



**Greiner**

# RELATIVISTIC QUANTUM MECHANICS WAVE EQUATIONS

Third Edition



Springer

# Relativistic Quantum Mechanics Wave Equations

**R. Moss**



## **Relativistic Quantum Mechanics Wave Equations:**

Relativistic Quantum Mechanics. Wave Equations Walter Greiner, 2013-03-09 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 **Relativistic**

**Quantum Mechanics** Walter Greiner, 2013-06-29 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

Relativistic Quantum Mechanics Walter Greiner, 2014-03-12 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 Spin - 1/2 Wave Equations in Relativistic Quantum Mechanics Donald Stephen Staudte, 1993

Relativistic Quantum Mechanics. Wave Equations Walter Greiner, 2000-06-15 This revised and up to date classic reference lays the foundation for subsequent studies in advanced quantum mechanics and field theory offering problems and solutions to guide readers through Greiner s lecture texts Includes 87 worked examples and exercises 443 p *Relativistic Quantum Mechanics: Wave Equations, 3E* Walter Greiner, 2007-01-01 **Theoretical Physics: Relativistic quantum mechanics: wave equations** Walter Greiner, 1989 **Relativistic Quantum Mechanics and Field Theory** Franz Gross, 2008-07-11 An accessible comprehensive reference to modern quantum mechanics and field theory In surveying

available books on advanced quantum mechanics and field theory Franz Gross determined that while established books were outdated newer titles tended to focus on recent developments and disregard the basics Relativistic Quantum Mechanics and Field Theory fills this striking gap in the field With a strong emphasis on applications to practical problems as well as calculations Dr Gross provides complete up to date coverage of both elementary and advanced topics essential for a well rounded understanding of the field Developing the material at a level accessible even to newcomers to quantum mechanics the book begins with topics that every physicist should know quantization of the electromagnetic field relativistic one body wave equations and the theoretical explanation of atomic decay Subsequent chapters prepare readers for advanced work covering such major topics as gauge theories path integral techniques spontaneous symmetry breaking and an introduction to QCD chiral symmetry and the Standard Model A special chapter is devoted to relativistic bound state wave equations an important topic that is often overlooked in other books Clear and concise throughout Relativistic Quantum Mechanics and Field Theory boasts examples from atomic and nuclear physics as well as particle physics and includes appendices with background material It is an essential reference for anyone working in quantum mechanics today

**Advanced Molecular Quantum Mechanics** R. Moss, 2012-12-06 This book is primarily intended for graduate chemists and chemical physicists Indeed it is based on a graduate course that I give in the Chemistry Department of Southampton University Nowadays undergraduate chemistry courses usually include an introduction to quantum mechanics with particular reference to molecular properties and there are a number of excellent textbooks aimed specifically at undergraduate chemists In valence theory and molecular spectroscopy physical concepts are often encountered that are normally taken on trust For example electron spin and the anomalous magnetic moment of the electron are usually accepted as postulates although they are well understood by physicists In addition the advent of new techniques has led to experimental situations that can only be accounted for adequately by relatively sophisticated physical theory Relativistic corrections to molecular orbital energies are needed to explain X ray photo electron spectra while the use of lasers can give rise to multiphoton transitions which are not easy to understand using the classical theory of radiation Of course the relevant equations may be extracted from the literature but if the underlying physics is not understood this is a practice that is at best dissatisfying and at worst dangerous One instance where great care must be taken is in the use of spectroscopically determined parameters to test the accuracy of electronic wave functions

**Practical Quantum Electrodynamics** Douglas M. Gingrich, 2006-05-10 Taking a heuristic approach to relativistic quantum mechanics Practical Quantum Electrodynamics provides a complete introduction to the theory methodologies and calculations used for explaining the physical interaction of charged particles This book combines the principles of relativity and quantum theory necessary for performing the calculations

**The Dirac Equation and its Solutions** Vladislav G. Bagrov, Dmitry Gitman, 2014-08-20 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

