Spinors In Hilbert Space

A definitive self-contained account of the subject. Of appeal to a wide audience in mathematics and physics.
Spinors in Hilbert SpaceSpringer Science & Business Media
This volume provides a series of tutorials on mathematical structures which recently have gained prominence in physics, ranging from quantum foundations, via quantum information, to quantum gravity. These include the theory of monoidal categories and corresponding graphical calculi, Girard's linear logic, Scott domains, lambda calculus and corresponding logics for typing, topos theory, and more general process structures. Most of these structures are very prominent in computer science; the chapters here are tailored towards an audience of physicists.
Quantum Field Theory provides a theoretical framework for understanding fields and the particles associated with them, and is the basis of particle physics and condensed matter research. This graduate level textbook provides a comprehensive introduction to quantum field theory, giving equal emphasis to operator and path integral formalisms. It covers modern research such as helicity spinors, BCFW construction and generalized unitarity cuts; as well as treating

advanced topics including BRST quantization, loop equations, and finite temperature field theory. Various quantum fields are described, including scalar and fermionic fields, Abelian vector fields and Quantum ElectroDynamics (QED), and finally non-Abelian vector fields and Quantum ChromoDynamics (QCD). Applications to scattering cross sections in QED and QCD are also described. Each chapter ends with exercises and an important concepts section, allowing students to identify the key aspects of the chapter and test their understanding.

A distinctive collection of essays, discussions, and personal descriptions of the evolution of particle physics.

This authoritative volume in honor of Alain Connes, the foremost architect of Noncommutative Geometry, presents the state-of-the art in the subject. The book features an amalgam of invited survey and research papers that will no doubt be accessed, read, and referred to, for several decades to come. The pertinence and potency of new concepts and methods are concretely illustrated in each contribution. Much of the content is a direct outgrowth of the Noncommutative Geometry conference, held March 23–April 7, 2017, in Shanghai, China. The conference covered the latest research and future areas of potential exploration surrounding topology and physics, number theory, as well as index theory and its ramifications in geometry.

Quantum mechanics provides the fundamental theoretical apparatus for describing the structure and properties of atoms and molecules in terms of the behaviour of their fundamental components, electrons and nudeL For heavy atoms and molecules containing them, the electrons can move at speeds which represent a substantial fraction of the speed of light, and thus relativity must be taken into account. Relativistic quantum mechanics therefore provides the basic formalism for calculating the properties of heavy-atom systems. The purpose of this book is to provide a detailed description of the application of relativistic quantum mechanics to the many-body prob lem in the theoretical chemistry and physics of heavy and superheavy elements. Recent years have witnessed a continued and growing interest in relativistic quantum chemical methods and the associated computa tional algorithms which facilitate their application. This interest is fu elled by the need to develop robust, yet efficient theoretical approaches, together with efficient algorithms, which can be applied to atoms in the lower part of the Periodic Table and, more particularly, molecules and molecular entities containing such atoms. Such relativistic theories and computational algorithms are an essential ingredient for the description of heavy element chemistry, becoming even more important in the case of superheavy elements. They are destined to become an indispensable tool in the quantum chemist's armoury. Indeed, since relativity influences the structure of every atom in the Periodic Table, relativistic molecular structure methods may replace in many applications the non-relativistic techniques widely used in contemporary research.

Application of the concepts and methods of topology and geometry have led to a deeper understanding of many crucial aspects in condensed matter physics, cosmology, gravity and particle physics. This book can be considered an advanced textbook on modern applications and recent developments in these fields of physical research. Written as a set of largely self-contained extensive lectures, the book gives an introduction to topological concepts in gauge theories, BRST quantization, chiral anomalies, supersymmetric solitons and noncommutative geometry. It will be of benefit to postgraduate students, educating newcomers to the field and lecturers looking for advanced material.

This book contains lectures presented at the MIT symposium on the 100th anniversary of Norbert Wiener's birth held in October 1994. The topics reflect Wiener's main interests while emphasizing current developments. In addition to lectures dealing directly with problems on which Wiener worked, such as potential theory, harmonic analysis, Wiener-Hopf theory, and Paley-Wiener theory, the book discusses the following topics: BLFourier integral operators with complex phase (a contemporary successor to the Paley-Wiener theory) BLstatistical aspects of quantum mechanics and of liquid crystals BLfinancial markets, including the new trading strategies for options based on Wiener processes BLstatistical methods of genetic research BLmodels of the nervous system, pattern recognition, and the nature of intelligence The volume includes reviews on Norbert Wiener's contributions from historical and current perspectives. This book gives mathematical researchers an overview of new mathematical problems presented by other areas and gives researchers in other fields a broad overview of the ways in which advanced mathematics might be useful to them.

