On The Dirac Equation In Curved Space Time

Geared toward advanced undergraduate and graduate students of physics, this text advances from a brief introduction to a three-part treatment covering particles of spin zero, particles of one-half, and collision and radiation processes. 1963 edition.

From Spinors to Quantum Mechanics discusses group theory and its use in quantum mechanics. Chapters 1 to 4 offer an introduction to group theory, and it provides the reader with an exact and clear intuition of what a spinor is, showing that spinors are just a mathematically complete notation for group elements. Chapter 5 contains the first rigorous derivation of the Dirac equation from a simple set of assumptions. The remaining chapters will interest the advanced reader who is interested in the meaning of quantum mechanics. They propose a novel approach to the foundations of quantum mechanics, based on the idea that the meaning of the formalism is already provided by the mathematics.In the traditional approach to quantum mechanics as initiated by Heisenberg, one has to start from a number of experimental results and then derive a set of rules and calculations that reproduce the observed experimental results. In such an inductive approach the underlying assumptions are not given at the outset. The reader has to figure them out, and this has proven to be difficult. The book shows that a different, bottom-up approach to quantum mechanics is possible, which merits further investigation as it demonstrates that with the methods used, the reader can obtain the correct results in a context where one would hitherto not expect this to be possible.

Please note that the content of this book primarily consists of articles available from Wikipedia or other free sources online. Pages: 38. Chapters: Dirac adjoint, Dirac equation, Dirac equation in the algebra of physical space, Dirac spinor, Fermionic field, Feynman checkerboard, Feynman slash notation, Fierz identity, Gamma matrices, Higher-dimensional gamma matrices, Killing spinor, Majorana equation, Orientation entanglement, Plate trick, Pure spinor, Rarita-Schwinger equation, Spinors in three dimensions, Spinor field, Spin connection, Spin group, Spin representation, Spin spherical harmonics, Tangloids, Triality, Van der Waerden notation, Weyl-Brauer matrices.

Unique in its coverage of all aspects of modern particle physics, this textbook provides a clear connection between the theory and recent experimental results, including the discovery of the Higgs boson at CERN. It provides a comprehensive and self-contained description of the Standard Model of particle physics suitable for upper-level undergraduate students and graduate students studying experimental particle physics. Physical theory is introduced in a straightforward manner with full mathematical derivations throughout. Fully-worked examples enable students to link the mathematical theory to results from modern particle physics experiments. End-of-chapter exercises, graded by difficulty, provide students with a deeper understanding of the subject. Online resources available at www.cambridge.org/MPP feature password-protected fully-worked solutions to problems for instructors, numerical solutions and hints to the problems for students and PowerPoint slides and JPEGs of figures from the book.

techniques, and raises new issues of physical interpretation as well as possibilities for deepening the theory. (3) Barut contributes a comprehensive review of his own ambitious program in electron theory and quantum electrodynamics. Barut's work is rich with ingenious ideas, and the interest it provokes among other theorists can be seen in the cri tique by Grandy. Cooperstock takes a much different approach to nonlinear field-electron coupling which leads him to conclusions about the size of the electron. (4) Capri and Bandrauk work within the standard framework of quantum electrodynamics. Bandrauk presents a valuable review of his theoretical approach to the striking new photoelectric phenomena in high intensity laser experiments. (5) Jung proposes a theory to merge the ideas of free-free transitions and of scattering chaos, which is becoming increasingly important in the theoretical analysis of nonlinear optical phenomena. For the last half century the properties of electrons have been probed primarily by scattering experiments at ever higher energies. Recently, however, two powerful new experimental techniques have emerged capable of giving alternative experimental views of the electron. We refer to (1) the confinement of single electrons for long term study, and (2) the interaction of electrons with high intensity laser fields. Articles by outstanding practitioners of both techniques are included in Part II of these Proceedings. The precision experiments on trapped electrons by the Washington group quoted above have already led to a Nobel prize for the most accurate measurements of the electron magnetic moment.

The author discusses the implementation and performance on massively parallel, distributed-memory computers of a message-passing program to solve the time-dependent dirac equation in three Cartesian coordinates. Luses pseudo-spectral methods to obtain a discrete representation of the dirac spinor wavefunction and all coordinate-space operators. Algorithms for the solution of the discrete equations are iterative and depend critically on the dirac hamiltonian-wavefunction product, which he implements as a series of parallel matrix products using MPI. He investigated two communication algorithms, a ring algorithm and a collective-communication algorithm, and present performance results for each on a Paragon-MP (1024 nodes) and a Cray T3E-900 (512 nodes). The ring algorithm achieves very good performance, scaling up to the maximum number of nodes on each machine. However, the collective-communication algorithm scales effectively only on the Paragon.

