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Field perturbations in general relativity and infinite derivative gravity

Harmesen, Gerhard Erwin

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UNIVERSITY OF THE
WITWATERSRAND,
JOHANNESBURG

Field perturbations in general relativity and infinite derivative gravity

PhD thesis

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University of Groningen
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the decision by the College of Deans.

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the decision by faculty of science

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by

Gerhard Erwin Harmsen

born on 21 August 1992
in Randburg, South Africa

Supervisors

Prof. A. S. Cornell

Prof. A. Mazumdar

Assessment Committee

Prof. B. Mellado

Prof. D. Roest

Prof. V. P. Frovol

Prof. C. Kiefer

Field perturbations in general relativity and infinite derivative gravity

Gerhard Harmsen

Abstract

In the first part of this thesis we will determine the Quasi Normal Modes (QNMs) associated to spin-3/2 fields near higher dimensional Reissner-Nordström black holes, and Schwarzschild black holes which are in higher dimensional (Anti-) de Sitter space times. In order to do this we will present the idea of QNMs, and then show how effective potentials can be obtained for the spin-3/2 fields near the black holes. Where the effective potentials will give us an indication of the fields behaviour near the black hole. We then show that using the effective potential we obtain the numerical values of the QNMs by using numerical approximations. This approach will be used for each of the space times that we are interested in. We then determine what the effects of the electrical charge and asymptotic curvature are on the emitted QNMs. In the case of the electrically charge black hole we also investigate the absorption probabilities of the QNMs.

In the second part of this thesis we investigate how the theory of Infinite Derivative Gravity (IDG) can be used to obtain linear metrics, which are singularity free. In this case we provide a motivation for why we need a modified theory of gravity, such as IDG, and then show how to obtain the action and propagator for this theory. From the action of the IDG we are able to produce a metric for an electrically charged massive point source. After which we obtain the metric for a rotating object with mass. We check that these metrics are indeed non-singular, by checking that the potentials in the metric remain finite in the entire region of the space time. We also ensure that the curvature scalars and tensors are non-singular in the entire region.

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Contents

Abstract

Acknowledgements

1	Introduction	1
1.1	Gravitational waves	4
1.2	QNMs	6
1.3	Higher order derivative theories of gravity	7
I	Quasi normal modes in black hole backgrounds	11
2	Introduction to QNMs	13
2.1	A Mathematical description of QNMs	13
2.2	Spin-3/2 fields	14
2.3	Super covariant derivative	17
2.4	Eigenvalues on the N-Sphere	19
2.4.1	Eigenmodes of spinors on S^N	20
2.4.2	Eigenmodes of spinor-vectors on S^N	21
2.5	Numerical methods	21
2.5.1	WKB Approximation	21
2.5.2	Improved AIM	23
2.6	Absorption probabilities of a black hole	24
3	Electrically charged black holes	27
3.1	Potential function	27
3.1.1	Non-TT eigenfunctions	28
	Equations of motion	28
	Effective potential	29
3.1.2	TT eigenfunctions	32
	Equations of motion	32
	Effective potential	33
3.2	QNMs	35
3.2.1	non-TT eigenfunctions related QNMs	35
3.2.2	TT eigenfunctions related QNMs	36
3.3	Absorption probabilities	39
3.3.1	Non-TT eigenmodes related absorption probabilities	39
3.3.2	TT eigenmodes related	40
4	Black holes in (A)dS space	41
4.1	The effective potential	41
4.1.1	Potential function for the non-TT eigenfunctions	41
	Equations of motion	42

Effective potential	43
The dS space time potentials	45
AdS space time potentials	46
4.1.2 TT eigenspinor potential functions	46
4.2 QNMs	48
4.2.1 QNMs for the non-TT spinors	48
II Infinite derivative Gravity	53
5 Infinite derivative gravity	55
5.1 The linearised action	55
5.2 The linearised field equations	56
5.3 The modified gravitational propagator	58
5.4 The quadratic propagator	59
5.5 Metric of a point particle in IDG	62
6 Electrically charged black holes in modified gravity	65
6.1 Reissner-Nordström metric in Einstein's GR	65
6.2 Linearised metric solution for an electrically charged source in IDG	66
6.2.1 Comparing the IDG and the GR metrics	70
6.3 Curvature tensors	71
7 Rotating black holes in IDG	75
7.1 The Kerr metric	75
7.2 The linearised rotating metric in IDG	76
7.3 Smearing out the ring singularity at the linearised level	77
7.3.1 Computing h_{0i} components for a rotating ring	79
7.4 Rotating metric outside the source: multipole expansion in IDG	82
8 Conclusions	85
8.1 QNMs for spin-3/2 fields	85
8.2 Metrics in IDG	86
A Gamma Matrices	91
B Full expressions of the curvature tensors	93
Bibliography	97