This is the title of a thesis submitted to Iowa State University on the first line.

Second line, only the first letter of the first word and names are capitalized!

by

Alice Wonder

A dissertation submitted to the graduate faculty

in partial fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

Major: Mathematics

Program of Study Committee:
John Smith, Major Professor
Jane Dee
Allen Wrench
Katniss Everdeen

The student author, whose presentation of the scholarship herein was approved by the program of study committee, is solely responsible for the content of this dissertation. The Graduate College will ensure this dissertation is globally accessible and will not permit alterations after a degree is conferred.

Iowa State University

Ames, Iowa

2025

DEDICATION

I would like to dedicate this thesis to my wife Glenda and to my daughter Alice without whose support I would not have been able to complete this work.

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ACKNOWLEDGMENTS

I would like to take this opportunity to express my thanks to those who helped me with various aspects of conducting research and the writing of this thesis. First and foremost, Dr. Susan D. Ross for her guidance, patience and support throughout this research and the writing of this thesis. Her insights and words of encouragement have often inspired me and renewed my hopes for completing my graduate education. I would also like to thank my committee members for their efforts and contributions to this work: Dr. August Tanner and Dr. Lewis Hargrave. I would additionally like to thank Dr. Tanner for his guidance throughout the initial stages of my graduate career and Dr. Hargrave for his inspirational teaching style.

ABSTRACT

This is the text of my abstract that is part of the thesis itself. The abstract describes the work in general and the heading and style match the rest of the document.

CHAPTER 1. GENERAL INTRODUCTION

This chapter will have the introduction to your thesis as a whole.

This is the opening paragraph to my thesis which explains in general terms the concepts and hypothesis which will be explored in my thesis.

With more general information given here than really necessary.

1.1 Overview Two Words

Here initial concepts and conditions are explained and several hypothesis are mentioned in brief.

1.1.1 Hypothesis

Here one particular hypothesis is explained in depth and is examined in the light of current literature.

1.1.1.1 Parts of the hypothesis

Here one particular part of the hypothesis that is currently being explained is examined and particular elements of that part are given careful scrutiny.

1.1.2 Second Hypothesis

Here one particular hypothesis is explained in depth and is examined in the light of current literature.

1.1.2.1 Parts of the second hypothesis

Here one particular part of the hypothesis that is currently being explained is examined and particular elements of that part are given careful scrutiny (Bui, 2023), abcd.

1.2 Criteria Review

Here certain criteria are explained thus eventually leading to a foregone conclusion.

Theorem 1.1. *Here's a theorem!*

1.3 References

Bui, Vuong (Apr. 13, 2023). *Every Generating Polytope Is Strongly Monotypic*. arXiv: 2210.07690 [math]. URL: http://arxiv.org/abs/2210.07690 (visited on 09/19/2024). Pre-published.

CHAPTER 2. PAPER 1 TITLE GOES HERE

Authors and Affiliations

Modified from a manuscript to be submitted to/ under review/ published in *Name of the Journal*

2.1 Abstract

This is the text of my abstract that is part of the thesis itself. The abstract describes the work in the first paper general. You can use the same abstract as your paper here.

2.2 Overview

The construct of this section or any further section is same as the authors paper. This is the opening paragraph to my thesis which explains in general terms the concepts and hypothesis which will be used in my thesis.

With more general information given here than really necessary.

2.3 Introduction

Here initial concepts and conditions are explained and several hypothesis are mentioned in brief.

(Klee, Danzer, and Grünbaum, 1963) the definitive model is seen.

A version of this chapter appears in Journal of Discipline, Volume 18, Issue 3

2.3.1 Hypothesis

Here one particular hypothesis is explained in depth and is examined in the light of current literature.

2.3.1.1 Parts of the hypothesis

Here one particular part of the hypothesis that is currently being explained is examined and particular elements of that part are given careful scrutiny.

