Mathematical Foundations Of Quantum Information And Computation And Its Applications To Nano And Bio Systems Theoretical And Mathematical Physics

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Mathematical methods of quantum information theory, Lecture 1

The Mathematics of Quantum Computers | Infinite Series

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Abstract: The purpose of this paper is to survey some topics on mathematical foundations of quantum information developed mainly by the present author and co-workers for the last three decades. The topics include an axiomatic construction of quantum measurement theory based on completely positive map-valued measures, a universally valid new formulation of the uncertainty principle for error and disturbance in quantum measurements, the Wigner-Araki-Yanase limit of quantum measurements, the ...

Mathematical foundations of quantum information ...

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Quantum information and foundations. Our research in quantum information and foundations spans a range of topics from the abstract to the concrete. On the one hand we are working towards a deeper understanding of the puzzling features of quantum theory such as indeterminacy, entanglement and non-locality. On the other, we are exploiting these fundamental ideas for information-processing tasks such as quantum cryptography and quantum computing.

Quantum information and foundations - Mathematics ...

The book Mathematical Foundations of Quantum Mechanics (1932) by John von Neumann is an important early work in the development of quantum theory.

Mathematical Foundations of Quantum Mechanics - Wikipedia

Since the publication of the preceding book Quantum Information: An Introduction, there have been tremendous strides in the field of quantum information. In particular, the following topics – all of which are addressed here – made seen major advances:

quantum state discrimination, quantum channel capacity, bipartite and multipartite entanglement, security analysis on quantum communication, reverse Shannon theorem and uncertainty relation.

Quantum Information Theory - Mathematical Foundation ...
Mathematical foundations of quantum information and computation and its applications to nano- and bio-systems, 2011 (Theoretical and mathematical physics) Series Authors: Ohya Masanori, Volovich I. Language: Anglais

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Quantum set theory (QST) and topos quantum theory (TQT) are two long running projects in the mathematical foundations of quantum mechanics that share a great deal of conceptual and technical affinity.

Foundations of Quantum Mechanics and Quantum Information ...
information security, mathematics, quantum mechanics and quantum computing. We ' ll repeat it many times: quantum physics isn ' t about mathematics, it ' s about the behaviour of nature at its core. But since mathematics is the language of nature, it ' s required to quantify the prediction of quantum mechanics. This present document has been ...

THE MATHEMATICS OF QUANTUM MECHANICS
Staff supervising projects in mathematical physics are: Dr Henning Bostelmann; Rigorous quantum field theory. Dr Roger Colbeck; I am principally offering projects in quantum cryptography (in particular device-independent protocols) or quantum foundations (understanding cause in quantum theory).

PhD Projects - Mathematics, University of York
Mathematical Foundations of Quantum Information and Computation and Its Applications to Nano- and Bio-systems by Masanori Ohya; I. Volovich and Publisher Springer. Save up to 80% by choosing the eTextbook option for ISBN: 9789400701717, 9400701713. The print version of this textbook is ISBN: 9789400701717, 9400701713.

Mathematical Foundations of Quantum Information and ...
In physics and computer science, quantum information is the information of the state of a quantum system. It is the basic entity of study in quantum information theory, and can be manipulated using quantum information processing techniques. Quantum information refers to both the technical definition in terms of Von Neumann entropy and the general computational term. Quantum information, like classical information, can be processed using digital computers, transmitted from one location to another

This text shows that insights in quantum physics can be obtained by exploring the mathematical structure of quantum mechanics. It presents the theory of Hermitean operators and Hilbert spaces, providing the framework for transformation theory, and using th

This book provides the reader with the mathematical framework required to fully explore the potential of small quantum information processing devices. As decoherence will continue to limit their size, it is essential to master the conceptual tools which make such investigations possible. A strong emphasis is given to information measures that are essential for the study of devices of finite size, including R é nyi entropies and smooth entropies. The presentation is self-contained and includes rigorous and concise proofs of the most important properties of these measures. The first chapters will introduce the formalism of quantum mechanics, with particular emphasis on norms and metrics for quantum states. This is necessary to explore quantum generalizations of R é nyi divergence and conditional entropy, information measures that lie at the core of information theory. The smooth entropy framework is discussed next and provides a natural means to lift many arguments from information theory to the quantum setting. Finally selected applications of the theory to statistics and cryptography are discussed. The book is aimed at graduate students in Physics and Information Theory. Mathematical fluency is necessary, but no prior knowledge of quantum theory is required.

