Jeffrey Morais

Github

Quantum Computing ⊗ Topology

Educational Background

Fall 2024 **M.Sc. in Physics**, *University of Victoria*, Victoria, Canada.

◇ **Thesis Advisor:** Prof. Kristan Jensen.

◇ **Thesis Title:** Quantum virtual cooling via many-body holographic systems of qubits.

2019 - 2023 **B.Sc. in Honours Physics**, *McGill University*, Montréal, Canada. (GPA: 3.84/4.0)

◇ **Thesis Advisor:** Prof. Keshav Dasgupta.

◇ **Thesis Title:** de Sitter cosmology compactifications in quantum gravity.

Research Experience

Present **Researcher**, *University of Victoria*, Victoria, Canada

Studying strong correlations in entangled copies of qubit systems for accessing lower temperature regimes of quantum computation. We make use of the holographic frameworks of AdS/CFT to protect these cooling algorithms with holographic quantum error correction codes on scalable systems.

Supervisor: Prof. Kristan Jensen

Present **Head of Quantum Software**, *BTQ*, Vancouver, Canada

Using persistent homology and topological data analysis techniques to make proof protocols more robust and scalable in entangled quantum systems, such as quantum key distribution (QKD) networks. We characterize the autonomous evolution and interaction of these networks by studying their topology at different grained length scales.

Collaborators: Prof. Gavin Brennen, Dr. Peter Rohde

2023 - 2024 **Researcher**, *Fudan University*, Shanghai, China

Using topological quantum neural networks to address the issue of generalization in deep neural networks and make quantum algorithms more efficient. We characterize the networks with the use of topological quantum field theory, a monoidal functor from the (∞, n)-category of cobordisms to the category of vector spaces.

Supervisors: Prof. Antonino Marcianò, Prof. Emanuele Zappala

Summer 2023 **Undergraduate Researcher**, *NSERC, University of Alberta*, Edmonton, Canada

Study of the extended entanglement structure of entangled qubit systems with non-perturbative topological wormhole corrections. We use this to describe the structure of tunneling events at a finer scale to perform quantum algorithms in lattice confined systems of qubits.

Supervisor: Prof. Igor Boettcher

2022 - 2023 **Honours Bachelor Thesis**, *McGill University*, Montréal, Canada

Study of the problematic non-existence of vacua with de Sitter isometries occurring in type II string theory and M-theory. We studied generalized coherent states over supersymmetric Minkowski space with these isometries to allow for non-singular compactifications to the de Sitter spacetime, a candidate to model our Lorentzian universe.

Supervisor: Prof. Keshav Dasgupta

Summer 2022 **Undergraduate Researcher**, *NSERC, McGill University*, Montréal, Canada

Characterization of U(1) topological defect — cosmic string — signals occurring in a class of renormalizable quantum field theories. We developed statistics to extract these signals from primordial ΛCDM background noise in 21cm inflationary cosmology.

Supervisor: Prof. Robert Brandenberger

Spring 2022 **Undergraduate Researcher**, *McGill University*, Montréal, Canada

Study of the interaction of light and the dynamical Casimir effect occurring in photon recycling via scalar quantum field theory. We computed the quantum corrections to the radiation force for light propulsion with relativistically moving boundary conditions for the mirrors.

Supervisors: Prof. Simon Caron-Huot, Prof. Andrew Higgins

Fall 2021 **Undergraduate Researcher**, *McGill University*, Montréal, Canada

Numerical computations of scintillation densities for fast radio bursts and their corresponding black-white hole tunneling events in quantum cosmology. The fast radio burst signals are embedded in non-linear cosmological noise given by primordial perturbations.

Supervisor: Prof. Victoria Kaspi

Summer 2021 **Undergraduate Researcher**, *McGill University Health Center*, Montréal, Canada

Construction and training of models administering tumour suppressing radiation with neural networks. We investigated dose volume tensor estimation models with helically distributed electromagnetic waves.

Supervisor: Prof. Marija Popovic

Summer 2020 **Undergraduate Researcher**, *SURA, McGill University*, Montréal, Canada

Study of γ-rays and Cherenkov radiation in superluminous supernovae and tidal disruption events with the NASA Fermi-LAT: Unbinned/binned likelihood analyses, upper limit analyses, extended source analyses.

Supervisor: Prof. Kenneth Ragan

2018 - 2019 **Undergraduate Researcher**, *Vanier College*, Montréal, Canada

Numerically solved the quantum Hamilton-Jacobi equations of motion and generated trajectories for de Broglie-Bohm theory with recurrent neural networks and the Crank-Nicolson method.

Supervisor: Prof. Ivan Ivanov

Summer 2018 **Undergraduate Researcher**, *Concordia University*, Montréal, Canada

Study of topological confinement in a nanobeam microcavity. We characterized resonant modes of electromagnetic waves in nano-scale photonic crystal ring resonators with MIT Electromagnetic Equation Propagation.

Supervisor: Prof. Pablo Bianucci

Presentations

July 2023 **8th Interstellar Symposium**, *McGill University*, Montréal, Canada

Presented the effects of light interference and the dynamical Casimir effect in photon recycling via scalar quantum field theory.

May 2019 **Physics & AI Workshop**, *McGill University*, Montréal, Canada

Presented numerically computed quantum Hamilton-Jacobi trajectories for de Broglie–Bohm Theory using recurrent neural networks and the Crank-Nicolson method.

Awards and Distinctions

Fall 2024 **NSERC CREATE - Quantum Computing Program Scholarship**, *University of Victoria, Department of Physics.*

Fall 2024 **BCGS - British Columbia Graduate Scholarship**, *University of Victoria, Department of Physics.*

Fall 2024 **UVic FGS - University of Victoria Fellowship - Master's**, *University of Victoria, Department of Physics.*

May 2023 **NSERC USRA - Undergraduate Student Research Award + FRQNT Scholarship Supplement**, *University of Alberta, Department of Physics.*

May 2022 **NSERC USRA - Undergraduate Student Research Award + FRQNT Scholarship Supplement**, *McGill University, Department of Physics.*

May 2021 **BSA - Banner Student Award**, *McGill University Faculty of Medicine, Medical Physics Unit.*

May 2020 **SURA - Science Undergraduate Research Award**, *McGill University, Department of Physics.*

Relevant Extracurricular Activity

2022 - 2023 **Group Seminar**, *Superstring Theory*, Organized a graduate seminar on superstring theory based off modern HEP research papers and textbooks by Kiritsis, & Polchinski.

Spring 2022 **Group Seminar**, *Gauge Theory*, Organized a graduate seminar on non-abelian gauge theory based off Baez's *Gauge Fields, Knots and Gravity* textbook, as well as Kibble's *Classification of Topological Defects and Their Relevance to Cosmology* paper.

Fall 2021 **Physics Hackathon**, *McGill University*, Montréal, Canada

Numerically reproduced the interference pattern in the double slit experiment with path integrals using the Metropolis-Hastings algorithm and Glauber dynamics for the Markov chain Monte Carlo method.