1. Hilbert Space The words "Hilbert space" here will always denote what math ematicians call a separable Hilbert space. It is composed of vectors each with a denumerable infinity of coordinates ql' q2' Q3, ... Usually the coordinates are considered to be complex numbers and each vector has a squared length ~rIQrI2. This squared length must converge in order that the q's may specify a Hilbert vector. Let us express qr in terms of real and imaginary parts, qr = Xr + iYr' Then the squared length is l:.r(x; + y;). The x's and y's may be looked upon as the coordinates of a vector. It is again a Hilbert vector, but it is a real Hilbert vector, with only real coordinates. Thus a complex Hilbert vector uniquely determines a real Hilbert vector. The second vector has, at first sight, twice as many coordinates as the first one. But twice a denumerable in finity is again a denumerable infinity, so the second vector has the same number of coordinates as the first. Thus a complex Hilbert vector is not a more general kind of

quantity than a real one.

Causal fermion systems and Riemannian fermion systems are proposed as a framework for describing non-smooth geometries. In particular, this framework provides a setting for spinors on singular spaces. The underlying topological structures are introduced and analyzed. The connection to the spin condition in differential topology is worked out. The constructions are illustrated by many simple examples such as the Euclidean plane, the two-dimensional Minkowski space, a conical singularity, a lattice system as well as the curvature singularity of the Schwarzschild space-time. As further examples, it is shown how complex and Kähler structures can be encoded in Riemannian fermion systems.

In his rich and varied career as a mathematician, computer scientist, and educator, Jacob T. Schwartz wrote seminal works in analysis, mathematical economics, programming languages, algorithmics, and computational geometry. In this volume of essays, his friends, students, and collaborators at the Courant Institute of Mathematical Sciences present recent results in some of the fields that Schwartz explored: quantum theory, the theory and practice of programming, program correctness and decision procedures, dextrous manipulation in Robotics, motion planning, and genomics. In addition to presenting recent results in these fields, these essays illuminate the astonishingly productive trajectory of a brilliant and original scientist and thinker.

A straightforward introduction to Clifford algebras, providing the necessary background

material and many applications in mathematics and physics.
This volume contains selected papers presented at the Second Workshop on Clifford Algebras and their Applications in Mathematical Physics. These papers range from various algebraic and analytic aspects of Clifford algebras to applications in, for example, gauge fields, relativity theory, supersymmetry and supergravity, and condensed phase physics. Included is a biography and list of publications of Mário Schenberg, who, next to Marcel Riesz, has made valuable contributions to these topics. This volume will be of interest to mathematicians working in the fields of algebra, geometry or special functions, to physicists working on quantum mechanics or supersymmetry, and to historians of mathematical physics.
This should be a useful reference for anybody with an interest in quantum theory.
This provides a major review of the two-level system Kondo model, as applied to metallic glasses, nanoscale devices and some doped semiconductors; and the quadripolar and magnetic two-channel Kondo models developed for rare-earth and actinide ions with crystal splitting metals. These contrast with the simple single-channel model, and allow the study of non-Fermi liquid physics. This book forms a valuable and unique source of information for statistical and condensed matter physicists and graduate students. Key Features: * An invaluable and unique source of information on this highly popular area of condensed matter physics * Based upon a special edition of the Advances in Physics journal * Magnetic impurities in metals present a major

challenge to condensed matter physicists, for which a strong starting point has long been the early insights of Kondo into the resistance medium

The 23 review lectures in this volume were presented by prominent specialists in the field. The scope is wide: major trends in gauge field theory and its applications are covered. A considerable part of the articles contain previously unpublished results.

This selection of reviews and papers is intended to stimulate renewed reflection on the fundamental and practical aspects of probability in physics. While putting emphasis on conceptual aspects in the foundations of statistical and quantum mechanics, the book deals with the philosophy of probability in its interrelation with mathematics and physics in general. Addressing graduate students and researchers in physics and mathematics togehter with philosophers of science, the contributions avoid cumbersome technicalities in order to make the book worthwhile reading for nonspecialists and specialists alike.