This monograph provides a mathematical foundation to the theory of quantum information and computation, with applications to various open systems including nano and bio systems. It includes introductory material on algorithm, functional analysis, probability theory, information theory, quantum mechanics and quantum field theory. Apart from standard material on quantum information like quantum algorithm and teleportation, the authors discuss findings on the theory of entropy in C*-dynamical systems, space-time dependence of quantum entangled states, entangling operators, adaptive dynamics, relativistic quantum information, and a new paradigm for quantum computation beyond the usual quantum Turing machine. Also, some important applications of information theory to genetics and life sciences, as well as recent experimental and theoretical discoveries in quantum photosynthesis are described.

This graduate textbook provides a unified view of quantum information theory. Clearly explaining the necessary mathematical basis, it merges key topics from both information-theoretic and quantum- mechanical viewpoints and provides lucid explanations of the basic results. Thanks to this unified approach, it makes accessible such advanced topics in quantum communication as quantum teleportation, superdense coding, quantum state transmission (quantum error-correction) and quantum encryption. Since the publication of the preceding book Quantum Information: An Introduction, there have been tremendous strides in the field of quantum information. In particular, the following topics – all of which are addressed here – made seen major advances: quantum state discrimination, quantum channel capacity, bipartite and multipartite entanglement, security analysis on quantum communication, reverse Shannon theorem and uncertainty relation. With regard to the analysis of quantum security, the present book employs an improved method for the evaluation of leaked information and identifies a remarkable relation between quantum security and quantum coherence. Taken together, these two improvements allow a better analysis of quantum state transmission. In addition, various types of the newly discovered uncertainty relation are explained. Presenting a wealth of new developments, the book introduces readers to the latest advances and challenges in quantum information. To aid in understanding, each chapter is accompanied by a set of exercises and solutions.

Mathematical Foundations of Quantum Theory is a collection of papers presented at the 1977 conference on the Mathematical Foundations of Quantum Theory, held in New Orleans. The contributors present their topics from a wide variety of backgrounds and specialization, but all shared a common interest in answering quantum issues. Organized into 20 chapters, this book's opening chapters establish a sound mathematical basis for quantum theory and a mode of observation in the double slit experiment. This book then describes the Lorentz particle system and other mathematical structures with which fundamental quantum theory must deal, and then some unsolved problems in the quantum logic approach to the foundations of quantum mechanics are considered. Considerable chapters cover topics on manuals and logics for quantum mechanics. This book also examines the problems in quantum logic, and then presents examples of their interpretation and relevance to nonclassical logic and statistics. The accommodation of conventional Fermi-Dirac and Bose-Einstein statistics in quantum mechanics or quantum field theory is illustrated. The final chapters of the book present a system of axioms for nonrelativistic quantum mechanics, with particular emphasis on the role of density operators as states. Specific connections of this theory with other formulations of quantum theory are also considered. These chapters also deal with the determination of the state of an elementary quantum mechanical system by the associated position and momentum distribution. This book is of value to physicists, mathematicians, and researchers who are interested in quantum theory.

Developing many of the major, exciting, pre- and post-millennium developments from the ground up, this book is an ideal entry point for graduate students into quantum information theory. Significant attention is given to quantum mechanics for quantum information theory, and careful studies of the important protocols of teleportation, superdense coding, and entanglement distribution are presented. In this new edition, readers can expect to find over 100 pages of new material, including detailed discussions of Bell's theorem, the CHSH game, Tsirelson's theorem, the axiomatic approach to quantum channels, the definition of the diamond norm and its interpretation, and a proof of the Choi – Kraus theorem. Discussion of the importance of the quantum dynamic capacity formula has been completely revised, and many new exercises and references have been added. This new edition will be welcomed by the upcoming generation of quantum information theorists and the already established community of classical information theorists.