2.3.2 Second Hypothesis

Heading

Here one particular hypothesis is explained in depth and is examined in the light of current literature.

Even smaller heading

Another sentence.

2.3.2.1 Parts of the second hypothesis

Here one particular part of the hypothesis that is currently being explained is examined and particular elements of that part are given careful scrutiny.

Theorem 2.1. *If true, then this theorem is vacuous.*

2.4 Criteria Review

Here certain criteria are explained thus eventually leading to a foregone conclusion.

2.5 Conclusion

The conclusion of the paper goes here. (Bui, 2023)

2.6 References

Bui, Vuong (Apr. 13, 2023). *Every Generating Polytope Is Strongly Monotypic*. arXiv: 2210.07690 [math]. URL: http://arxiv.org/abs/2210.07690 (visited on 09/19/2024). Pre-published.

Chen, Beifang, Shing-Tung Yau, and Yeong-Nan Yeh (Oct. 2001). "Graph Homotopy and Graham Homotopy". In: *Discrete Mathematics* 241.1-3, pp. 153–170. ISSN: 0012365X. DOI: 10.1016/S0012-365X(01)00115-7. URL: https://linkinghub.elsevier.com/retrieve/pii/S0012365X01001157 (visited on 08/28/2024).

Klee, Victor, Ludwig Danzer, and Branko Grünbaum (1963). "Helly's Theorem and Its Relatives". In: *Convexity*. Seventh Symposium in Pure Mathematics. Ed. by Victor Klee. Vol. 7. Proceedings of Symposia in Pure Mathematics ; v. 7. Providence: American Mathematical Society, pp. 101–180.

2.7 Appendix A: Appendix A Title Goes Here After The Colon

If there is an appendix that needs to go with the paper it can be as a section (Klee, Danzer, and Grünbaum, 1963)

2.7.1 Procedure details

Details of the paper specific appendix procedures

2.8 Appendix B: Appendix B Title Goes Here After The Colon

If there is an appendix that needs to go with the paper it can be as a section (Chen, Yau, and Yeh, 2001)

2.8.1 Procedure details

Details of the paper specific appendix procedures

CHAPTER 3. PAPER 2 TITLE GOES HERE

Authors and Affiliations

Modified from a manuscript to be submitted to/ under review/ published in *Name of the Journal*

3.1 Abstract

This is the text of my abstract that is part of the thesis itself. The abstract describes the work in the first paper general. You can use the same abstract as your paper here.

3.2 Overview

The construct of this section or any further section is same as the authors paper. This is the opening paragraph to my thesis which explains in general terms the concepts and hypothesis which will be used in my thesis.

With more general information given here than really necessary.

3.3 Introduction

Here initial concepts and conditions are explained and several hypothesis are mentioned in brief.

did the initial work the definitive model is seen.

A version of this chapter appears in Journal of Discipline, Volume 18, Issue 3

3.3.1 Hypothesis

Here one particular hypothesis is explained in depth and is examined in the light of current literature.

3.3.1.1 Parts of the hypothesis

Here one particular part of the hypothesis that is currently being explained is examined and particular elements of that part are given careful scrutiny.

3.3.2 Second Hypothesis

Here one particular hypothesis is explained in depth and is examined in the light of current literature.

3.3.2.1 Parts of the second hypothesis

Here one particular part of the hypothesis that is currently being explained is examined and particular elements of that part are given careful scrutiny.

3.4 Criteria Review

Here certain criteria are explained thus eventually leading to a foregone conclusion.

3.5 Conclusion

The conclusion of the paper goes here.

(Ziegler, 1995a) (Ziegler, 1995b)

3.6 References

Ziegler, Günter M. (1995a). *Lectures on Polytopes*. Graduate Texts in Mathematics 152. New York: Springer-Verlag. ISBN: 978-0-387-94329-9.

