Quantum Kinetic Theory And Applications Electrons Photons Phonons 1st Edition

Boltzmann and Vlasov equations played a great role in the past and still play an important role in modern natural sciences, technique and even philosophy of science. Classical Boltzmann equation derived in 1872 became a cornerstone for the molecular-kinetic theory, the second law of thermodynamics (increasing entropy) and derivation of the basic hydrodynamic equations. After modifications, the fields and numbers of its applications have increased to include diluted gas, radiation, neutral particles transportation, atmosphere optics nuclear reactor modelling. Vlasov equation was obtained in 1938 and serves as a basis of plasma physics and describes large-scale processes and galaxies in astronomy, star wind theory. This book provides a comprehensive review of both equations and presents both classical and modern applications. In addition, it discusses several open problems of great importance. Reviews the whole field from the beginning to today Includes practical applications Provides classical and modern (semi-analytical) solutions
Imparts the similarities and differences between ratified and condensed matter, classical and quantum systems as well as real and ideal gases. Presents the quasi-thermodynamic theory of gas-liquid interface and its application for density profile calculation within the van der Waals theory of surface tension. Uses inductive logic to lead readers from observation and facts to personal interpretation and from specific conclusions to general ones.
This book consists of two parts, theory and applications. Part I introduces the kinetic theory of gases with relevance to molecular energies and intermolecular forces. Part II focuses on how these theories are used to explain real techniques and phenomena involving gases. By stressing the practical implications, the book explains the theory of gas dynamics in a highly readable and comprehensive manner.
This book provides an overview of the basic concepts and new methods in the emerging scientific area known as quantum plasmas. In the near future, quantum effects in plasmas will be unavoidable, particularly in high density scenarios such as those in the next-generation intense laser-solid density plasma experiment or in compact astrophysics objects. Currently, plasmas are in the forefront of many intriguing questions around the transition from microscopic to macroscopic modeling of charged particle systems. Quantum Plasmas: a Hydrodynamic Approach is devoted to the quantum hydrodynamic model paradigm, which, unlike straight quantum kinetic theory, is much more amenable to investigate the nonlinear realm of quantum plasmas. The reader will have a step-by-step construction of the quantum hydrodynamic method applied to plasmas. The book is intended for specialists in classical plasma physics interested in methods of quantum plasma theory, as well as scientists interested in common aspects of two major areas of knowledge: plasma and quantum these chapters, the quantum hydrodynamic model for plasmas, which has continuously evolved over the past decade, will be summarized to include both the development and applications of the method.
Quantum Plasmas
Advances in Methods and Applications of Quantum Systems in Chemistry, Physics, and Biology
Applications to Kinetic Theory and Quantum Mechanics
Theory and Applications

A thorough examination of kinetic theory and its successes in understanding and describing irreversible phenomena in physical systems.
Principles and Applications of Quantum Chemistry offers clear and simple coverage based on the author's extensive teaching at advanced universities around the globe. Where needed, derivations are detailed in an easy-to-follow manner so that you will understand the physical and mathematical aspects of quantum chemistry and molecular electronic structure. Building on this foundation, this book then explores applications, using illustrative examples to demonstrate the use of quantum chemical tools in research problems. Each chapter also uses innovative problems and bibliographic references to guide you, and throughout the book chapters cover important advances in the field including: Density functional theory (DFT) and time-dependent DFT (TD-DFT), characterization of chemical reactions, prediction of molecular geometry, molecular electrostatic potential, and quantum theory of atoms in molecules. Simplified mathematical content and derivations for reader understanding Useful overview of advances in the field such as Density Functional Theory (DFT) and Time-Dependent DFT (TD-DFT) Accessible level for students and researchers interested in the use of quantum chemistry tools
Physicalkineticsisthe?nalsectionofthecourseoftheoreticalphysics in its standard presentation. It stays at the boundary between g- eral theories and their applications (solid state theory, theory of gases, plasma, and so on), because the treatment of kinetic phenomena always depends on speci?c structural features of materials. On the other hand, the physical kinetics as a part of the quantum theory of macroscopic systems is far from being complete. A number of its fundamental - sues, such as the problem of irreversibility and mechanisms of chaotic responses, are now attracting considerable attention. Other important sections, for example, kinetic phenomena in disordered and/or strongly non-equilibrium systems and, in particular, phase transitions in these systems, are currently under investigation. The quantum theory of m- surements and quantum information processing actively developing in the last decade are based on the quantum kinetic theory. Because a deductive theoretical exposition of the subject is not c- venient, the authors restrict themselves to a lecture-style presentation. Now the physical kinetics seems to be at the stage of development when, according to Newton, studying examples is more instructive than lea- ing rules. In view of these circumstances, the methods of the kinetic theory are presented here not in a general form but as applications for description of speci?c systems and treatment of particular kinetic p- nomena. The quantum features of kinetic phenomena can arise for several r- sons.
