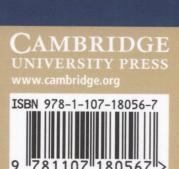
This largely self-contained book on the theory of quantum information focuses on precise mathematical formulations and proofs of fundamental facts that form the foundation of the subject. It is intended for graduate students and researchers in mathematics, computer science, and theoretical physics seeking to develop a thorough understanding of key results, proof techniques, and methodologies that are relevant to a wide range of research topics within the theory of quantum information and computation.

The book is accessible to readers with an understanding of basic mathematics, including linear algebra, mathematical analysis, and probability theory. An introductory chapter summarizes these necessary mathematical prerequisites, and starting from this foundation the book includes clear and complete proofs of all results it presents. Each subsequent chapter includes challenging exercises intended to help readers develop their own skills for discovering proofs concerning the theory of quantum information.

John Watrous is a Professor in the School of Computer Science and a Faculty Member of the Institute for Quantum Computing at the *University of Waterloo*, *Ontario*. He is also an Affiliate Member of the Perimeter Institute for Theoretical Physics and a Senior Fellow of the Canadian Institute for Advanced Research. Quantum information and computation has been his primary research focus for over 20 years.

"This book serves not only as a beautiful introduction to quantum information, but also to the most important techniques for reasoning about it. By introducing representation theory, semidefinite programming, measure concentration, and other important tools on the way to presenting many quantum information highlights, Watrous equips the reader with the skills necessary to contribute at the research frontier."

Patrick Hayden, Stanford University, California



	Pref	face	page vii
1	Mathematical Preliminaries		
	1.1	Linear Algebra	1
	1.2	Analysis, Convexity, and Probability Theory	35
	1.3	Suggested References	57
2	Basic Notions of Quantum Information		
	2.1	Registers and States	58
	2.2	Quantum Channels	72
	2.3	Measurements	100
	2.4	Exercises	120
	2.5	Bibliographic Remarks	122
3	Similarity and Distance Among States and Channels		
	3.1	Quantum State Discrimination	124
	3.2	The Fidelity Function	139
	3.3	Channel Distances and Discrimination	164
	3.4	Exercises	197
	3.5	Bibliographic Remarks	198
	Unital Channels and Majorization		
	4.1	Subclasses of Unital Channels	201
	4.2	General Properties of Unital Channels	222
	4.3	Majorization	233
	4.4	Exercises	246
	4.5	Bibliographic Remarks	247
5	Quantum Entropy and Source Coding		
	5.1	Classical Entropy	250
	5.2	Quantum Entropy	265

1	- 1		
Co	$n_l$	en	$\imath ts$

vi

	5.3	Source Coding	283			
	5.4	Exercises	30			
	5.5	Bibliographic Remarks	30			
6	Bip	artite Entanglement	31			
	6.1	Separability	31			
	6.2	Manipulation of Entanglement	33			
	6.3	Phenomena Associated With Entanglement	35			
	6.4	Exercises	38			
	6.5	Bibliographic Remarks	38			
7	Permutation Invariance and Unitarily Invariant					
	Mea	asures	39			
	7.1	Permutation-Invariant Vectors and Operators	39			
	7.2	Unitarily Invariant Probability Measures	40			
	7.3	Measure Concentration and Its Applications	42			
	7.4	Exercises A mank! I.I.	46			
	7.5	Bibliographic Remarks	46			
8	Quantum Channel Capacities					
	8.1	Classical Information Over Quantum Channels	46			
	8.2	Quantum Information Over Quantum Channels	51			
	8.3	Non-Additivity and Super-Activation	53			
	8.4	Exercises	55			
	8.5	Bibliographic Remarks	55			
	Refe	erences	56			
	Inde	ex of Symbols	57			
	Inde	ex / nonsemminosid pasid minimanO 1.8	58			