**Relativistic and Non-Relativistic Quantum Mechanics** Luis Grave de Peralta, Maricela Fernández Lozada, Hira Farooq, Gage Eichman, Abhishek Singh, Gabrielle Prime, 2023-08-28 Currently relativistic quantum mechanics is considered an advanced topic only accessible to students who have already received considerable training in non relativistic quantum mechanics However the authors believe that they have found an excellent pedagogic approach for simultaneously introducing both topics This book is considered an Introductory Quantum Mechanics textbook that presents relativistic quantum mechanics to interested learners with no previous knowledge of it The authors avoid utilization of the well known Lorentz invariant equations Additionally they only refer to the Klein Gordon and Dirac equations to justify the use of the Poveda Poirier Grave de Peralta PPGP equations upon which this book is solely based while sporadically referring to well known results obtained using the Klein Gordon and Dirac equations to avoid unnecessary complications in an introductory book There also exist two complementary Schrödinger like and Pauli like PPGP equations the solutions of which are identical to the respective solutions of the Klein Gordon and Dirac equations associated with negative kinetic energies These equations relation to the existence of antiparticles is discussed The intended readership is undergraduate physics chemistry and engineering students with no previous knowledge of quantum mechanics as well as graduate students and professionals interested in the subject

*Wave Equations in Higher Dimensions* Shi-Hai Dong, 2011-07-09 Higher dimensional theories have attracted much attention because they make it possible to reduce much of physics in a concise elegant fashion that unifies the two great theories of the 20th century Quantum Theory and Relativity This book provides an elementary description of quantum wave equations in higher dimensions at an advanced level so as to put all current mathematical and physical concepts and techniques at the reader s disposal A comprehensive description of quantum wave equations in higher dimensions and their broad range of applications in quantum mechanics is provided which complements the traditional coverage found in the existing quantum mechanics textbooks and gives scientists a fresh outlook on quantum systems in all branches of physics In Parts I and II the basic properties of the SO(n) group are reviewed and basic theories and techniques related to wave equations in higher dimensions are introduced Parts III and IV cover important quantum systems in the framework of non relativistic and relativistic quantum mechanics in terms of the theories presented in Part II In particular the Levinson theorem and the generalized hypervirial theorem in higher dimensions the Schrödinger equation with position dependent mass and the Kaluza Klein theory in higher dimensions are investigated In this context the dependence of the energy levels on the dimension is shown Finally Part V contains conclusions outlooks and an extensive bibliography

Relativistic Quantum Mechanics and Introduction to Field Theory Francisco J. Yndurain, 2012-12-06 A fully relativistic

treatment of the quantum mechanics of particles requires the introduction of quantum field theory that is to say the quantum mechanics of systems with an infinite number of degrees of freedom This is because the relativistic equivalence of mass and energy plus the quantum possibility of fluctuations imply the existence of real or virtual creation and annihilation of particles in unlimited numbers In spite of this there exist processes and energy ranges where a treatment in terms of ordinary quantum mechanical tools is appropriate and the approximation of neglecting the full field theoretic description is justified Thus one may use concepts such as potentials and wave equations classical fields and classical currents etc The present text is devoted precisely to the systematic discussion of these topics to which we have added a general description of one and two particle relativistic states in particular for scattering processes A field theoretic approach may not be entirely avoided and in fact an introduction to quantum field theory is presented in this text However field theory is not the object per se of this book apart from a few examples field theory is mainly employed to establish the connection with equivalent potentials to study the classical limit of the emission of radiation or to discuss the propagation of a fermion in classical electromagnetic fields

*Relativistic Quantum Physics* Tommy Ohlsson, 2011-09-22 Quantum physics and special relativity theory were two of the greatest breakthroughs in physics during the twentieth century and contributed to paradigm shifts in physics This book combines these two discoveries to provide a complete description of the fundamentals of relativistic quantum physics guiding the reader effortlessly from relativistic quantum mechanics to basic quantum field theory The book gives a thorough and detailed treatment of the subject beginning with the classification of particles the Klein Gordon equation and the Dirac equation It then moves on to the canonical quantization procedure of the Klein Gordon Dirac and electromagnetic fields Classical Yang Mills theory the LSZ formalism perturbation theory elementary processes in QED are introduced and regularization renormalization and radiative corrections are explored With exercises scattered through the text and problems at the end of most chapters the book is ideal for advanced undergraduate and graduate students in theoretical physics