One of the questions about which humanity has often wondered is the arrow of time. Why does temporal evolution seem irreversible? That is, we often see objects break into pieces, but we never see them reconstitute spontaneously. This observation was first put into scientific terms by the so-called second law of thermodynamics: entropy never decreases. However, this law does not explain the origin of irreversibly; it only quantifies it. Kinetic theory gives a consistent explanation of irreversibility based on a statistical description of the motion of electrons, atoms, and molecules. The concepts of kinetic theory have been applied to innumerable situations including electronics, the production of particles in the early universe, the dynamics of astrophysical plasmas, quantum gases or the motion of small microorganisms in water, with excellent quantitative agreement. This book presents the fundamentals of kinetic theory, considering classical paradigmatic examples as well as modern applications. It covers the most important systems where kinetic theory is applied, explaining their major features. The text is balanced between exploring the fundamental concepts of kinetic theory (irreversibility, transport processes, separation of time scales, conservations, coarse graining, distribution functions, etc.) and the results and predictions of the theory, where the relevant properties of different systems are computed. To request a copy of the Solutions Manual, visit http: //global.oup.com/uk/academic/physics/admin/solutions.
Kinetic Theory and Transport Phenomena
Interacting Systems Far from Equilibrium
Topics in Kinetic Theory
The Kinetic Theory of Gases
Kinetic Theory of Nonideal Gases and Nonideal Plasmas
The state-of-the-art of quantum transport and quantum kinetics in semiconductors, plus the latest applications, are covered in this monograph. Since the publishing of the first edition in 1996, the nonequilibrium Green function technique has been applied to a large number of new research topics, and the revised edition introduces the reader to many of these areas. This book is both a reference work for researchers and a self-tutorial for graduate students.
In recent years kinetic theory has developed in many areas of the physical sciences and engineering, and has extended the borders of its traditional fields of application. This monograph is a self-contained presentation of such recently developed aspects of kinetic theory, as well as a comprehensive account of the fundamentals of the theory. Emphasizing modeling techniques and numerical methods, the book provides a unified treatment of kinetic equations not found in more focused works. Specific applications presented include plasma kinetic models, traffic flow models, granular media models, and coagulation-fragmentation problems. The work may be used for self-study, as a reference text, or in graduate-level courses in kinetic theory and its applications.
A unified approach to the modern statistical theory of nonequilibrium processes. This book explores applications of this unified approach to classical and quantum kinetic theory of nonideal gases, to plasmas, and to solid state physics.
A pioneering text in its field, this comprehensive study is one of the most valuable texts and references available. The author explores the classical kinetic theory in the first four chapters, with discussions of the mechanical picture of a perfect gas, the mean free path, and the distribution of molecular velocities. Tbhe fifth chapter deals with the more accurate equations of state, or Van der Waals' equation, and later chapters examine viscosity, heat conduction, surface phenomena, and Browninan movements. The text surveys the application of quantum theory to the problem of specific heats and the contributions of kinetic theory to knowledge of electrical and magnetic properties of molecules, concluding with applications of the kinetic theory to the conduction of electricity in gases. 1934 edition.
Classical, Quantum, and Relativistic Descriptions
Applications to Gases, Semiconductors, Photons, and Biological Systems
Multidimensional Quantum Dynamics
The Boltzmann Equation
Spectral Methods in Chemistry and Physics
The first book dedicated to this new and powerful computational method begins with a comprehensive description of MCTDH and its theoretical background. There then follows a discussion of recent extensions of MCTDH, such as the treatment of identical particles, leading to the MCTDHF and MCTDHB methods for fermions and bosons. The third section presents a wide spectrum of very different applications to reflect the large diversity of problems that can be tackled by MCTDH. The result is handbook and ready reference for theoretical chemists, physicists, chemists, graduate students, lecturers and software producers.