This book presents the modern quantum field theory view of the electron. This view is very different from the outdated classical view that is most often taught in schools and colleges. We cannot present the QFT view of the electron without also presenting the electron's sister particle the neutrino, and so the QFT view of the neutrino is presented also. The quantum physics equations which describe the electron and the neutrino are presented in a simple and clear way. The Dirac equation is rewritten using quaternions, and this leads to a resolution of the neutrino mass problem and to an understanding of why neutrinos are all left-handed. Thus we come to understand the violation of parity by the weak force and how neutrinos can both move at the speed of light and oscillate between generations. This book is a landmark book in this area of physics.

This book presents the long sought after quaternion form of the Dirac equation. Recent developments in understanding quaternion differentiation by the author of this book have produced a rewrite of the Dirac equation as a quaternion equation. The quaternion Dirac equation predicts parity violation by the weak force and explains how neutrinos can be both massless and oscillate between generations. We also have a significant step towards the unification of general relativity and quantum field theory. This book is a monumental triumph of work by many individuals over almost a century. It will be of interest to students and advanced theorists alike.

The Dirac equation is of fundamental importance for relativistic quantum mechanics and quantum electrodynamics. In relativistic quantum mechanics, the Dirac equation is referred to as one-particle wave equation of motion for electron in an external electromagnetic field. In quantum electrodynamics, exact solutions of this equation are needed to treat the interaction between the electron and the external field exactly. In this monograph, all propagators of a particle, i.e., the various Green's functions, are constructed in a certain way by using exact solutions of the Dirac equation.

The solution of the Dirac equation for an electron in a Coulomb field is systematically treated here by utilizing new insights provided by supersymmetry. It is shown that each of the concepts has its analogue in the non-relativistic case. Indeed, the non-relativistic case is developed first, in order to introduce the new concepts in a familiar context. The symmetry of the non-relativistic model is already present in the classical limit, so the classical Kepler problem is first discussed in order to bring out the role played by the Laplace vector, one of the central concepts of the whole book. Analysis of the concept of eccentricity of the orbits turns out to be essential to understanding the relation of the classical and quantum mechanical models. The opportunity is taken to relive the great moments of physics: From Kepler's discovery of the laws of motion of the planets the development is traced through the Dirac equation up to modern advances, which bring the concepts of supersymmetry to bear on the derivation of the solutions.

This book covers advanced topics in quantum mechanics, including nonrelativistic multi-particle systems, relativistic wave equations, and relativistic fields. Numerous examples for application help readers gain a thorough understanding of the subject. The presentation of relativistic wave equations and their symmetries, and the fundamentals of quantum field theory lay the foundations for advanced studies in solid-state physics, nuclear, and elementary particle physics. The authors earlier book, Quantum Mechanics, was praised for its unsurpassed clarity.

This book explains and develops the Dirac equation in the context of general relativistic quantum mechanics in a range of spacetime dimensions. It clarifies the subject by carefully pointing out the various conventions used and explaining how they are related to each other. The prerequisites are familiarity with general relativity and an exposure to the Dirac equation at the level of special relativistic quantum mechanics, but a review of this latter topic is given in the first chapter as a reference and framework for the physical interpretations that follow. Worked examples and exercises with solutions are provided. Appendices include reviews of topics used in the body of the text. This book should benefit researchers and graduate students in general relativity and in condensed matter.

Paul Dirac was among the great scientific geniuses of the modern age. One of the discoverers of quantum mechanics, the most revolutionary theory of the past century, his contributions had a unique insight, eloquence, clarity, and mathematical power. His prediction of antimatter was one of the greatest triumphs in the history of physics. One of Einstein's most admired colleagues, Dirac was in 1933 the youngest theoretician ever to win the Nobel Prize in physics. Dirac's personality is legendary. He was an extraordinarily reserved loner, relentlessly literal-minded and appeared to have no empathy with most people. Yet he was a family man and was intensely loyal to his friends. His tastes in the arts ranged from Beethoven to Cher, from Rembrandt to Mickey Mouse. Based on previously undiscovered archives, The Strangest Man reveals the many facets of Dirac's brilliantly original mind. A compelling human story, The Strangest Man also depicts a spectacularly exciting era in scientific history.

