[Title of MS Thesis]

[Name of the Student]

A dissertation submitted for the partial fulfilment of BS-MS dual degree in Science

Indian Institute of Science Education and Research, Mohali

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Certificate of Examination

This is to certify that the dissertation titled **[Title of MS Thesis]** submitted by **Aditya Dev** (Reg. No. MS19022) for the partial fulfillment of BS-MS Dual Degree programme of the institute, has been examined by the thesis committee duly appointed by the institute. The committee finds the work done by the candidate satisfactory and recommends that the report be accepted.

Dr. Abhishek Chaudhuri　　Dr. Ambresh Shivaji　　Dr. Ramandeep S. Johal

Dr. Abhishek Chaudhuri
(Supervisor)

Dated: [Enter Relevant Date]

Declaration

The work presented in this dissertation has been carried out by me under the joint supervision of **Dr. Abhishek Chaudhuri** at the Indian Institute of Science Education and Research, Mohali, and **Prof. Dr. Jan Micheal Rost** at Max Planck Institute for the Physics of Complex Systems, Dresden Germany.

This work has not been submitted in part or in full for a degree, a diploma, or a fellowship to any other university or institute. Whenever contributions of others are involved, every effort is made to indicate this clearly, with due acknowledgment of collaborative research and discussions. This thesis is a bonafide record of my original work, and all sources listed within have been detailed in the bibliography.

Aditya Dev
(Candidate)
Dated: [Enter Relevant Date]

In my capacity as the supervisor of the candidate's project work, I certify that the above statements by the candidate are true to the best of my knowledge.

Dr. Abhishek Chaudhuri
(Supervisor)
Dated: [Enter Relevant Date]

Abstract

Use this section to include an abstract of the thesis.

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Chapter 1

Introduction

> "Our greatest glory is not in never falling, but in rising every time we fall."
>
> Confucius

Unification of Quantum Mechanics and General Relativity has been the Holy Grail of physics for since their inception. But no satisfactory theory has ever been proposed that solves this problem? General relativity states that a physical theory should not depend on background structures. However, standard quantization techniques often rely on background structures, such as imposing the canonical commutation relations. The Hamiltonian of a generally covariant theory, such as general relativity, is constrained to vanish in the absence of boundaries. If one tries to incorporate the theory of general relativity and quantum mechanics i.e in Canonical Quantization of gravity one ends up with a Hamiltonian constraint (i.e. $\hat{\mathbf{H}}\,|\Psi\rangle\!\rangle = 0$). This leads to an infamous problem known as "the problem of time in the canonical approach to quantum gravity. The issue is that quantum states of spacetime (and matter in it) do not seem to undergo any time evolution as dictated by the constraints of the theory.

1.1 Example Section

Include equations if required:

$$i\hbar\frac{\partial\Psi}{\partial t} = -\frac{\hbar^2}{2m}\nabla^2\Psi + \hat{V}\Psi \tag{1.1}$$

$$\nabla\times\boldsymbol{B} = \mu_0\boldsymbol{J} + \mu_0\varepsilon_0\frac{\partial\boldsymbol{E}}{\partial t}$$

The issue is that quantum states [Leggett 87] of spacetime (and matter in it) do not seem to undergo any time evolution as dictated by the constraints of the theory.

Frame Title

However, upon closer inspection, it is clear that the quantum theory is not 'timeless' as often stated. The problem of time is rather a manifestation of background independence and means that physical states do not evolve relative to an external background time. Instead, one must extract a time evolution in a relational manner, i.e. pick some quantised degrees of freedom to serve as an internal time.

$$H = \sum_{k=0}^{N-1} H_k \equiv \sum_{k=0}^{N-1} \hbar\omega_k \sigma_z^{(k)} \tag{1.2}$$

The use of relational time in Quantum Mechanics is a framework in which one promotes all variables to Quantum operators and later chooses one of the variables to operate like a "clock". There are various approaches to the time problem; my work focuses on the "Page-Wootters Formalism" which defines relational dynamics in terms of conditional probabilities for the clock and evolving degrees of freedom.

Include figures if required:

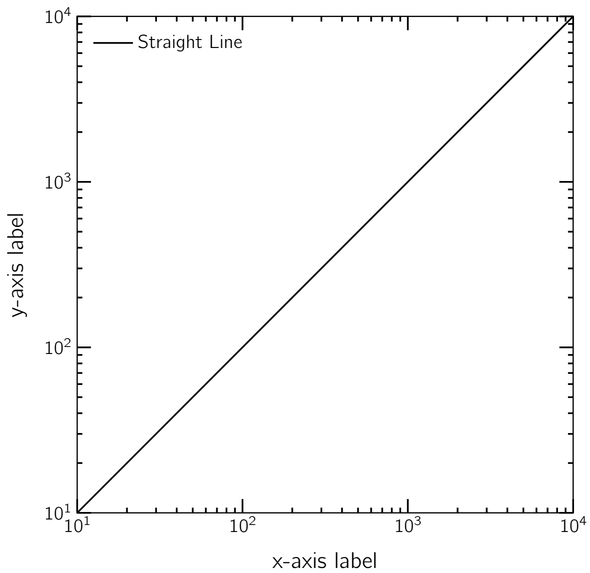

Figure 1.1: Example Figure: Include a caption.

Include tables if required:

Col1	Col2	Col2	Col3
1	2	3	4
5	6	7	8

Table 1.1: Example Table: Include a caption.

To refer to Equations/Figures/Tables, use the `\ref{}` command: Equation 1.1 / Figure 1.1 / Table 1.1. `\ref{}` can also be used to refer to Sections: Section 1.1, Section 1.1.1.

To cite references, use the `\cite{}` command: [Leggett 87]. All cited references will automatically appear in the Bibliography section.

1.1.1 Example Sub-Section

Create a sub-section if required.

Example Sub-Sub-Section

Create a sub-sub-section if required.

Chapter 2

Name of Chapter 2

Include as many chapters as required by using the `\chapter{}` command.

Chapter 3

Summary

Use this section to include a summary of the thesis [Leggett 87].

Appendix A

Name of the Appendix Chapter

If required, include an appendix section.

Bibliography

[Leggett 87] A. J. Leggett, S. Chakravarty, A. T. Dorsey, Matthew P. A. Fisher, Anupam Garg & W. Zwerger. *Dynamics of the dissipative two-state system*. Rev. Mod. Phys., vol. 59, pages 1–85, Jan 1987. [Cited on pages 1, 3, and 5]