Noncommutative geometry, inspired by quantum physics, describes singular spaces by their noncommutative coordinate algebras and metric structures by Dirac-like operators. Such metric geometries are described mathematically by Connes' theory of spectral triples. These lectures, delivered at an EMS Summer School on noncommutative geometry and its applications, provide an overview of spectral triples based on examples. This introduction is aimed at graduate students of both mathematics and theoretical physics. It deals with Dirac operators on spin manifolds, noncommutative tori, Moyal quantization and tangent groupoids, action functionals, and isospectral deformations. The structural framework is the concept of a noncommutative spin geometry; the conditions on spectral triples which determine this concept are developed in detail. The emphasis throughout is on gaining understanding by computing the details of specific examples. The book provides a middle ground between a comprehensive text and a narrowly focused research monograph. It is intended for self-study, enabling the reader to gain access to the essentials of noncommutative geometry. New features since the original course are an expanded bibliography and a survey of more recent examples and applications of spectral triples.

This conference brought together physicists and mathematicians working on spinors, which have played an important role in recent research on supersymmetry, Kaluza-Klein theories, twistors and general relativity. Contents:Killing Spinors According to O Hijazi and Applications (A Lichnerowicz)Self-Duality Conditions Satisfied by the Spin Connections on Spheres (J Rawnsley)Maslov Index and Half-Forms (M Cahen)Spin-3/2 Field on Black Hole Spacetimes (P Aichelburg)Indecomposable Conformal Spinors and Operator Product Expansions in a Massless QED Model (Y S Stanev & I T Todorov)Nonlinear Spinor Representations (R Raçka)Nonlinear Wave Equations for Intrinsic Spinor Coordinates (P Furlan)Twistors-“Spinors” of SU(2,2), Their Generalizations and Achievements (J Niederle)Spinors, Reflections and Clifford Algebras: A Review (R Coquereaux)SL (n,R) Spinors for Particles, Gravity and Superstrings (Dj Šija?ki)Spinors on Compact Riemann Surfaces (C Reina)Simple Spinors as Urfelder (E Caianiello)Applications of Cartan Spinors to Differential Geometry in Higher Dimensions (L P Hughston)Killing Spinors on Spheres and Projective Spaces (S Gutt)Spinor Structures on Homogeneous Riemann Spaces (L Dabroswki & A Trautman)Classical Strings and Minimal Surfaces (H Urbantke)Representing Spinors with Differential Forms (I M Benn & R W Tucker)Inequalities for Spinors Norms in Clifford Algebras (G N Hile & P Lounesto)The Importance of Spin (A O Barut)The Theory of World Spinors (Y

Ne'eman) Readership: Theoretical physicists and mathematicians.
Visual Quantum Mechanics is a systematic effort to investigate and to teach quantum mechanics with the aid of computer-generated animations. Although it is self-contained, this book is part of a two-volume set on Visual Quantum Mechanics. The first book appeared in 2000, and earned the European Academic Software Award in 2001 for oustanding innovation in its field. While topics in book one mainly concerned quantum mechanics in one- and two-dimensions, book two sets out to present three-dimensional systems, the hydrogen atom, particles with spin, and relativistic particles. Together the two volumes constitute a complete course in quantum mechanics that places an emphasis on ideas and concepts, with a fair to moderate amount of mathematical rigor.
An in depth exploration of how Clifford algebras and spinors have been sparking collaboration and bridging the gap between Physics and Mathematics. This collaboration has been the consequence of a growing awareness of the importance of algebraic and geometric properties in many physical phenomena, and of the discovery of common ground through various touch points: relating Clifford algebras and the arising geometry to so-called spinors, and to their three definitions (both from the mathematical and physical viewpoint). The main points of contact are the representations of Clifford algebras and the periodicity theorems. Clifford algebras also constitute a highly intuitive formalism, having an intimate relationship to quantum field theory. The text strives to seamlessly combine these various viewpoints and is devoted to a wider audience of both physicists and mathematicians. Among the existing approaches to Clifford algebras and spinors this book is unique in that it provides a didactical presentation of the topic and is accessible to both students and researchers. It emphasizes the formal

character and the deep algebraic and geometric completeness, and merges them with the physical applications.

This book is intended for physicists and chemists who need to understand the theory of atomic and molecular structure and processes, and who wish to apply the theory to practical problems. As far as practicable, the book provides a self-contained account of the theory of relativistic atomic and molecular structure, based on the accepted formalism of bound-state Quantum Electrodynamics. The author was elected a Fellow of the Royal Society of London in 1992.