This book on Special Relativity, with unique chapters on the Dirac equation and General Relativity, is especially suitable for a one-semester undergraduate physics course on Special Relativity (with perhaps some coverage of the qualitative features of General Relativity). It can also be used in a combination of undergraduate courses including modern physics, particle physics, optics, and Quantum Mechanics; or in classical mechanics at the physics graduate level. The book also includes coverage of the history of relativity, particularly with respect to developments in electricity and magnetism, particle physics, and cosmology. This is the revised second edition.

Topological insulators are insulating in the bulk, but process metallic states present around its boundary owing to the topological origin of the band structure. The metallic edge or surface states are immune to weak disorder or impurities, and robust against the deformation of the system geometry. This book, the first of its kind on topological insulators, presents a unified description of topological insulators from one to three dimensions based on the modified Dirac equation. A series of solutions of the bound states near the boundary are derived, and the existing conditions of these solutions are described. Topological invariants and their applications to a variety of systems from one-dimensional polyacetalene, to two-dimensional quantum spin Hall effect and p-wave superconductors, and three-dimensional topological insulators and superconductors or superfluids are introduced, helping readers to better understand this fascinating new field. This book is intended for researchers and graduate students working in the field of topological insulators and related areas. Shun-Qing Shen is a Professor at the Department of Physics, the University of Hong Kong, China.

Looks at the mysteries, scientific discoveries, and benefits of the chemical element hydrogen.

The fundamental goal of physics is an understanding of the forces of nature in their simplest and most general terms. Yet there is much more involved than just a basic set of equations which eventually has to be solved when applied to specific problems. We have learned in recent years that the structure of the ground state of field theories (with which we are generally concerned) plays an equally funda mental role as the equations of motion themselves. Heisenberg was probably the first to recognize that the ground state, the vacuum, could acquire certain prop erties (quantum numbers) when he devised a theory of ferromagnetism. Since then, many more such examples are known in solid state physics, e. g. supercon ductivity, superfluidity, in fact all problems concerned with phase transitions of many-body systems, which are often summarized under the name synergetics. Inspired by the experimental observation that also fundamental symmetries, such as parity or chiral symmetry, may be violated in nature, it has become wide ly accepted that the same field theory may be based on different vacua. Practical ly all these different field phases have the status of more or less hypothetical models, not (yet) directly accessible to experiments. There is one magnificent ex ception and this is the change of the ground state (vacuum) of the electron-posi tron field in superstrong electric fields.

Geared toward advanced undergraduate and graduate students of physics, this text provides readers with a background in relativistic wave mechanics and prepares them for the study of field theory. The treatment originated as a series of lectures from a course on advanced quantum mechanics that has been further amplified by student contributions. An introductory section related to particles and wave functions precedes the three-part treatment. An examination of particles of spin zero follows, addressing wave equation, Lagrangian formalism, physical quantities as mean values, translation and rotation operators, spin zero particles in electromagnetic field, pi-mesic atoms, and discontinuous transformations. The second section explores particles of spin one-half in terms of spin operators, the Weyl and Dirac equations, constants of motion, plane wave solutions and invariance properties of the Dirac equation, the Dirac equation for a charged particle in an electromagnetic field, non-relativistic limit of the Dirac equation, and Dirac particle in a central electrostatic field. The final section, on collision and radiation processes, covers time-independent scattering of a spinless particle, non-relativistic steady-state scattering of a particle of spin one-half, time-independent scattering of Dirac particles, non-relativistic time-dependent scattering theory, emission and absorption of electromagnetic radiation, and time-dependent relativistic scattering theory.

Relativistic Quantum Mechanics begins with the Klein-Gordon equation describing its features and motivating the need for a correct relativistic equation for the electron. It then introduces the Dirac equation by linearizing the second order relativistic equation which reveals the spin, spin magnetic moment and the spin-orbit coupling of the electron. After demonstrating the relativistic covariance of the Dirac equation, the discrete transformations of the Dirac spinor, are explained. The Dirac equation for a free electron and an electron in hydrogen atom are solved these solutions are used to interpret the negative energy states in the hole theory' of Dirac. As applications of the Dirac equation, the scattering of electrons by a Coulomb potential is given in detail and extended to electron-proton scattering. As a further application, the Dirac equation with zero mass is considered to describe the neutrino. The chapter on neutrinos contains a brief description of neutrino oscillations'. The book ends with giving an elementary treatment of spin manifolds with illustrative examples.