This is a brief introduction to the mathematical foundations of quantum mechanics based on lectures given by the author to Ph.D.students at the Delhi Centre of the Indian Statistical Institute in order to initiate active research in the emerging field of quantum probability. The material in the first chapter is included in the author's book "An Introduction to Quantum Stochastic Calculus" published by Birkhauser Verlag in 1992 and the permission of the publishers to reprint it here is acknowledged. Apart from quantum probability, an understanding of the role of group representations in the development of quantum mechanics is always a fascinating theme for mathematicians. The first chapter deals with the definitions of states, observables and automorphisms of a quantum system through Gleason's theorem, Hahn-Hellinger theorem and Wigner's theorem. Mackey's imprimitivity theorem and the theorem of inducing representations of groups in stages are proved directly for projective unitary antiunitary representations in the second chapter. Based on a discussion of multipliers on locally compact groups in the third chapter all the well-known observables of classical quantum theory like linear momenta, orbital and spin angular momenta, kinetic and potential energies, gauge operators etc., are derived solely from Galilean covariance in the last chapter. A very short account of observables concerning a relativistic free particle is included. In conclusion, the spectral theory of Schrodinger operators of one and two electron atoms is discussed in some detail.

Among the most exciting developments in science today is the design and construction of the quantum computer. Its realization will be the result of multidisciplinary efforts, but ultimately, it is mathematics that lies at the heart of theoretical quantum computer science. Mathematics of Quantum Computation brings together leading computer scientists, mathematicians, and physicists to provide the first interdisciplinary but mathematically focused exploration of the field's foundations and state of the art. Each section of the book addresses an area of major research, and does so with introductory material that brings newcomers quickly up to speed. Chapters that are more advanced include recent developments not yet published in the open literature. Information technology will inevitably enter into the realm of quantum mechanics, and, more than all the atomic, molecular, optical, and nanotechnology advances, it is the device-independent mathematics that is the foundation of quantum computer and information science. Mathematics of Quantum Computation offers the first up-to-date coverage that has the technical depth and breadth needed by those interested in the challenges being confronted at the frontiers of research.

Quantum mechanics was still in its infancy in 1932 when the young John von Neumann, who would go on to become one of the greatest mathematicians of the twentieth century, published Mathematical Foundations of Quantum Mechanics--a revolutionary book that for the first time provided a rigorous mathematical framework for the new science. Robert Beyer's 1955 English translation, which von Neumann reviewed and approved, is cited more frequently today than ever before. But its many treasures and insights were too often obscured by the limitations of the way the text and equations were set on the page. In this new edition of this classic work, mathematical physicist Nicholas Wheeler has completely reset the book in TeX, making the text and equations far easier to read. He has also corrected a handful of typographic errors, revised some sentences for clarity and readability, provided an index for the first time, and added prefatory remarks drawn from the writings of Léon Van Hove and Freeman Dyson. The result brings new life to an essential work in theoretical physics and mathematics.

This book presents a concise introduction to an emerging and increasingly important topic, the theory of quantum computing. The development of quantum computing exploded in 1994 with the discovery of its use in factoring large numbers--an extremely difficult and time-consuming problem when using a conventional computer. In less than 300 pages, the authors set forth a solid foundation to the theory, including results that have not appeared elsewhere and improvements on existing works. The book starts with the basics of classical theory of computation, including NP-complete problems and the idea of complexity of an algorithm. Then the authors introduce general principles of quantum computing and pass to the study of main quantum computation algorithms: Grover's algorithm, Shor's factoring algorithm, and the Abelian hidden subgroup problem. In concluding sections, several related topics are discussed (parallel quantum computation, a quantum analog of NP-completeness, and quantum error-correcting codes). This is a suitable textbook for a graduate course in quantum computing. Prerequisites are very modest and include linear algebra, elements of group theory and probability, and the notion of an algorithm (on a formal or an intuitive level). The book is complete with problems, solutions, and an appendix summarizing the necessary results from number theory.