

Preface

The field of Quantum Information Processing and Technology was born in obscurity in the 1980s, at the intersection of physics, mathematics and computer science. In the decades that followed, the field experienced an explosive growth, with numerous theoretical and experimental scientific breakthroughs. The use of quantum mechanical principles in computation and communication tasks has changed our perception of the nature of information, and has led us to a reconsideration of its processing. Nowadays Quantum Information Processing and Technology is a well established discipline, with many ideas and discoveries that pave the way to more efficient and faster information processing, and more secure quantum networks and communication.

In contrast to classical information processing, where the information is typically coded into sequences of zeros and ones, in the framework of quantum information processing one deals with quantum states of physical systems, such as atoms, ions, quantum dots, Josephson junctions, topological defects, etc. Individual physical systems can be interconnected in various configurations, giving rise to large clusters and networks that are designed so as to perform efficiently certain information processing tasks, by exploiting fundamental principles of quantum mechanics. Faithful transfer of quantum states between two distant points is a necessary precondition for large-scale quantum information processing and networking, irrespective of the physical platform. Hence, the problems of quantum-state transfer and quantum-network engineering have attracted enormous interest over the last decade, and constitute one of the most active areas of research in Quantum Information Processing and Technology.

The present book is a representative collection of contributions dealing with various aspects of this exciting research area. The authors are leading figures in the field who have contributed significantly to its development and are responsible for some of the chief achievements. The chapters illustrate the interdisciplinary character of this research area which has links to transport phenomena, complex systems and spintronics. Possible physical platforms for the realization of quantum networks and studies of quantum-state transfer schemes include liquid and solid-state NMR systems, condensed-matter systems, and quantum optical systems. Each

chapter of this book is a review of theoretical or experimental achievements on a particular topic. We emphasize here that the present book is devoted to a rapidly changing research area and despite the efforts of the authors, some of the recent developments and publications may have not been covered. We hope, however, that the book will serve the interested reader as a welcome reference and introduction to quantum networks and the problem of quantum-state transfer, and will stimulate the scientific community toward new developments in the field.

Heraklion, Greece
Prague, Czech Republic
June 2013

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Quantum State Transfer and Network Engineering

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2014, X, 250 p. 80 illus., 68 illus. in color., Hardcover

ISBN: 978-3-642-39936-7