More than a generation of Gennan-speaking students around the world have worked their way to an understanding and appreciation of the power and beauty of modern theoretical physics - with mathematics, the most fundamental of sciences - using Walter Greiner's textbooks as their guide. The idea of developing a coherent, complete presentation of an entire field of science in a series of closely related textbooks is not a new one. Many older physicists remember with real pleasure their sense of adventure and discovery as they worked their ways through the classic series by Sommerfeld, by Planck and by Landau and Lifshitz. From the students' viewpoint, there are a great many obvious advantages to be gained through use of consistent notation, logical ordering of topics and coherence of presentation; beyond this, the complete coverage of the science provides a unique opportunity for the author to convey his personal enthusiasm and love for his subject. The present five volume set, Theoretical Physics, is in fact only that part of the complete set of textbooks developed by Greiner and his students that presents the quantum theory. I have long urged him to make the remaining volumes on classical mechanics and dynamics, on electromagnetism, on nuclear and particle physics, and on special topics available to an English-speaking audience as well, and we can hope for these companion volumes covering all of theoretical physics some time in the future.

* Which problems do arise within relativistic enhancements of the Schrödinger theory, especially if one adheres to the usual one-particle interpretation? * To what extent can these problems be overcome? * What is the physical necessity of quantum field theories? In many textbooks, only insufficient answers to these fundamental questions are provided by treating the relativistic quantum mechanical one-particle concept very superficially and instead introducing field quantization as soon as possible. By contrast, this book emphasizes particularly this point of view (relativistic quantum mechanics in the "narrow sense"): it extensively discusses the relativistic one-particle view and reveals its problems and limitations, therefore illustrating the necessity of quantized fields in a physically comprehensible way. The first two chapters contain a detailed presentation and comparison of the Klein-Gordon and Dirac theory, always with a view to the non-relativistic theory. In the third chapter, we consider relativistic scattering processes and develop the Feynman rules from propagator techniques. This is where the indispensability of quantum field theory reasoning becomes apparent and basic quantum field theory concepts are introduced. This textbook addresses undergraduate and graduate Physics students who are interested in a clearly arranged and structured presentation of relativistic quantum mechanics in the "narrow sense" and its connection to quantum field theories. Each section contains a short summary and exercises with solutions. A mathematical appendix rounds out this excellent textbook on relativistic quantum mechanics.

This collection brings together the five books of the series "concepts of physics". The books cover the following topics: complex numbers, special relativity, the mathematics for quantum mechanics, the Dirac equation, relativity, decays and electromagnetic fields. These are basic concepts of physics, indispensable for its complete understanding.

This book provides an introduction to the essentials of relativistic effects in quantum chemistry, and a reference work that collects all the major developments in this field. It is designed for the graduate student and the computational chemist with a good background in nonrelativistic theory. In addition to explaining the necessary theory in detail, at a level that the non-expert and the student should readily be able to follow, the book discusses the implementation of the theory and practicalities of its use in calculations. After a brief introduction to classical relativity and electromagnetism, the Dirac equation is presented, and its symmetry, atomic solutions, and interpretation are explored. Four-component molecular methods are then developed: self-consistent field theory and the use of basis sets, double-group and time-reversal symmetry, correlation methods, molecular properties, and an overview of relativistic density functional theory. The emphases in this section are on the basics of relativistic theory and how relativistic theory differs from nonrelativistic theory. Approximate methods are treated next, starting with spin separation in the Dirac equation, and proceeding to the Foldy-Wouthuysen, Douglas-Kroll, and related transformations, Breit-Pauli and direct perturbation theory, regular approximations, matrix approximations, and pseudopotential and model potential methods. For each of these approximations, one-electron operators and many-electron methods are developed, spin-free and spin-orbit operators are presented, and the calculation of electric and magnetic properties is discussed. The treatment of spin-orbit effects with correlation rounds off the presentation of approximate methods. The book concludes with a discussion of the qualitative changes in the picture of structure and bonding that arise from the inclusion of relativity.

Differential Equations in Engineering: Research and Applications describes advanced research in the field of the applications of differential equations in engineering and the sciences, and offers a sound theoretical background, along with case studies. It describes the advances in differential equations in real life for engineers. Along with covering many advanced differential equations and explaining the utility of these equations, the book provides a broad understanding of the use of differential equations to solve and analyze many real-world problems, such as calculating the movement or flow of electricity, the motion of an object to and from, like a pendulum, or explaining thermodynamics concepts by making use of various mathematical tools, techniques, strategies, and methods in applied engineering. This book is written for researchers and academicians, as well as for undergraduate and postgraduate students of engineering.

