Research Proposal

The application of theoretical quantum gravity models to the development of qubit architectures.

Introduction

There are many approaches being studied in Quantum Gravity, such as loop quantum gravity. The study of geometric models of a quantum nature arising in this context can be used to develop frameworks which model qubits for applications in various areas of quantum technology, such as quantum computing. Specifically, the ideas of holography and tensor networks along with the increased understanding of black hole entropy has lead to advancements in quantum information theory, which, in turn, has lead to advancements in quantum technology.

Research Objective

- Find a meaningful way to apply geometrical approaches in QG to the development of qubit architectures.

  Sub-Objectives

  - Study the use of holography in various related fields and all its possible applications to understand its use in studying black hole thermodynamics with a special focus on the ADS/CFT correspondence
  - Study the use of geometric models of quantum spacetime to model qubit networks and quantum phenomena such as entanglement and decoherence
  - Apply such models of QG to develop quantum logic in a rigorous manner which can be used to perform algorithms in a more efficient manner compared to classical methods.

Background

I pursued a BS in Physics from UCSD with a minor in mathematics, focusing on quantum mechanics and general relativity. I was primarily focused on two research pathways: quantum fluctuations in the early universe and various topics related to general relativity, such as the role of torsion in different formulations of the theory and the implications of the singularity theorems. I authored a paper on the latter, giving an overview and suggesting future implications. I have also independently, but with a professor's review, studied the role of gauge theories in particle physics and attempted to give a geometric description of them, with an implication about a possible theory in quantum gravity.I post these findings on my personal website, https://www.qgspinor.com.

Methodology/Proposed Research Direction

- Understand the use of major concepts in quantum gravity, such as CFT, in formulating consistent models of spacetime and black holes.
- Study the role of noise in negatively affecting both the ability to scale and the ability to accomplish tasks in a more efficient manner than current classical methods.
- Apply various theoretical models from quantum gravity to model qubit behavior, such as entanglement and superposition

- Analyze if such models provide solutions to current challenges while also being theoretically consistent; see how such architectures improve upon currently existing ones.
- Particularly focus on the architecture of topological qubits, which have a natural geometric interpretation akin to the structure of QG models and are directly related to concepts such as gauge theories.

Future Goals

I'm open to pursuing many opportunities in related fields in the future. My complementary goal is to use the insights I gain from this research towards the development of practical quantum architecture, with a focus on designing quantum computers for real-world applications. Completing this research would give me the necessary skills and experience to make this goal a reality.