The Greatest Thesis in the World

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Doctor of Philosophy

2024

Statement of Originality

I hereby certify that the work embodied in this thesis is the result of original research, is free of plagiarised materials, and has not been submitted for a higher degree to any other University or Institution.

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Prof. Einstein XXX

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Chapter 4 is published as D.T. Murphy, S. Schmid, J.R. Hester, P.E.R. Blanchard, and W. Miiller. Coordination site disorder in spinel-type LiMnTiO4. Inorganic Chemistry 54, 4636-4643 (2015). DOI: 10.1021/ic502747p.

The contributions of the co-authors are as follows:

- A/Prof Schmid provided the initial project direction and edited the manuscript drafts.
- I prepared the manuscript drafts. The manuscript was revised by Dr Hester and Dr. Blanchard.
- I co-designed the study with A/Prof Siegbert Schmid and performed all the laboratory work at the School of Materials Science and Engineering and the Singapore Synchrotron Light Source. I also analyzed the data.
- All microscopy, including sample preparation, was conducted by me in the Facility for Analysis, Characterization, Testing and Simulation.
- Dr James Hester assisted in the collection of the neutron powder diffraction data.
- Dr Peter Blanchard assisted in the interpretation of the X-ray absorption spectroscopy data and carried out the spectral interpretation.
- Dr Wojciech Miiller assisted in the collection and provide guidance in the interpretation of the magnetic measurement data.

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The contributions of the co-authors are as follows:

- Prof Ting suggested the materials area and edited the manuscript drafts.
- I wrote the drafts of the manuscript. The manuscript was revised together with Dr. Sartbaeva and Dr. Yao.
- II performed all the materials synthesis, collected X-ray diffraction patterns and visible light spectra, carried transmission electron microscopy, and conducted data evaluation.
- IDr. Y. Fang conducted the Rietveld analysis of the powder X-ray diffraction data and single crystal structure determinations.
- IDr U. Hintermair conducted the molecular dynamics simulations.
- IMs. A. Sartbaeva prepared the samples for electron microscopy.

Mar. 2019

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Date   Author Name

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I wish to express my greatest gratitude to my advisor.

"If I had one hour to save the world, I would spend 55 minutes defining the problem and only five minutes finding the solution."

—Einstein, Albert

To my dear family

Abstract

My abstracts

Contents

List of Figures

List of Tables

Symbols and Acronyms

Symbols

$\mathcal{R}^n$	the n-dimensional Euclidean space
$\mathcal{H}$	the Euclidean space
$\\|\cdot\\|$	the 2-norm of a vector or matrix in Euclidean space
$\\|\cdot\\|_G$	the induced norm of a vector in G-space
$\\|\cdot\\|_E$	the induced norm of a vector or matrix in probabilistic space
$\odot$	the Hadamard (component-wise) product
$\otimes$	the Kronecker product
$\langle\cdot,\cdot\rangle$	the inner product of two vectors
$\circ$	the composition of functions
∇f	the gradient vector
$\mathcal{C}^k$	the function with continuous partial derivatives up to k orders
$x_{i,k}$	the i-th component of a vector x at time k
$\bar{x}$	the vector with the average of all components of x as each element
$\mathbf{1}$	all-ones column vector with proper dimension
$\mathcal{C}$	the average space, i.e., $span\{\mathbf{1}\}$
$\mathcal{C}^\perp$	the disagreement space, i.e., $span^\perp\{\mathbf{1}\}$
$\Pi_\\|$	the projection matrix to the average space $\mathcal{C}$
$\Pi_\perp$	the projection matrix to the disagreement space $\mathcal{C}^\perp$
$O(\cdot)$	order of magnitude or ergodic convergence rate (running average)
$o(\cdot)$	non-ergodic convergence rate
$\mathcal{N}_i$	the index set of the neighbors of agent i

