturbative renormalization in quantum field theory.

Publications

- **On Infinite Tensor Networks, Complementary Recovery and Type II Factors.** W. Chemissany, E. Gesteau, A. Jahn, D. Murphy, **L. Shaposhnik**. J. Phys. A 58 (2025) 435301.
- **Searching for Emergent Spacetime in Spin Glasses.** D. Saraidaris, **L. Shaposhnik**. JHEP 04 (2026) 032.

Preprints

- **Entanglement Entropy, Local IR/UV Connection and MPS in Weyl-deformed Geometries.** **L. Shaposhnik**. arXiv:2211.16430 [hep-th] (2022).

Awards & Honors

- Honorable mention for my poster “On Infinite Tensor Networks, Complementary Recovery and Type II Factors”. IQQG 2025, Perimeter Institute.

Technical Skills

- **Mathematical and statistical methods:** probability theory, statistics, linear algebra, numerical analysis.
- **Programming and quantitative computing:** Python, SciPy, pandas, C++, Julia, MATLAB, Wolfram Language.
- **Data and software engineering:** SQL, SAS, Git, GitHub, Azure DevOps, CI/CD.
- **High-performance computing and formal methods:** Linux, Slurm, Lean 4.
- **Scientific AI tools:** PyTorch, Qiskit, LangGraph, Model Context Protocol (MCP), retrieval-augmented generation (RAG).

Languages

- **English** (Fluent)
- **German** (Native)
- **Russian** (Native)
- **Ukrainian** (Beginner)

Selected Computational Projects

A selection of recent side projects in research and research automation.

- **Large N spin-glass solver (GitHub):** A Python framework for studying chaos in the quantum p -spin model across its spin-glass transition and the model’s relation to the large N spectral function.
- **A simple model of string fields in Lean 4 (GitHub):** Sorry-free formalization of a simple model of string field theory given by an infinite collection of free scalar fields, enabling verified agentic exploration for a future benchmark.
- **Codex–Aristotle auto-formalization loop (GitHub):** Multi-agent workflow to enable collaboration between Codex and Aristotle for the auto-formalization of parts of the theory of operator algebras for an ongoing research project.
- **Autonomous research harness (GitHub):** Adversarial automated research workflow for a problem in quantum information theory.

Talks & Posters

- **Observers and algebras in quantum gravity.** Talk, DPG Frühjahrsfachtagung, 18 Mar 2024.
- **Chaos and emergent algebras.** Talk, AG Eisert group meeting (FU Berlin), 11 Jan 2025.
- **On Infinite Tensor Networks, Complementary Recovery and Type II Factors.** Invited Talk, Information, Geometry & Physics Seminar (Caltech), 18 Jun 2025.
- **On Infinite Tensor Networks, Complementary Recovery and Type II Factors.** Poster, IQQG 2025 (Perimeter Institute), 23–27 Jun 2025.
- **On Infinite Tensor Networks, Complementary Recovery and Type II Factors.** Talk, Panorama of Tensor Networks 2025 (Jagiellonian University, Krakow), 5–10 Oct 2025.
- **Searching for emergent spacetime in spin glasses.** Talk, AG Eisert group meeting (FU Berlin), 27 Nov 2025.
- **On Infinite Tensor Networks, Complementary Recovery and Type II Factors.** Talk, When Quantum Field Theory meets Quantum Information 2025 (UC3M, Madrid), 14–17 Dec 2025.