**Advanced Quantum Mechanics** Franz Schwabl, 2008-08-01 Advanced Quantum Mechanics the second volume on quantum mechanics by Franz Schwabl discusses nonrelativistic multi particle systems relativistic wave equations and relativistic quantum fields Characteristic of the author's work are the comprehensive mathematical discussions in which all intermediate steps are derived and where numerous examples of application and exercises help the reader gain a thorough working knowledge of the subject The topics treated in the book lay the foundation for advanced studies in solid state physics nuclear and elementary particle physics This text both extends and complements Schwabl's introductory Quantum Mechanics which covers nonrelativistic quantum mechanics and offers a short treatment of the quantization of the radiation field The fourth edition has been thoroughly revised with new material having been added Furthermore the layout of the figures has been unified which should facilitate comprehension

Quantum Electrodynamics Walter Greiner, Joachim Reinhardt, 1992 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

### **Relativistic Quantum Mechanics and Quantum Fields**

Ta-you Wu, W.-Y. Pauchy Hwang, 1991 A sequel to the well received book Quantum Mechanics by T Y Wu this book carries on where the earlier volume ends This present volume follows the generally pedagogic style of Quantum Mechanics The scope ranges from relativistic quantum mechanics to an introduction to quantum field theory with quantum electrodynamics as the basic example and ends with an exposition of important issues related to the standard model The book presents the subject in basic and easy to grasp notions which will enhance the purpose of this book as a useful textbook in the area of relativistic quantum mechanics and quantum electrodynamics

### **Relativistic Quantum Mechanics and Field Theory of Arbitrary Spin**

Volodimir Simulik, 2020-04-21 Foundations of the relativistic quantum mechanics and field theory of arbitrary spin are presented New relativistic wave equations without redundant components for the particle antiparticle doublets of arbitrary spin are considered The comparison with known arbitrary spin equations of Bhabha Bargman Wigner and with Pauli Fierz Rarita Schwinger equations for the spin  $s = 3/2$  demonstrates the advantages of the presented approach The special procedure of synthesis of higher spin relativistic wave equations is suggested New equations are considered on three levels of i relativistic canonical quantum mechanics ii canonical Foldy Wouthuysen type field theory and iii manifestly covariant field theory The derivation of field equations based on the start from the relativistic canonical quantum mechanics is given The corresponding transition operator which is the extended Foldy Wouthuysen transformation is suggested and described This model of relativistic quantum mechanics is described here on the level of von Neumann s consideration of non relativistic case The Lagrange approach for the spinor field in the Foldy Wouthuysen representation is analyzed The proof of the Fermi Bose duality property of a few main equations of field theory which before were known to have only single Fermi or single Bose property is given Hidden Bose properties symmetry solutions and conservation laws of the Dirac equation are proved Both cases of non zero and zero mass are considered New useful mathematical objects which are the pure matrix representations of the 64 dimensional Clifford and 28 dimensional  $SO(8)$  algebras over the field of real numbers are put into consideration The application of such algebras to the Dirac and Dirac like equations properties analysis is demonstrated Fermi and Bose  $SO(4)$  symmetries of the relativistic hydrogen atom are found New symmetries and solutions of the Maxwell equations are considered The Maxwell equations in the form having maximal symmetry are suggested and described The application of such field strength equations to the atomic microworld phenomena is demonstrated On the basis of such

Maxwell system the relativistic hydrogen atom spectrum and quantum properties of this atom are described The Sommerfeld Dirac fine structure formula Plank constant and the Bohr postulates are derived in the frameworks of classical electrodynamics The limits and boarders of classical physics applications in inneratomic microworld are discussed In order to determine the place of our approach among other investigations the 26 variants of the Dirac equation derivation are considered

**Unitary Representations Of The Poincare Group And Relativistic Wave Equations Y**

Ohnuki,1988-04-01 This book is devoted to an extensive and systematic study on unitary representations of the Poincar group The Poincar group plays an important role in understanding the relativistic picture of particles in quantum mechanics Complete knowledge of every free particle states and their behaviour can be obtained once all the unitary irreducible representations of the Poincar group are found It is a surprising fact that a simple framework such as the Poincar group when unified with quantum theory fixes our possible picture of particles severely and without exception In this connection the theory of unitary representations of the Poincar group provides a fundamental concept of relativistic quantum mechanics and field theory



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