Acronyms

DOP	Distributed Optimization Problem
EDOP	Equivalent Distributed Optimization Problem
SDOP	Stochastic Distributed Optimization Problem
OEP	Optimal Exchange Problem
OCP	Optimal Consensus Problem
DOCP	Dynamic Optimal Consensus Problem
AugDGM	Augmented Distributed Gradient Methods
AsynDGM	Asynchronous Distributed Gradient Methods
D-ESC	Distributed Extremum Seeking Control
D-SPA	Distributed Simultaneous Perturbation Approach
D-FBBS	Distributed Forward-Backward Bregman Splitting
ADMM	Alternating Direction Method of Multipliers
DSM	Distributed (Sub)gradient Method
GAS	Globally Asymptotically Stable
UGAS	Uniformly Globally Asymptotically Stable
SPAS	Semi-globally Practically Asymptotically Stable
USPAS	Uniformly Semi-globally Practically Asymptotically Stable
HoS	Heterogeneity of Stepsize
FPR	Fixed Point Residual
OBE	Objective Error
i.i.d.	independent and identically distributed
a.s.	almost sure convergence of a random sequence

Chapter 1

Introduction

1.1 Some useful hints

My figure citation: Figure 1.1. (command: fref)

My section citation: Section 1.2. (command: sref)

My Chaptere citation: Chapter 1. (command: cref)

My Paper citation: [1]. (notice back reference to page from bibliograph)

My equation citation: (1.1). (command: eqref), or cite equation by tag: (DOP).

$$F(\theta) = \sum_{i=1}^{m} f_i(\theta) \tag{DOP}$$

$$F(\theta) = \sum_{i=1}^{m} f_i(\theta) \tag{1.1}$$

1.2 Major Contributions

Our main contributions can be stated as follows:

- *First part*: My first contributions, several lines

Figure 1.1: An illustration.

- *Second*: Second contributions, several lines
- *Third name*: Third contributions, several lines

1.3 Outline of the Thesis

Chapter 1 introduces ...

Chapter 2 reviews ...

More chapters ....

....

Part I

Part Name: Use it when there are many chapters

Chapter 2

Literature Review

2.1 Part 1

When you cite a paper [1], the back reference from bibgraph will apper as page number.

You can also cite paper with author name using the command 'citet': such as: Bauschke and Combettes [1].

2.2 Part 2

cite another paper [2].

Lemma 2.1 (My lemma)**.** *A great lemma.*

$$c^2 = a^2 + b^2 \tag{2.1}$$

Theorem 2.2 (My theorem)**.** *A great theorem.*

$$c^2 = a^2 + b^2 \tag{2.2}$$

Proof. The proof is intuitive. □

Corollary 2.3 (My corollary)**.** *A great corollary.*

$$c^2 = a^2 + b^2 \tag{2.3}$$

Proposition 2.1 (My proposition)**.** *A great proposition.*

$$c^2 = a^2 + b^2 \tag{2.4}$$

Example 2.1 (My example)**.** A great example.

$$c^2 = a^2 + b^2 \tag{2.5}$$

Definition 2.1 (My definition)**.** A great definition.

$$c^2 = a^2 + b^2 \tag{2.6}$$

Assumption 2.1 (My assumption)**.** A great assumption.

$$c^2 = a^2 + b^2 \tag{2.7}$$

Remark 2.1 (My remark)*.* A great remark.

$$c^2 = a^2 + b^2 \tag{2.8}$$

Chapter 3

Chapter3 Name

3.1 Section1

See Figure 3.1

FIGURE 3.1: Another illustration.

Let's cite out first table: Table 3.1.

Table	Group 1		Group 2	
	Col 1	Col 2	Col 1	Col 2
Row 1	14.37	**5.76**	2.65	**2.84**
Row 2	5.43	**7.36**	2.22	**2.49**
Row 3	5.54	**5.68**	**4.42**	2.92

TABLE 3.1: My Table.

