Statement of Purpose

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Fascinated by the fact that almost all physical phenomena can be concisely reduced to the standard model and general relativity, I decided to join the field of quantum gravity or string theory and contribute as much as I can in reconciling them.

After studying quantum mechanics, in my 2nd year, I studied category theory applications to quantum mechanics with the help of Prof. Rentala (IIT Bombay), specifically to understand no-go theorems.

Later after doing a general relativity course and in parallel to my first quantum field theory course that covered canonical quantization, I studied pre-holography era black hole information paradox, i.e., starting from Hawking radiation up to Page curve & theorem with the help of Prof. Rentala (IIT Bombay). Before this, I did not appreciate other areas of physics and was only interested in areas directly related to quantum gravity and cosmology. However, while studying the information paradox, I realized that fields like quantum information and condensed matter physics help understand quantum gravity, and I started learning them with a newfound appreciation. Later I did an advanced quantum field theory course covering topics such as the path integral approach and renormalization and a particle physics course.

During the summer of 2022, with the help of funding from the Mitacs Globalink Research Internship Award, I worked with Prof. Saurya Das (University of Lethbridge, Canada) on a semi-classical gravity theory obtained by replacing classical geodesics with Bohmian trajectories. In this theory, dark matter and dark energy are naturally unified. I initially clarified some minor subtleties in previous papers by Prof. Das. I later implemented a specific case of this model and estimated the cosmological parameters using Monte Carlo sampling and Planck 2018 data. We hoped this model could explain the Hubble tension, like a few other modified gravity models that did, but unfortunately, it did not.

In the following semester, I started working with Prof. Ramadevi (IIT Bombay) on the information perspective of the AdS/CFT correspondence. In August and September, I extensively studied the AdS/CFT (with a focus on black hole thermodynamics) from a textbook by Năstase. I was already acquainted with some basics of string theory from a preliminary reading of Polchinski and Kiritsis. Later I read several review articles related to the Ryu Takayanagi prescription. Then I read recent papers that generalized the RT formula culminating in the quantum extremal surface prescription and the island formula that resolved the information paradox.

After reading several recent papers on islands in de Sitter spacetimes, I started working on a related research problem. Using a concept called timelike entanglement from information theory papers, I wrote a paper related to timelike entangled islands in FLRW spacetimes with positive cosmological constant. My paper argues that an island at the begging of the universe is timelike entangled with the future Gibbons–Hawking radiation. So, the information about the particles that went beyond the cosmological horizon is not lost for our observer. By measuring the

Gibbons–Hawking radiation, we can get that information from the past when those particles were near the initial singularity. (K. Sreeman Reddy, "*A timelike entangled island at the initial singularity in a JT FLRW (Λ>0) universe*", arXiv:2211.14893 [hep-th])

Even before I started my undergraduate, I knew the names of many approaches to quantum gravity from popular science, but I did not decide which approach I should work on. In my 3rd year, after finding that progress has been mundane in all the other approaches except string theory, I decided to work on string theory as it seemed like the only productive approach to quantum gravity.

I would like to focus my Ph.D. research on two problems: black hole interior and de Sitter holography. To begin with, I plan to study these problems in two dimensions for simplicity. Towards the second half of my Ph.D., I will move on to higher dimensional cases that are more realistic.

These two problems are my main interests. Apart from them, I could work for a few months on short-term research projects related to conformal field theories (CFTs), information theory, and cosmology, all of which will be useful in understanding quantum gravity. I am also interested in the interplay between pure mathematics and string theory, and my strong background due to my undergraduate mathematics minor degree will be helpful.

I am incredibly interested in working with Prof. Andreas Karch. I am more interested in the kinda work that he has been doing recently, such as on double holography, compared to his earlier works related to applications of holography to QCD. Prof. Karch is highly skeptical of the island prescription. Though I worked on the island approach, I am very open-minded and would be very interested in working with him on alternative approaches to the information paradox. I am also very interested in working with Prof. Elena Caceres on understanding to what extent there is a duality between JT gravity and SYK models. I am also interested in working with Prof. Vadim Kaplunovsky on string theory and instantons.

My long-term goal is to become a full professor and conduct substantial research on quantum gravity and its applications to cosmology. Earning a Ph.D. from UT Austin would be a valuable step in achieving my career goals.

I am very determined to contribute to the field of high energy physics, and I am confident that I will be an excellent addition to the vibrant HEP community at UT Austin.