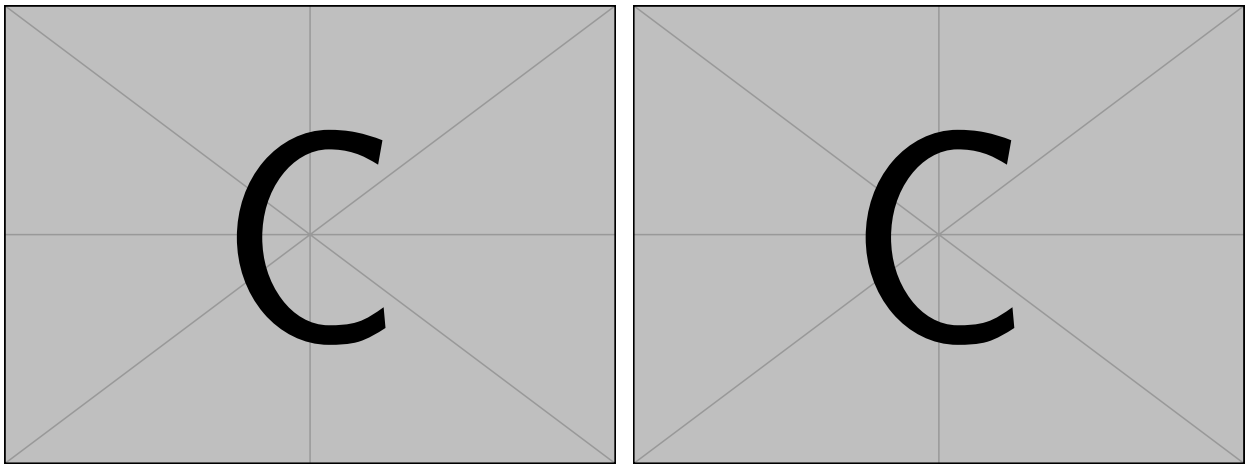
— (1995b). *This is a super long title that just goes on and on and on and on This is a super long title that just goes on and on and on and on This is a super long title that just goes on and on and on and on This is a super long title that just goes on and on and on and on This is a super long title that just goes on and on and on and on This is a super long title that just goes on and on and on and on This is a super long title that just goes on and on and on and on This is a super long title that just goes on and on and on and on This is a super long title that just goes on and on and on and on This is a super long title that just goes on and on and on and on This is a super long title that just goes on and on and on and on*. Graduate Texts in Mathematics that goes on and on and on and on Graduate Texts in Mathematics that goes on and on and on and onGraduate Texts in Mathematics that goes on and on and on and onGraduate Texts in Mathematics that goes on and on and on and onGraduate Texts in Mathematics that goes on and on and on and onGraduate Texts in Mathematics that goes on and on and on and onGraduate Texts in Mathematics that goes on and on and on and onGraduate Texts in Mathematics that goes on and on and on and onGraduate Texts in Mathematics that goes on and on and on and onGraduate Texts in Mathematics that goes on and on and on and onGraduate Texts in Mathematics that goes on and on and on and onGraduate Texts in Mathematics that goes on and on and on and on 1523333342424343333333333442424313423423423432423 4. New York: Springer-Verlag that is super long et al. ISBN: 978-0-387-94329-9.

3.7 Appendix: Appendix Title Goes Here

If there is an appendix that needs to go with the

3.7.1 Procedure details

Details of the paper specific appendix procedures



(a) (b)

Figure 3.1: A figure with two subfigures: (a) first subfigure; (b) second subfigure.

PART I

Let us have a part page

CHAPTER 4. PAPER 3 TITLE GOES HERE

Authors and Affiliations

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4.1 Abstract

This is the text of my abstract that is part of the thesis itself. The abstract describes the work in the first paper general. You can use the same abstract as your paper here.

4.2 Methods and procedures

This is the opening paragraph to my thesis which explains in general terms the concepts and hypothesis which will be used in my thesis.

