

Undergraduate Lecture Notes in Physics

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Relativistic and Non-Relativistic Quantum Mechanics

Both at Once

 Springer

Relativistic Quantum Mechanics

Silvan S. Schweber



Relativistic Quantum Mechanics:

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.

Relativistic Quantum Mechanics Luciano Maiani, Omar Benhar, 2015-11-18 Written by two of the most prominent leaders in particle physics, *Relativistic Quantum Mechanics: An Introduction to Relativistic Quantum Fields* provides a classroom-tested introduction to the formal and conceptual foundations of quantum field theory. Designed for advanced undergraduate and graduate-level physics students, the text only requires [p](#) [Relativistic Quantum Mechanics](#) Paul Strange, 1998-09-17 This graduate text introduces relativistic quantum theory, emphasising its important applications in condensed-matter physics. Relativistic quantum theory is the unification into a consistent theory of Einstein's theory of relativity and the quantum mechanics of Bohr, Schrödinger, and Heisenberg, etc. Beginning with basic theory, the book then describes essential topics. Many worked examples and exercises are included, along with an extensive reference list. This clear account of a crucial topic in science will be valuable to graduates and researchers working in condensed-matter physics and quantum physics.

Relativistic Quantum Mechanics And Quantum Fields Ta-yu Wu, Pauchy W-y Hwang, 1991-03-06 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 Introduction to Quantum Field Theory Anton Z. Capri, 2002 This invaluable textbook is divided into two parts. The first part includes a detailed discussion on the discrete transformations for the Dirac equation, as well as on the central force problem for the Dirac equation. In the second part, the external field problem is examined; pair production and vacuum polarization leading to charge renormalization are treated in detail. *Relativistic Quantum Mechanics and Introduction to Quantum Field Theory* has arisen from a graduate course which the

author taught for several years at the University of Alberta to students interested in particle physics and field theory

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 Mechanics James D. Bjorken, Sidney Drell, 1964 In this text the authors develop a propagator theory of Dirac particles photons and Klein Gordon mesons and perform a series of calculations designed to illustrate various useful techniques and concepts in electromagnetic weak and strong interactions these include defining and implementing the renormalization program and evaluating effects of radiative corrections such as the Lamb shift in low order calculations The necessary background for the book is provided by a course in nonrelativistic quantum mechanics at the general level of Schiff's text QUANTUM MECHANICS

Relativistic Quantum Mechanics Armin Wächter, 2010-09-29 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 **Relativistic Quantum Mechanics** Ian Johnston Rhind Aitchison,1972

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 Relativistic Quantum Mechanics Walter Greiner,2013-11-11 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 **An Introduction to Relativistic Quantum Field Theory**

Silvan S. Schweber,2013-10-10 Complete systematic and self contained this text introduces modern quantum field theory Combines thorough knowledge with a high degree of didactic ability and a delightful style Mathematical Reviews 1961 edition Relativistic Quantum Mechanics R. Parthasarathy,2010 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

Relativistic Quantum Mechanics Hartmut Pilkuhn, 2005-08-03 In this book quantum mechanics is developed from the outset on a relativistic basis using the superposition principle Lorentz invariance and gauge invariance Nonrelativistic quantum mechanics as well as classical relativistic mechanics appear as special cases They are the sources of familiar names such as orbital angular momentum spin orbit coupling and magnetic moment for operators of the relativistic quantum formalism The theory of binaries in terms of differential equations is treated for the first time in this book These have the mathematical structure of the corresponding one body equations Klein Gordon for two spinless particles Dirac for two spinor particles with a relativistically reduced mass They allow the calculation of radiative corrections via the vector potential operator This second edition of the successful textbook adds various new sections on relativistic quantum chemistry and on the relativistic treatment of the proton in hydrogen Others chapters have been expanded e g on hyperfinite interactions or carefully revisited

Relativistic Quantum Mechanics And Quantum Fields: Second Edition For The 21st Century Pauchy W-y Hwang, 2018-04-26 This present edition of the book 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 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 Relativistic Quantum Mechanics of Leptons and Fields W.T. Grandy,1991 The material contained in this work concerns relativistic quantum mechanics and as such pertains to classical fields On the one hand it is meant to serve as a text on the subject a desire stemming from the author s fruitless searches for an adequate up to date reference when lecturing on these topics At times the supplementary material was found to exceed by far that in the assigned text On the other hand there is some flavor of a monograph to what follows most particularly in the later chapters for a major goal is to demonstrate just how far we can advance our understanding of the behavior of stable particles and their interactions without introducing quantized fields Those wishing to describe the world in this way may view the result as a point of departure despite the fact that their wish remains unfulfilled Confirmed quantum field theorists however will doubtless view it as a summary of just why they feel compelled to quantize the fields Approximately half the book is devoted to the single particle Dirac equation and its solutions A great deal of detail is provided in this respect and the discussion is reasonably comprehensive The Dirac equation is extraordinarily important in its own right particularly as a basis for quantum electrodynamics QED and is thus worthy of extensive study **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 Relativistic Quantum Theory of Atoms and Molecules Ian P Grant,2007-04-15 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 Relativistic Quantum Mechanics
Luciano Maiani, Omar Benhar, 2024 Written by two of the most prominent leaders in particle physics Relativistic Quantum
Mechanics An Introduction to Relativistic Quantum Fields provides a classroom tested introduction to the formal and
conceptual foundations of quantum field theory Designed for advanced undergraduate and graduate level physics students
the text only requires previous courses in classical mechanics relativity and quantum mechanics The introductory chapters of
the book summarise the theory of special relativity and its application to the classical description of the motion of a free
particle and a field The authors then explain the quantum formulation of field theory through the simple example of a scalar
field described by the Klein Gordon equation as well as its extension to the case of spin particles described by the Dirac
equation They also present the elements necessary for constructing the foundational theories of the standard model of
electroweak interactions namely quantum electrodynamics and the Fermi theory of neutron beta decay Many applications to
quantum electrodynamics and weak interaction processes are thoroughly analysed The book also explores the timely topic of
neutrino oscillations Logically progressing from the fundamentals to recent discoveries this textbook provides students with
the essential foundation to study more advanced theoretical physics and elementary particle physics It will help them
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Relativistic Quantum Mechanics Book Review: Unveiling the Magic of Language

In a digital era where connections and knowledge reign supreme, the enchanting power of language has been apparent than ever. Its capability to stir emotions, provoke thought, and instigate transformation is actually remarkable. This extraordinary book, aptly titled "**Relativistic Quantum Mechanics**," written by a very acclaimed author, immerses readers in a captivating exploration of the significance of language and its profound impact on our existence. Throughout this critique, we will delve into the book's central themes, evaluate its unique writing style, and assess its overall influence on its readership.

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