This monograph is devoted to the systematic and encyclopedic presentation of the foundations of quantum field theory. It represents mathematical problems of the quantum field theory with regard to the new methods of the constructive and Euclidean field theory formed for the last thirty years of the 20th century on the basis of rigorous mathematical tools of the functional analysis, the theory of operators, and the theory of generalized functions. The book is useful for young scientists who desire to understand not only the formal structure of the quantum field theory but also its basic concepts and connection with classical mechanics, relativistic classical field theory, quantum mechanics, group theory, and the theory of functional integration.

The Springer Handbook of Spacetime is dedicated to the ground-breaking paradigm shifts embodied in the two relativity theories, and describes in detail the profound reshaping of physical sciences they ushered in. It includes in a single volume chapters on foundations, on the underlying mathematics, on physical and astrophysical implications, experimental evidence and cosmological predictions, as well as chapters on efforts to unify general relativity and quantum physics. The Handbook can be used as a desk reference by researchers in a wide variety of fields, not only by specialists in relativity but also by researchers in related areas that either grew out of, or are deeply influenced by, the two relativity theories: cosmology, astronomy and astrophysics, high energy physics, quantum field theory, mathematics, and philosophy of science. It should also serve as a valuable resource for graduate students and young researchers entering these areas, and for instructors who teach courses on these subjects. The Handbook is divided into six parts. Part A: Introduction to Spacetime Structure. Part B: Foundational Issues. Part C: Spacetime Structure and Mathematics. Part D: Confronting Relativity theories with observations. Part E: General relativity and the universe. Part F: Spacetime beyond Einstein.

This is the first text to be written on the topic of Self-Field Theory (SFT), a new mathematical description of physics distinct from quantum field theory, the physical theory of choice by physicists at the present time. SFT is a recent development that has evolved from the classical electromagnetics of the electron’s self-fields that were studied by Abraham and Lorentz in 1903-04. Due to its bi-spinorial motions for particles and fields that obviate uncertainty, SFT is capable of obtaining closed-form solution for all atomic structures rather than the probabilistic solutions of QFT.

There is an apparent trend towards geometrization of physical theories. During the last 20 years, the most successful mathematical models for the description and understanding of physical systems have been based on the Lie theory in its widest sense and various generalizations, for example, deformations of it. This proceedings volume reflects part of the development. On the mathematical side, they report on representations of Lie algebras, quantization procedures, non-commutative geometry, quantum groups, etc. Furthermore, possible physical applications of these techniques are discussed (e.g. quantization of classical systems, derivations of evolution equations, discrete and deformed physical systems). This volume complements the book Generalized Symmetries in Physics, published by World Scientific in 1994. Contents:Representation Theory and Quantization MethodsNoncommutative Geometry, Quantum Algebras and Applications to Relativistic and Nonrelativistic SystemsSpecial Applications to Physical Systems and Their Generalized ModelsRepresentation Theory and Quantization Methods Readership: Mathematicians and physicists. keywords:

ZBIGNIEW OZIEWICZ University of Wroclaw, Poland December 1992 The First Max Born Symposium in Theoretical and Mathematical Phy sics, organized by the University of Wrodaw, was held in September 1991 with the intent that it would become an annual event. It is the outgrowth of the annual Seminars organized jointly since 1972 with the University of Leipzig. The name of the Symposia was proposed by Professor Jan Lopu szanski. Max Born, an outstanding German theoretical physicist, was born in 1883 in Breslau (the German name of Wrodaw) and educated here. The Second Max Born