A stunning and unique look at the great equations that lie at the heart of many of the most successful scientific theories.

' Paul Adrian Maurice Dirac (1902–84) is one of the icons of modern physics. His work provided the mathematical foundations of quantum mechanics. He also made key contributions to quantum field theory and quantum statistical mechanics. He is perhaps best known for formulating the Dirac equation, a relativistic wave equation which described the properties of the electron, and also predicted the existence of anti-matter. He was awarded the Nobel prize in Physics in 1933 along with Erwin Schreodinger for his contributions to quantum theory. The Dirac Centennial Symposium held commemorated the contributions of Dirac to all areas of physics, and assessed their impact on frontier research. This invaluable book constitutes the proceedings of the symposium, containing articles by Leopold Halpern, Pierre Ramond, Frank Wilczek, Maurice Goldhaber, Jonathan Bagger, Joe Lykken, Roman Jackiw, Stanley Deser, Joe Polchinski, Andre Linde and others. A special contribution from Dirac's daughter Monica Dirac presents a portrait of Paul Dirac as father and family man. The proceedings have been selected for coverage in: • Index to Scientific & Technical Proceedings (ISTP CDROM version / ISI Proceedings) Contents:Introduction (H Baer)Paul Dirac: Building Bridges of the Mind (L M Brown)From Reminiscences to Outlook (L Halpern)My Father (M Dirac)The Dirac Equation (F Wilczek)Anomalous Magnetic Moments (W J Marciano)Dirac's Footsteps and Supersymmetry (P Ramond)PAM Dirac and the Development of Modern General Relativity (S Deser)Building Atomic Nuclei with the Dirac Equation (B D Serot)New Focus on Neutrinos (V Barger)Dirac's Magnetic Monopoles (Again) (R W Jackiw)Monopoles, Duality, and String Theory (J Polchinski)Time Variation of Fundamental Constants as a Probe of New Physics (P Langacker)Amending the Standard Model of Particle Physics (M Goldhaber) Readership: Graduate students and researchers in high energy physics. Keywords:High Energy Physics;Particle Physics;Quantum PhysicsReviews:"There are 13 contributions from the speakers, more-or-less centred around areas of Dirac's interest. The anecdotes sprinkled throughout are particularly entertaining to read, especially for younger readers who may not have heard many of them."CERN Courier "For the more general reader there is a long, accessible and interesting chapter by Frank Wilczek on the Dirac Equation, and a charming memoir by his daughter Monica on life as a child in the Dirac home."Contemporary Physics '

This new edition presents a unified description of these insulators from one to three dimensions based on the modified Dirac equation. It derives a series of solutions of the bound states near the boundary, and describes the current status of these solutions. Readers are introduced to topological invariants and their applications to a variety of systems from one-dimensional polyacetylene, to two-dimensional quantum spin Hall effect and p-wave superconductors, three-dimensional topological insulators and superconductors or superfluids, and topological Weyl semimetals, helping them to better understand this fascinating field. To reflect research advances in topological insulators, several parts of the book have been updated for the second edition, including:

Spin-Triplet Superconductors, Superconductivity in Doped Topological Insulators, Detection of Majorana Fermions and so on. In particular, the book features a new chapter on Weyl semimetals, a topic that has attracted considerable attention and has already become a new hotpot of research in the community.

This book comprises the lectures of a two-semester course on quantum field theory, presented in a quite informal and personal manner. The course starts with relativistic one-particle systems, and develops the basics of quantum field theory with an analysis on the representations of the Poincaré group. Canonical quantization is carried out for scalar, fermion, Abelian and non-Abelian gauge theories. Covariant quantization of gauge theories is also carried out with a detailed description of the BRST symmetry. The Higgs phenomenon and the standard model of electroweak interactions are also developed systematically. Regularization and (BPHZ) renormalization of field theories as well as gauge theories are discussed in detail, leading to a derivation of the renormalization group equation. In addition, two chapters — one on the Dirac quantization of constrained systems and another on discrete symmetries — are included for completeness, although these are not covered in the two-semester course.This second edition includes two new chapters, one on Nielsen identities and the other on basics of global supersymmetry. It also includes two appendices, one on fermions in arbitrary dimensions and the other on gauge invariant potentials and the Fock-Schwinger gauge.