With more general information given here than really necessary.

4.3 Introduction

Here initial concepts and conditions are explained and several hypothesis are mentioned in brief.

As can be seen in Table 4.1 it is truly obvious what I am saying is true.

4.3.1 Hypothesis

Here one particular hypothesis is explained in depth and is examined in the light of current literature.

A version of this chapter appears in Journal of Discipline, Volume 18, Issue 3

Table 4.1: This table shows a standard empty table. In case of long captions, we want to use the long caption as the description to the table and image but not use it in the table of contents and list of figures/ tables. In order to do this, there are two captions which have been provided, remove the first square bracket options if there is only one small caption. You can use citations like this to

Bach	Cello Suite Number 1
Beethoven	Cello Sonata Number 3
Brahms	Cello Sonata Number 1

This can also be seen in Figure 4.1 that the rest is obvious.

Figure 4.1: This table shows a standard empty figure

4.3.1.1 Parts of the hypothesis

Here one particular part of the hypothesis that is currently being explained is examined and particular elements of that part are given careful scrutiny.

4.3.2 Second Hypothesis

Here one particular hypothesis is explained in depth and is examined in the light of current literature.

4.3.2.1 Parts of the second hypothesis

Here one particular part of the hypothesis that is currently being explained is examined and particular elements of that part are given careful scrutiny.

4.4 Criteria Review

Here certain criteria are explained thus eventually leading to a foregone conclusion as can be seen in Table 4.2.

Table 4.2: This table shows a standard empty table with a limited caption width

4.5 Continuing Tables

Note, tables with cells spanning multiple columns work automatically, but cells spanning multiple rows require extra tagging.

4.6 Results

Include any results

4.7 Conclusion

The conclusion of the paper goes here.

(Dochtermann et al., 2023) (Ziegler, 1995)

4.8 References

Dochtermann, Anton et al. (Oct. 1, 2023). "Minimal Graphs for Contractible and Dismantlable Properties". In: *Discrete Mathematics* 346.10, p. 113516. ISSN: 0012-365X. DOI: 10.1016/j.disc.2023.113516. URL: https://www.sciencedirect.com/science/article/pii/S0012365X23002029 (visited on 08/28/2024).

Virk, Žiga (Aug. 6, 2024). *Contractibility of the Rips Complexes of Integer Lattices via Local Domination*. arXiv: 2405.09134 [math]. URL: http://arxiv.org/abs/2405.09134 (visited on 08/28/2024). Pre-published.

Ziegler, Günter M. (1995). *This is a super long title that just goes on and on and on and on This is a super long title that just goes on and on and on and on This is a super long title that just goes on and on and on and on This is a super long title that just goes on and on and on and on This is a super long title that just goes on and on and on and on This is a super long title that just goes on and on and on and on This is a super long title that just goes on and on and on and on This is a super long title that just goes on and on and on and on This is a super long title that just goes on and on and on and on This is a super long title that just goes on and on and on and on This is a*

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4.9 Appendix: Appendix Title Goes Here

If there is an appendix that needs to go with the paper it can be as a section (Virk, 2024)

4.9.1 Procedure details

Details of the paper specific appendix procedures

Table 4.3: This is a two-part table doing things.