This book is a pedagogical presentation of the application of spectral and pseudospectral methods to kinetic theory and quantum mechanics. There are additional applications to astrophysics, engineering, biology and many other fields. The main objective of this book is to provide the basic concepts to enable the use of spectral and pseudospectral methods to solve problems in diverse fields of interest and to a wide audience. While spectral methods are generally based on Fourier Series or Chebychev polynomials, non-classical polynomials and associated quadratures are used for many of the applications presented in the book. Fourier series methods are summarized with a discussion of the resolution of the Gibbs phenomenon. Classical and non-classical quadratures are used for the evaluation of integrals in reaction dynamics including nuclear fusion, radial integrals in density functional theory, in elastic scattering theory and other applications. The subject matter includes the calculation of transport coefficients in gases and other gas dynamical problems based on spectral and pseudospectral solutions of the Boltzmann equation. Radiative transfer in astrophysics and atmospheric science, and applications to space physics are discussed. The relaxation of initial non-equilibrium distributions to equilibrium for several different systems is studied with the Boltzmann and Fokker-Planck equations. The eigenvalue spectra of the linear operators in the Boltzmann, Fokker-Planck and Schrödinger equations are studied with spectral and pseudospectral methods based on non-classical orthogonal polynomials. The numerical methods referred to as the Discrete Ordinate Method, Differential Quadrature, the Quadrature Discretization Method, the Discrete Variable Representation, the Lagrange Mesh Method, and others are discussed and compared. MATLAB codes are provided for most of the numerical results reported in the book - see Link under 'Additional Information' on the the right-hand column.
This book reviews the most significant advances in concepts, methods, and applications of quantum systems in a broad variety of problems in modern chemistry, physics, and biology. In particular, it discusses atomic, molecular, and solid structure, dynamics and spectroscopy, relativistic and correlation effects in quantum chemistry, topics of computational chemistry, physics and biology, as well as applications of theoretical chemistry and physics in advanced molecular and nano-materials and biochemical systems. The book contains peer-reviewed contributions written by leading experts in the fields and based on the presentations given at the Twenty-Fourth International Workshop on Quantum Systems in Chemistry, Physics, and Biology held in Odessa, Ukraine, in August 2019. This book is aimed at advanced graduate students, academics, and researchers, both in university and corporation laboratories, interested in state-of-the-art and novel trends in quantum chemistry, physics, biology, and their applications.
This book commines detailed presentation of the basic material using easy to understand density operator methods (Quantum BBGKY-hierarchy); advanced applications to ultrafast relaxation processes (motivated by modern developments in femtosecond lasers) and detailed analysis of the interaction of charged particles with electomagnetic fields; compact and coprehensive presentation of nonequilibrium Green´s functions, starting from relativistic systems (QED), and detailed comparison to density operators; discussion of Molecular dynamic methods in nonequilibrium and of its relation to quantum knietics; state of the art numericsl results to all subjects, supplemented with a detailed appemdix devoted to numerical methods in quantum kinetics; extensive references, both to classical works on knietic theory and to modern applications in various field.
Introduction to Relativistic Statistical Mechanics
Electrons, Photons, Phonons
With Applications to Chemistry
Modeling Complex Living Systems
Kinetic Theory
This book presents quantum kinetic theory in a comprehensive way. The focus is on density operator methods and on non-equilibrium Green functions. The theory allows to rigorously treat nonequilibrium dynamics in quantum many-body systems. Of particular interest are ultrafast processes in plasmas, condensed matter and trapped atoms that are stimulated by rapidly developing experiments with short pulse lasers and free electron lasers. To describe these experiments theoretically, the most powerful approach is given by non-Markovian quantum kinetic equations that are discussed in detail, including computational aspects.
This book gives an updated and detailed presentation of modern quantum-mechanical treatments and practical computational methods for dynamical processes of small molecular systems. The main emphasis is on the recent development of successful theories and computational methods for the reactive scattering process. Specific applications are given in detail for a number of benchmark chemical reaction systems in the gas phase and gas surface. Differing from traditional physics books focusing on abstract collision theory for elastic collisions, the book has been written in a fashion in which the development of general reactive or rearrangement scattering theory is accompanied by practical applications for realistic reaction systems.
