Karpur Shukla

Graduate Research Assistant, Department of Fluids and Thermal Sciences, Brown University

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300 Wedgewood Road, Morganville, New Jersey, 07751 • U.S. Citizen (native-born), Overseas Citizen of India

Education and Awards

Doctor of Philosophy: Department of Fluids and Thermal Sciences, School of Engineering, Brown University — *May 2028 (Anticipated)*

Master of Engineering: Department of Fluids and Thermal Sciences, School of Engineering, Brown University — *May 2024 (Anticipated)*

Current GPA: 4.00 / 4.00

Master of Science: Department of Physics, Carnegie Mellon University — *May 2016*

- *GPA*: 3.28 / 4.00
- *Awards:* Associate Member, Sigma Xi (Scientific Research Honors Society)

Bachelor of Science: Department of Physics, Carnegie Mellon University — *May 2014*

- *Awards:* Science and Humanities Scholar
  Senior Leadership Award, Department of Physics, Carnegie Mellon University

Publications

Thermodynamic Length for Multiple Asymptotic States

(2024, expected, in preparation)

Karpur Shukla and Michael P. Frank

Chirality-Induced Spin Selectivity from the Curved-Spacetime Fermionic Axial Anomaly

(2023, expected, in preparation)

Karpur Shukla and Tucker Manton

Quantum Foundations of Classical Reversible Computing

Entropy **23**, *6*, 701 (2021). Invited article; Feature Article; cover article (June 2021 volume).

Michael P. Frank and **Karpur Shukla**

Special Session: Exploring the Ultimate Limits of Adiabatic Circuits

Proc. IEEE 38th Intl. Conf. Comp. Design **1**, 21 (2020).

Michael P. Frank, Robert Brocato, Tom Conte, Anirudh Jain, Nancy Missert, **Karpur Shukla**, Brian Tierney

Synergistic Biophysical Techniques Reveal Structural Interactions of Engineered Cationic Antimicrobial Peptides with Membrane Mimics

Chemistry – A European Journal **26**, 6247 (2020).

Frank Heinrich, Aria Salyapongse, Akari Kumagai, Fernando G. Dupuy, **Karpur Shukla**, Anja Penke, Daniel Husterd, Robert K. Ernst, Anna Pavlova, James C. Gumbart, Berthony Deslouches, Peter Y. Di, Stephanie Tristram-Nagle

Invited, Workshop, and Conference Talks

Exploring Fundamental Limits of Reversible Computing Technologies from Nonequilibrium Quantum Thermodynamics [🔗] — *Mar. 2022*

Authors: Michael P. Frank, **Karpur Shukla**

Invited talk, *APS March Meeting 2022, Session T42: Thermodynamics of Quantum Information Processing*

Host: American Physical Society

The Reversible Computing Scaling Path: Challenges and Opportunities [🔗] — *Feb. 2022*

Authors: Michael P. Frank, Hannah Earley, **Karpur Shukla**

Invited talk, *2022 Energy Consequences of Information Workshop*

Host: U.S. Air Force Office of Scientific Research and U.S. Air Force Research Laboratory

Interplay of Negative Quantum and Ferroelectric Capacitances for Low-Power Transistor Operations — *Apr. 2021*

Authors: **Karpur Shukla**, Meng-Ju (Mark) Yu, Jimmy Xu

Submitted talk, *2021 Materials Research Society Spring Meeting*

Host: Materials Research Society

Foundations of the Lindbladian Approach to Adiabatic and Reversible Computing [🔗, 📹] — *Oct. 2020*

Plenary talk, *Physics & Engineering Issues in Adiabatic/Reversible Classical Computing Workshop*

Host: Computing Research Association

Nonequilibrium Dynamics and Superadiabatic Fluxon Motion for Reversible Computing [🔗] — *Feb. 2020*

Invited talk

Host: Center for Computing Research, Sandia National Laboratories

Pathfinding Thermodynamically Reversible Quantum Computation [🔗] — *Jan. 2020*

Authors: **Karpur Shukla**, Michael P. Frank

Invited talk, *NSF Quantum Leap Challenge Institute Workshop on the Identification and Control of Fundamental Properties of Quantum Systems*

Host: Department of Physics, Brown University

Review of Holographic Second Laws for Conformal Field Theories Out of Equilibrium [🔗, 📹] — *Mar. 2019*

Submitted talk, *II Workshop on Quantum Information and Thermodynamics*

Host: International Institute of Physics, Federal University of Rio Grande do Norte

Nonequilibrium Disorder Operators and Topological Quantum Computation — *Aug. 2017*

Invited talk, *Thermodynamics and Computation: Towards a New Synthesis*

Host: Thermodynamics of Computation Group, Santa Fe Institute

Physical Aspects of Topological Quantum Computation — *Aug. 2017*

Invited talk

Host: Center for Computing Research, Sandia National Laboratories

Grants and Contracts Awarded

- **Sandia National Laboratories Purchase Order 2489418, 0**: ($30k total for 4 months)
- **Sandia National Laboratories Purchase Order 2178181, 0**: ($50k/yr. for 3 years)
  - Includes **Advanced Simulation and Computing Grant** ($30k/yr. for 3 years), National Nuclear Security Administration

Peer-Reviewed Position Papers

Fundamental Thermodynamic Limits of Classical Reversible Computing via Open Quantum Systems
(Position paper for the Physics & Engineering Issues in Adiabatic/Reversible Classical Computing Workshop, Oct. 2020)
Karpur Shukla, Victor V. Albert, Michael P. Frank, Jimmy Xu

Posters

Thermodynamic Dissipation Bounds on Classical and Quantum Reversible Information Processing — *Feb. 2020*
Authors: **Karpur Shukla**, Michael P. Frank
Submitted poster, 22nd Southwest Quantum Information and Technology Conference
Host: Center for Quantum Information and Control, University of New Mexico

Information Flows in Reversible Computing Out of Equilibrium, with Applications to Models of Topological Quantum Computing — *Feb. 2019*
Authors: **Karpur Shukla**, Michael P. Frank
Submitted poster, 21st Southwest Quantum Information and Technology Conference
Host: Center for Quantum Information and Control, University of New Mexico

Scientific Community Service and Outreach

- **Co-interviewed** alongside Michael P. Frank on the *It's About Time* podcast, regarding "Reversible Computing and Digital Technology Trends" (Dec. 2022) [🔊]
- **Member, Organizing Committee**, *Physics & Engineering Issues in Adiabatic/Reversible Classical Computing Workshop* (Host: Computing Research Association; 2020)

Work and Research Experience

Graduate Research Assistant: School of Engineering, Brown University
Aug. 2020 – Present (Medical Leave: May 2021 – Aug. 2023)

Visiting Professor: Department of Applied Mathematics, Flame University
Dec. 2017 – Aug. 2020

Research Assistant: Biological Physics Group, Carnegie Mellon University
Jan. 2016 – May 2016

Research Assistant: Quantum Condensed Matter Theory Group, Carnegie Mellon University
Aug. 2013 – Dec. 2013

Programming Languages and Software Packages

- Mathematica 12 {intermediate}
- Python *(with NumPy, SciPy, and Matplotlib)* {beginner}
- MATLAB / Octave {beginner}
- Origin 2020 {beginner}

Natural Languages

- English {fluent}
- Hindi {intermediate}
- Gujarati {intermediate}
- Spanish {beginner}