k	q	p+	p-	s1	s2	s3	RHS
2	2	2	1	1	0	0	1
-T	0	1	1	0	1	0	0
T	-1	0	1	0	0	1	0
-1	1	-1	1				
2(T+1)	2	0	1	1	-2	0	1
-T	0	1	1	0	1	0	0
T	-1	0	1	0	0	1	0
-(T+1)	1	0	1	0	1	0	
0	2+2(T+1)/T	0	1	1	-2	-2(T+1)/T	1
0	-1	1	1	0	1	1	0
1	-1/T	0	1	0	0	1/T	0
0	1-(T+1)/T	0	1	0	1	(T+1)/T	
0	2(2T+1)/T	0	1	1	-2	-2(T+1)/T	1
0	-1	1	1	0	1	1	0
1	-1/T	0	1	0	0	1/T	0
0	-1/T	0	1	0	1	(T+1)/T	
0	1	0	1	T/2(2T+1)	-T/(2T+1)	-1	T/2(2T+1)
0	0	1	1	T/2(2T+1)	1-T/(2T+1)	0	T/2(2T+1)
1	0	0	1	1/2(2T+1)	-1/(2T+1)	0	1/2(2T+1)
0	0	0	1	1/2(2T+1)	1-1/(2T+1)	-1+(T+1)/TT	
0	0	0	1	1/2(2T+1)	1-1/(2T+1)	-1+(T+1)/TT	
0	0	0	0				
0	0	0	0				
0	0	0	0				
0	0	0	0	1/2(2T+1)	1/2(2T+1)	1/2(2T+1)	
0	0	0	0				
0	0	0	0				
0	0	0	0				
0	0	0	0				

Table 4.3: Continued

k	q	p+	p-	s1	s2	s3	RHS
2	2	2	-2	1	0	0	1
-T	0	1	-1	0	1	0	0
T	-1	0	0	0	0	1	0
-1	1	-1	1				
2(T+1)	2	0	0	1	-2	0	1
-T	0	1	-1	0	1	0	0
T	-1	0	0	0	0	1	0
-(T+1)	1	0	0	0	1	0	
0	2+2(T+1)/T	0	0	1	-2	-2(T+1)/T	1
0	-1	1	-1	0	1	1	0
1	-1/T	0	0	0	0	1/T	0
0	1-(T+1)/T	0	0	0	1	(T+1)/T	
0	2(2T+1)/T	0	0	1	-2	-2(T+1)/T	1
0	-1	1	-1	0	1	1	0
1	-1/T	0	0	0	0	1/T	0
0	-1/T	0	0	0	1	(T+1)/T	
0	1	0	0	T/2(2T+1)	-T/(2T+1)	-1	T/2(2T+1)
0	0	1	-1	T/2(2T+1)	1-T/(2T+1)	0	T/2(2T+1)
1	0	0	0	1/2(2T+1)	-1/(2T+1)	0	1/2(2T+1)
0	0	0	0	1/2(2T+1)	1-1/(2T+1)	-1+(T+1)/TT	

CHAPTER 5. PAPER 4 TITLE GOES HERE

Authors and Affiliations

Modified from a manuscript to be submitted to/ under review/ published in *Name of the Journal*

5.1 Abstract

This is the text of my abstract that is part of the thesis itself. The abstract describes the work in the first paper general. You can use the same abstract as your paper here.

5.2 Overview

This is the opening paragraph to my thesis which explains in general terms the concepts and hypothesis which will be used in my thesis.

With more general information given here than really necessary.

Lemma 5.1. *Another lemma.*

5.3 Introduction

Here initial concepts and conditions are explained and several hypothesis are mentioned in brief.

Of course, data on this as seen in Table 5.1 is few and far between.

A version of this chapter appears in Journal of Discipline, Volume 18, Issue 3

Table 5.1: Moon Data

Element	Control	Experimental
Moon Rings	1.23	3.38
Moon Tides	2.26	3.12
Moon Walk	3.33	9.29

5.3.1 Hypothesis

Here one particular hypothesis is explained in depth and is examined in the light of current literature.

Or graphically as seen in Figure 5.1 it is certain that my hypothesis is true.

Figure 5.1: Durham Centre

5.3.1.1 Parts of the hypothesis

Here one particular part of the hypothesis that is currently being explained is examined and particular elements of that part are given careful scrutiny.

5.3.2 Second Hypothesis

Here one particular hypothesis is explained in depth and is examined in the light of current literature.

5.3.2.1 Parts of the second hypothesis

Here one particular part of the hypothesis that is currently being explained is examined and particular elements of that part are given careful scrutiny.