Symposium was held during the four days 24- 27 September 1992 in an old Sobotka Castle 30 km west of Wrodaw. The Sobotka Castle was built in the eleventh century. The dates engraved on the walls of the Castle are 1024, 1140, and at the last rebuilding, 1885. The castle served as a cloister until the end of the sixteenth century. This proceedings is based on the interdisciplinary workshop held in Madrid, 5-9 March 2018, dedicated to Alberto Ibort on his 60th birthday. Alberto has great and significantly contributed to many fields of mathematics and physics, always with highly original and innovative ideas.Most of Albertos's scientific activity has been motivated by geometric ideas, concepts and tools that are deeply related to the framework of classical dynamics and quantum mechanics.Let us mention some of the fields of expertise of Alberto Ibort:Geometric Mechanics; Constrained Systems; Variational Principles; Multisymplectic structures for field theories; Super manifolds; Inverse problem for Bosonic and Fermionic systems; Quantum Groups, Integrable systems, BRST Symmetries; Implicit differential equations; Yang-Mills Theories; BiHamiltonian Systems; Topology Change and Quantum Boundary Conditions; Classical and Quantum Control; Orthogonal Polynomials; Quantum Field Theory and Noncommutative Spaces; Classical and Quantum Tomography; Quantum Mechanics on phase space; Wigner-Weyl formalism; Lie-Jordan Algebras, Classical and Quantum; Quantum-to-Classical transition; Contraction of Associative Algebras; contact geometry, among many others.In each contribution, one may find not only technical novelties but also completely new way of looking at the considered problems. Even an experienced reader, reading Alberto's contributions on his field of expertise, will find new perspectives on the considered topic.His enthusiasm is happily contagious, for this reason he has had, and still has, very bright students wishing to elaborate their PhD thesis under his guidance.What is more impressive, is the broad list of rather different topics on which he has contributed.

Topological GeometroDynamics is a modification of general relativity inspired by the conceptual problems related to the definitions of inertial and gravitational energy in general relativity. Topological geometrodynamics can be also seen as a generalization of super string models. Physical space-times are seen as four-dimensional surfaces in certain eight-dimensional space. The choice of this space is fixed by symmetries of the standard model so that geometrization of known classical fields and elementary particle quantum numbers results. The notion of many-sheeted space-time allows re-interpretation of the structures of perceived world in terms of macroscopic space-time topology. The generalization of the number concept based on fusion of real numbers and p-adic number fields implies a further generalization of the space-time concept allowing to identify space-time correlates of cognition and intentionality. Quantum measurement theory extended to a quantum theory of consciousness becomes an organic part of theory. A highly non-trivial prediction is the existence of a fractal hierarchy of copies of standard model physics with dark matter identified in terms of macroscopic quantum phases characterized by dynamical and quantized Planck constant. The book is a comprehensive overview and analysis of topological geometrodynamics as a mathematical and physical theory.

The outcome of a close collaboration between mathematicians and mathematical physicists, these lecture notes present the foundations of A. Connes noncommutative geometry as well as its applications in particular to the field of theoretical particle physics. The coherent and systematic approach makes this book useful for experienced researchers and postgraduate students alike.

This volume is a collection of papers on the application of operational research approaches and methods to problems in the health services.

Ideas of Quantum Chemistry shows how quantum mechanics is applied to chemistry to give it a theoretical foundation. The structure of the book (a TREE-form) emphasizes the logical relationships between various topics, facts and methods. It shows the reader which parts of the text are needed for understanding specific aspects of the subject matter. Interspersed throughout the text are short biographies of key scientists and their contributions to the development of the field. Ideas of Quantum Chemistry has both textbook and reference work aspects. Like a textbook, the material is organized into digestable sections with each chapter following the same structure. It answers frequently asked questions and highlights the most important conclusions and the essential mathematical formulae in the text. In its reference aspects, it has a broader range than traditional quantum chemistry books and reviews virtually all of the pertinent literature. It is useful both for beginners as well as specialists in advanced topics of quantum chemistry. The book is supplemented by an appendix on the Internet. * Presents the widest range of quantum chemical problems covered in one book * Unique structure allows material to be tailored to the specific needs of the reader * Informal language facilitates the understanding of difficult topics

This volume is dedicated to the memory of Albert Crumeyrolle, who died on June 17, 1992. In organizing the volume we gave priority to: articles summarizing Crumeyrolle's own work in differential geometry, general relativity and spinors, articles which give the reader an idea of the depth and breadth of Crumeyrolle's research interests and influence in the field, articles of high scientific quality which would be of general interest. In each of the areas to which Crumeyrolle made significant contribution - Clifford and exterior algebras, Weyl and pure spinors, spin structures on manifolds, principle of triality, conformal geometry - there has been substantial progress. Our hope is that the volume conveys the originality of Crumeyrolle's own work, the continuing vitality of the field he influenced, and the enduring respect for, and tribute to, him and his accomplishments in the mathematical community. It isour pleasure to thank Peter Morgan, Artibano Micali, Joseph Grifone, Marie Crumeyrolle and Kluwer Academic Publishers for their help in preparingthis volume.

