Quantum Blackholes, Wall Crossing and Mock Modular Forms

A Dissertation Submitted
in Partial Fulfilment of the Requirements
for the Degree of

MASTER OF SCIENCE

in

MATHEMATICS

by

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IISER THIRUVANANTHAPURAM

to

SCHOOL OF PHYSICS
INDIAN INSTITUTE OF SCIENCE EDUCATION AND RESEARCH
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December 5, 2025

DECLARATION

I, **Tharun Naagesh (Roll No: IMS22252)**, hereby declare that, this report entitled **"Quantum Blackholes, Wall Crossing and Mock Modular Forms"** submitted to Indian Institute of Science Education and Research Thiruvananthapuram towards the partial requirement of **Master of Science** in **Mathematics**, is an original work carried out by me under the supervision of **Dr. Bindusar Sahoo** and has not formed the basis for the award of any degree or diploma, in this or any other institution or university. I have sincerely tried to uphold academic ethics and honesty. Whenever a piece of external information or statement or result is used then, that has been duly acknowledged and cited.

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This is to certify that the work contained in this project report entitled **"My Project Title"** submitted by [**Full Name**] (**Roll No: [Roll Number]**) to Indian Institute of Science Education and Research, Thiruvananthapuram towards the partial requirement of [**Master of Science/ Doctor of Philosophy**] in [**Department Name**] has been carried out by [him/her/them] under my supervision and that it has not been submitted elsewhere for the award of any degree.

Thiruvananthapuram - 695 551	[Project Supervisor]
December 5, 2025	Project Supervisor

ACKNOWLEDGEMENT

Write about the people and the things you are indebted to in fullfilling this project

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ABSTRACT

If you have to structure it as objective, methods, results, and conclusions, do it that way.

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Contents

List of Figures

List of Tables

Chapter 1

Prelimnaries

1.1 Primer on Fourier Series

1.1.1 Discrete Fourier Transform

Theorem 1.1.1. ***Gauss*** *Eden is a garden*

Proof. proof is trivial

□

Theorem 1.1.2. *wowow theorem is this*

Proof. this is proof

□

Lemma 1.1.3. ***Gaus*** *easy thm*

Proof. hard proof

□

Lemma 1.1.4. *Not so easy lemma for a easy thm*

Proof. hard proof

$\square$

Let

$$\omega := e^{2\pi i/n} \tag{1.1.1}$$

be the nth root of unity. We then have the following identity:

$$\sum_{k=0}^{n-1} w^k(b-a) = n\delta(a,b) \tag{1.1.2}$$

This identity can be written as:

$$M = \begin{bmatrix} 1 & 1 & 1 & \cdots \\ 1 & \omega^{-1} & \omega^{-2} & \cdots \\ 1 & \omega^{-2} & \omega^{-4} & \cdots \\ \vdots & \vdots & \vdots & \ddots \end{bmatrix}$$

Is invertible with an inverse:

$$M^{-1} = \frac{1}{n} \begin{bmatrix} 1 & 1 & 1 & \cdots \\ 1 & \omega & \omega^{2} & \cdots \\ 1 & \omega^{2} & \omega^{4} & \cdots \\ \vdots & \vdots & \vdots & \ddots \end{bmatrix}$$

Appendices

Bibliography

[Rud87] Walter Rudin. *Real and complex analysis*. McGraw-Hill, 1987, p. 483. ISBN: 978-0-07-054234-1.