5.4 Criteria Review

Here certain criteria are explained thus eventually leading to a foregone conclusion.

Lemma 6.1

5.5 Results

5.6 Conclusion

The conclusion of the paper goes here.

5.7 References

Bui, Vuong (Apr. 13, 2023). *Every Generating Polytope Is Strongly Monotypic*. arXiv: 2210.07690 [math]. URL: http://arxiv.org/abs/2210.07690 (visited on 09/19/2024). Pre-published.

Ziegler, Günter M. (1995). *Lectures on Polytopes*. Graduate Texts in Mathematics 152. New York: Springer-Verlag. ISBN: 978-0-387-94329-9.

5.8 Appendix: Appendix title goes here

If there is an appendix that needs to go with the paper it can be as a section (Ziegler, 1995)

5.8.1 Procedure details

Details of the paper specific appendix procedures.

Figure 5.2: Durham Centre 2

(Bui, 2023)

CHAPTER 6. CHAPTER WITH MATH

Authors and Affiliations

Modified from a manuscript to be submitted to/ under review/ published in *Name of the Journal*

6.1 Abstract

This is the text of my abstract that is part of the thesis itself. The abstract describes the work in the first paper general. You can use the same abstract as your paper here.

6.2 Proofs and Stuff

Definition 6.1. A set A is something.

Lemma 6.1. *If cool, then great.*

Proof. Without loss of generality, it works.

$$d(x, y) = d(x, z) + d(z, y) \geq d(x, x - \langle x, n\rangle n) + 0 = \langle x, n\rangle. \tag{6.1}$$

A version of this chapter appears in Journal of Discipline, Volume 18, Issue 3

Furthermore,

$$\ell_1(\hat{x}, y) = \ell_1(x, y) \tag{6.2}$$

$$= |\ell_1(x, y) - 2\langle x, n\rangle \ell_1(n, 0)| \tag{6.3}$$

$$\left(\frac{x + y + z}{2x + y}\right) - \left(2x^2 - y\right) \tag{6.4}$$

$$B\left\langle \frac{4}{x} + x^3 \right\rangle \tag{6.5}$$

$$\left(x^2 - 2x\right) \tag{6.6}$$

From Equation 6.1, it follows

$$\ell_1(\hat{x}, y)\, \ell_1(\hat{x}, y) - 2\langle x, n\rangle \leq$$

□

Lemma 6.2. *A lemma.*

Proof.

$$3x + 4 = 12$$

□

Then, we should also have some in-line math $B\left(\frac{3x}{2y-x}\right)$ and then $d(x, y)$ if it is alright. We might also have $\sqrt{x^2 + \frac{3}{x}}$.

Theorem 6.1. *If true, then it all collapses.*

Proof. By Zorn's lemma, Zorn has the best name (Martini, Montejano, and Oliveros, 2019). Also, (Chen, Yau, and Yeh, 2001) and (Dochtermann et al., 2023).

$$x^2 + y^2 + x^2 = 2.$$

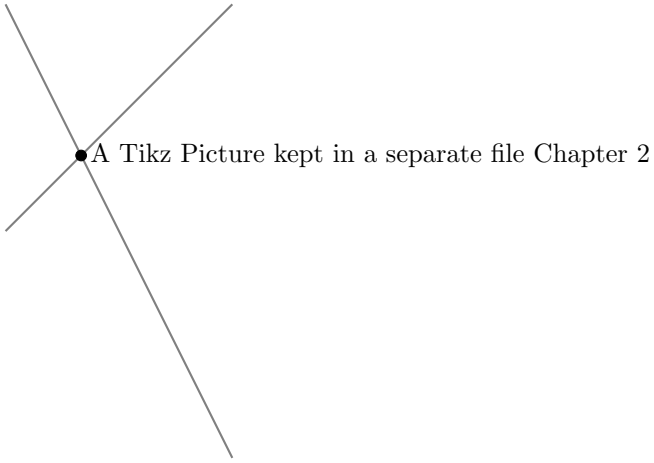

Figure 6.1: A Tikz figure with alt text and external reference

□

6.3 Floating Practice

Text here.