This book is an introduction to the principles of semiconductor physics, linking its scientific aspects with practical applications. It is addressed to both readers who wish to learn semiconductor physics and those seeking to understand semiconductor devices. It is particularly well suited for those who want to do both.Intended as a teaching vehicle, the book is written in an expository manner aimed at conveying a deep and coherent understanding of the field. It provides clear and complete derivations of the basic concepts of modern semiconductor physics. The mathematical arguments and physical interpretations are well balanced: they are presented in a measure designed to ensure the integrity of the delivery of the subject matter in a fully comprehensible form. Experimental procedures and measured data are included as well. The reader is generally not expected to have background in quantum mechanics and solid state physics beyond the most elementary level. Nonetheless, the presentation of this book is planned to bring the student to the point of research/design capability as a scientist or engineer. Moreover, it is sufficiently well endowed with detailed knowledge of the field, including recent developments bearing on submicron semiconductor structures, that the book also constitutes a valuable reference resource.In Chapter 1, basic features of the atomic structures, chemical nature and the macroscopic properties of semiconductors are discussed. The band structure of ideal semiconductor crystals is treated in Chapter 2, together with the underlying one-electron picture and other fundamental concepts. Chapter 2 also provides the requisite background of the tight binding method and the k.p-method, which are later used extensively. The electron states of shallow and deep centers, clean semiconductor surfaces, quantum wells and superlattices, as well as the effects of external electric and magnetic fields, are treated in Chapter 3. The one- or multi-band effective mass theory is used wherever this method is applicable. A summary of group theory for application in semiconductor physics is given in an Appendix. Chapter 4 deals with the statistical distribution of charge carriers over the band and localized states in thermodynamic equilibrium. Non-equilibrium processes in semiconductors are treated in Chapter 5. The physics of semiconductor junctions (pn-, hetero-, metal-, and insulator-) is developed in Chapter 6 under conditions of thermodynamic equilibrium, and in Chapter 7 under non-equilibrium conditions. On this basis, the most important electronic and opto-electronic semiconductor devices are treated, among them uni- and bi-polar transistors, photodetectors, solar cells, and injection lasers. A summary of group theory for applications in semiconductors is given in an Appendix.

Spinors are used extensively in physics. It is widely accepted that they are more fundamental than tensors, and the easy way to see this is through the results obtained in general relativity theory by using spinors — results that could not have been obtained by using tensor methods only.The foundation of the concept of spinors is groups; spinors appear as representations of groups. This textbook expounds the relationship between spinors and representations of groups. As is well known, spinors and representations are both widely used in the theory of elementary particles.The authors present the origin of spinors from representation theory, but nevertheless apply the theory of spinors to general relativity theory, and part of the book is devoted to curved space-time applications.Based on lectures given at Ben Gurion University, this textbook is intended for advanced undergraduate and graduate students in physics and mathematics, as well as being a reference for researchers.

Matrix algebra has been called "the arithmetic of higher mathematics" [Be]. We think the basis for a better arithmetic has long been available, but its versatility has hardly been appreciated, and it has not yet been integrated into the mainstream of mathematics. We refer to the system commonly called 'Clifford Algebra', though we prefer the name 'Geometric Algebm' suggested by Clifford himself. Many distinct algebraic systems have been adapted or developed to express geometric relations and describe geometric structures. Especially notable are those algebras which have been used for this purpose in physics, in particular, the system of complex numbers, the quatemions, matrix algebra, vector, tensor and spinor algebras and the algebra of differential forms. Each of these geometric algebras has some significant advantage over the others in certain applications, so no one of them provides an adequate algebraic structure for all purposes of geometry and physics. At the same time, the algebras overlap considerably, so they provide several different mathematical representations for individual geometrical or physical ideas.

This book is designed to make accessible to nonspecialists the still evolving concepts of quantum mechanics and the terminology in which these are expressed. The opening chapters summarize elementary concepts of twentieth century quantum mechanics and describe the mathematical methods employed in the field, with clear explanation of, for example, Hilbert space, complex variables, complex vector spaces and Dirac notation, and the Heisenberg uncertainty principle. After detailed discussion of the Schrödinger equation, subsequent chapters focus on isotropic vectors, used to construct spinors, and on conceptual problems associated with measurement, superposition, and decoherence in quantum systems. Here, due attention is paid to Bell's inequality and the possible existence of hidden variables. Finally, progression toward quantum computation is examined in detail: if quantum computers can be made practicable, enormous enhancements in computing power, artificial intelligence, and secure communication will result. This book will be of interest to a wide readership seeking to understand modern quantum mechanics and its potential applications.