This monograph gives a comprehensive treatment of spectral (linear) stability of weakly relativistic solitary waves in the nonlinear Dirac equation. It turns out that the instability is not an intrinsic property of the Dirac equation that is only resolved in the framework of the second quantization with the Dirac sea hypothesis. Whereas general results about the Dirac-Maxwell and similar equations are not yet available, we can consider the Dirac equation with scalar self-interaction, the model first introduced in 1938. In this book we show that in particular cases solitary waves in this model may be spectrally stable (no linear instability). This result is the first step towards proving asymptotic stability of solitary waves. The book presents the necessary overview of the functional analysis, spectral theory, and the existence and linear stability of solitary waves of the nonlinear Schrödinger equation. It also presents the necessary tools such as the limiting absorption principle and the Carleman estimates in the form applicable to the Dirac operator, and proves the general form of the Dirac-Pauli theorem. All of these results are used to prove the spectral stability of weakly relativistic solitary wave solutions of the nonlinear Dirac equation.

Relativistic Quantum Mechanics. Wave Equations concentrates mainly on the wave equations for spin-0 and spin-1/2 particles. Chapter 1 deals with the Klein-Gordon equation and its properties and applications. The chapters that follow introduce the Dirac equation, investigate its covariance properties and present various approaches to obtaining solutions. Numerous applications are discussed in detail, including the two-center Dirac equation, hole theory, CPT symmetry, Klein's paradox, and relativistic symmetry principles. Chapter 15 presents the relativistic wave equations for higher spin (Proca, Rarita-Schwinger, and Bargmann-Wigner). The extensive presentation of the mathematical tools and the 62 worked examples and problems make this a unique text for an advanced quantum mechanics course. This third edition has been slightly revised to bring the text up-to-date.

The Dirac equation, a relativistic quantum mechanical wave equation invented by Paul Dirac in 1928, originally designed to overcome the negative probability problem arising in the Klein-Gordon's scalar wave equation. The Dirac equation is fully consistent with the principles of quantum mechanics and largely in accordance with the theory of General Relativity. Paul Dirac's original equation can be modified to an advanced form in order to have the behaviors of the fermions in any curved spacetime. In this regard, the pioneering work of the Dirac equation in the asymptotically flat spacetime around a Kerr black hole was done by Nobel laureate Subrahmanyan Chandrasekhar in 976. After Chandrasekhar, progress was made to analyzing the Dirac equation in a non-asymptotically flat geometry, which is now a major focus of attention in Einstein's gravity theory enriched with various fields like Maxwell, Yang-Mills, Born-Infeld etc. Izzet Sakalli, one of the researchers of the Dirac equation, develops and explains some methods about how one separates and solves the Dirac equation in non-asymptotically flat geometry.

The Dirac EquationSpringer Science & Business Media

The Problem Book in Quantum Field Theory contains about 200 problems with solutions or hints that help students to improve their understanding and develop skills necessary for pursuing the subject. It deals with the Klein-Gordon and Dirac equations, classical field theory, canonical quantization of scalar, Dirac and electromagnetic fields, the processes in the lowest order of perturbation theory, renormalization and regularization. The solutions are presented in a systematic and complete manner. The material covered and the level of exposition make the book appropriate for graduate and undergraduate students in physics, as well as for teachers and researchers.

Four concise, brilliant lectures on mathematical methods in quantum mechanics from Nobel Prize–winning quantum pioneer build on idea of visualizing quantum theory through the use of classical mechanics.

This book is dedicated to the Dirac equation. The main arguments are: Dirac equation, gamma matrices in Dirac representation, properties of gamma matrices, covariance of the Dirac equation, Dirac Lagrangian and derivation of the Dirac equation from the equations of the Euler-Lagrange motion, Dirac equation in Hamiltonian form and free solutions in the rest and in any reference frame.

This report describes the implementation of nonlinear Dirac equations in the calculation of solitary waves. Conclusions and comments on quantum elasticity are also included.

Ever since its invention in 1929 the Dirac equation has played a fundamental role in various areas of modern physics and mathematics. Its applications are so widespread that a description of all aspects cannot be done with sufficient depth within a single volume. In this book the emphasis is on the role of the Dirac equation in the relativistic quantum mechanics of spin-1/2 particles. We cover the range from the description of a single free particle to the external field problem in quantum electrodynamics. Relativistic quantum mechanics is the historical origin of the Dirac equation and has become a fixed part of the education of theoretical physicists. There are some famous textbooks covering this area. Since the appearance of these standard texts many books (both physical and mathematical) on the non relativistic Schrodinger equation have been published, but only very few on the Dirac equation. I wrote this book because I felt that a modern, comprehensive presentation of Dirac's electron theory satisfying some basic requirements of mathematical rigor was still missing.