Algorithm 6.1 Score Algorithm

Input: s is a sensor

for $j \in \{1, 2, \dots, 15\}$ **do**
    Randomly choose 5 days
    for $x \in \{1, 2, \dots, 1000\}$ **do**
        Set a to be something in this very long state that will have to be wrapped quite possibly around and around and around

More text here. Now what is we ? Theorem 6.1

6.4 References

Chen, Beifang, Shing-Tung Yau, and Yeong-Nan Yeh (Oct. 2001). "Graph Homotopy and Graham Homotopy". In: *Discrete Mathematics* 241.1-3, pp. 153–170. ISSN: 0012365X. DOI: 10.1016/S0012-365X(01)00115-7. URL:

https://linkinghub.elsevier.com/retrieve/pii/S0012365X01001157 (visited on 08/28/2024).

Dochtermann, Anton et al. (Oct. 1, 2023). "Minimal Graphs for Contractible and Dismantlable Properties". In: *Discrete Mathematics* 346.10, p. 113516. ISSN: 0012-365X. DOI: 10.1016/j.disc.2023.113516. URL: https://www.sciencedirect.com/science/article/pii/S0012365X23002029 (visited on 08/28/2024).

Martini, Horst, Luis Montejano, and Déborah Oliveros (2019). "Complete and Reduced Convex Bodies". In: *Bodies of Constant Width: An Introduction to Convex Geometry with Applications*. Ed. by Horst Martini, Luis Montejano, and Déborah Oliveros. Cham: Springer International Publishing, pp. 143–165. ISBN: 978-3-030-03868-7. DOI: 10.1007/978-3-030-03868-7_7. URL: https://doi.org/10.1007/978-3-030-03868-7_7 (visited on 09/18/2024).

CHAPTER 7. GENERAL CONCLUSION

This is the opening paragraph to my thesis which explains in general terms the concepts and hypothesis which will be used in my thesis.

With more general information given here than really necessary.

7.1 Summary And Discussion

Here initial concepts and conditions are explained and several hypothesis are mentioned in brief.

7.1.1 Hypothesis

Here one particular hypothesis is explained in depth and is examined in the light of current literature.

As can be seen in Table 7.1 it is truly obvious what I am saying is true.

Table 7.1: This table shows almost nothing but is a sideways table and takes up a whole page by itself

Element	Control	Experimental
Moon Rings	1.23	3.38
Moon Tides	2.26	3.12
Moon Walk	3.33	9.29

7.1.1.1 Parts of the hypothesis

Here one particular part of the hypothesis that is currently being explained is examined and particular elements of that part are given careful scrutiny. (Chen, Yau, and Yeh, 2001), (Chen, Yau, and Yeh, 2001),(Virk, 2024) Here is an equation

$$x^2 + y^2 = 8.$$

7.2 Criteria Review

Here certain criteria are explained thus eventually leading to a foregone conclusion.

7.3 References

Chen, Beifang, Shing-Tung Yau, and Yeong-Nan Yeh (Oct. 2001). "Graph Homotopy and Graham Homotopy". In: *Discrete Mathematics* 241.1-3, pp. 153–170. ISSN: 0012365X. DOI: 10.1016/S0012-365X(01)00115-7. URL: https://linkinghub.elsevier.com/retrieve/pii/S0012365X01001157 (visited on 08/28/2024).

Virk, Žiga (Aug. 6, 2024). *Contractibility of the Rips Complexes of Integer Lattices via Local Domination*. arXiv: 2405.09134 [math]. URL: http://arxiv.org/abs/2405.09134 (visited on 08/28/2024). Pre-published.