Part II

Again for Second Part

Chapter 4

Chapter4 Name

Quisque facilisis auctor sapien. Pellentesque gravida hendrerit lectus. Mauris rutrum sodales sapien. Fusce hendrerit sem vel lorem. Integer pellentesque massa vel augue. Integer elit tortor, feugiat quis, sagittis et, ornare non, lacus. Vestibulum posuere pellentesque eros. Quisque venenatis ipsum dictum nulla. Aliquam quis quam non metus eleifend interdum. Nam eget sapien ac mauris malesuada adipiscing. Etiam eleifend neque sed quam. Nulla facilisi. Proin a ligula. Sed id dui eu nibh egestas tincidunt. Suspendisse arcu.

4.1 Section 1

Quisque facilisis auctor sapien. Pellentesque gravida hendrerit lectus. Mauris rutrum sodales sapien. Fusce hendrerit sem vel lorem. Integer pellentesque massa vel augue. Integer elit tortor, feugiat quis, sagittis et, ornare non, lacus. Vestibulum posuere pellentesque eros. Quisque venenatis ipsum dictum nulla. Aliquam quis quam non metus eleifend interdum. Nam eget sapien ac mauris malesuada adipiscing. Etiam eleifend neque sed quam. Nulla facilisi. Proin a ligula. Sed id dui eu nibh egestas tincidunt. Suspendisse arcu.

4.2 Section 2

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Chapter 5

Chapter5 Name

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5.1 Section 1

Quisque facilisis auctor sapien. Pellentesque gravida hendrerit lectus. Mauris rutrum sodales sapien. Fusce hendrerit sem vel lorem. Integer pellentesque massa vel augue. Integer elit tortor, feugiat quis, sagittis et, ornare non, lacus. Vestibulum posuere pellentesque eros. Quisque venenatis ipsum dictum nulla. Aliquam quis quam non metus eleifend interdum. Nam eget sapien ac mauris malesuada adipiscing. Etiam eleifend neque sed quam. Nulla facilisi. Proin a ligula. Sed id dui eu nibh egestas tincidunt. Suspendisse arcu.

5.2 Section 2

Quisque facilisis auctor sapien. Pellentesque gravida hendrerit lectus. Mauris rutrum sodales sapien. Fusce hendrerit sem vel lorem. Integer pellentesque massa vel augue. Integer elit tortor, feugiat quis, sagittis et, ornare non, lacus. Vestibulum posuere pellentesque eros. Quisque venenatis ipsum dictum nulla. Aliquam quis quam non metus eleifend interdum. Nam eget sapien ac mauris malesuada adipiscing. Etiam eleifend neque sed quam. Nulla facilisi. Proin a ligula. Sed id dui eu nibh egestas tincidunt. Suspendisse arcu.

Appendix A

Proofs for Part I or Chapter 3

A.1 Proof of Lemma

$$\psi^{av}(\theta) = \frac{1}{T}\int_0^T [\psi(\theta + \mu(\tau)) + C] \otimes \frac{\mu(\tau)}{a} d\tau$$

A.2 Proof of another Lemma

$$\begin{aligned} \gamma_1(\|x\|) \leq W(t,x) \leq \gamma_2(\|x\|) \\ \frac{\partial W}{\partial t} + \frac{\partial W}{\partial x}\phi(t,x,0) \leq -\gamma_3(\|x\|) \end{aligned} \tag{A.1}$$

List of Author's Awards, Patents, and Publications[1]

Awards

- **Best Paper Awards**, "A Great System," *Nature*.

Patents

- **A Great System**, "A Great System," *Nature*.

Journal Articles

- **My name** and My colleague, "A Great System," *Nature*.

Conference Proceedings

- **My name**, My colleague 1, My colleague 3 and My colleague 3, "Greater System," in *Conference of Vision, 2018*.

[1]The superscript * indicates joint first authors

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[1] Heinz H Bauschke and Patrick L Combettes. *Convex analysis and monotone operator theory in Hilbert spaces*. Springer Science & Business Media, 2011.

[2] J. B. Rawlings and B. T. Stewart. Coordinating multiple optimization-based controllers: New opportunities and challenges. *Journal of Process Control*, 18: 839–845, 2008.