This book presents an up-to-date formalism of non-equilibrium Green's functions covering different applications ranging from solid state physics, plasma physics, cold atoms in optical lattices up to relativistic transport and heavy ion collisions. Within the Green's function formalism, the basic sets of equations for these diverse systems are similar, and approximations developed in one field can be adapted to another field. The central object is the self-energy which includes all non-trivial aspects of the system dynamics. The focus is therefore on microscopic processes starting from elementary principles for classical gases and the complementary picture of a single quantum particle in a random potential. This provides an intuitive picture of the interaction of a particle with the medium formed by other particles, on which the Green's function is built on.
In this work we show that Non-equilibrium Green's Function Perturbation Theory (NEGF) is really the overarching perturbative transport theory. It is developed in 3 directions: Landauer-like theory, kinetic theory and Green-Kubo linear response theory. This work generalizes the 2 directions of Landauer-like theory and the kinetic theory. Firstly, NEGF is used to derive phonon-phonon Hedin-like functional derivative equations which generates conserving self energy approximations for phonon-phonon interaction. Secondly, for the Landauer-like theory, using the perturbation expansion, we obtain anharmonic corrections to the ballistic energy current and to the noise associated to the energy current. Along a seperate line, we incooperate high mass disorder into the ballistic energy current formula. The coherent potential approximation (CPA) is found to be compatible with the ballistic energy current expression. Lastly, for the kinetic theory, Wigner coordinates + gradient expansion easily allow the derivation of phonon-phonon correlation corrections to kinetic equations. The main feature of this work is the extremely detailed mathematical explanations.
Relativistic Kinetic Theory
A Kinetic Theory and Stochastic Game Approach
Theory and Application of Quantum Molecular Dynamics
Quantum Kinetic Theory and Applications
Detailed Mathematical Exposition and Applications to Phonons, Electrons and Disordered Systems
The aim of this book is to present the theory and applications of the relativistic Boltzmann equation in a self-contained manner, even for those readers who have no familiarity with special and general relativity. Though an attempt is made to present the basic concepts in a complete fashion, the style of presentation is chosen to be appealing to readers who want to understand how kinetic theory is used for explicit calculations. The book will be helpful not only as a textbook for an advanced course on relativistic kinetic theory but also as a reference for physicists, astrophysicists and applied mathematicians who are interested in the theory and applications of the relativistic Boltzmann equation.
This updated and expanded edition offers a collective description of all aspects of kinetic theory Kinetic Theory: Classical, Quantum, and Relativistic Descriptions, Second Edition goes beyond the scope of other works in the field with a significantly broader array of applications. This superior reference addresses a wide range of disciplines, including aerospace, mechanical, and chemical engineering; solid state and laser physics; and controlled and astrophysical thermonuclear fusion. Topics covered include: * Entirely new material on kinetic properties of metals and amorphous media. * Exposition and analysis of the Liouville equation. * The Boltzmann equation, fluid dynamics, and irreversibility. * Kinetic equations with applications to plasmas, neutral fluids, and shock waves. * Elements of quantum kinetic theory and the many-body Green's function. * Relativistic kinetic theory--covariant Liouville equation * List of classical and quantum hierarchies of kinetic equations Support materials include problem sets at the end of each chapter, many of which provide self-contained descriptions of closely allied topics. Numerous appendices supply vector formulas and tensor notation, properties of special functions, physical constants, references, and a historical time chart. Kinetic Theory, Second Edition is an indispensable resource for physicists involved in plasma physics, condensed matter, and statistical mechanics; electrical engineers working with laser and solid state devices; and researchers in industry and academia. It is also an excellent text for graduate courses in these and other disciplines.
Kinetic Theory of Nonideal Gases and Nonideal Plasmas presents the fundamental aspects of the kinetic theory of gases and plasmas. The book consists of three parts, which attempts to present some of the ideas, methods and applications in the study of the kinetic processes in nonideal gases and plasmas. The first part focuses on the classical kinetic theory of nonideal gases. The second part discusses the classical kinetic theory of fully ionized plasmas. The last part is devoted to the quantum kinetic theory of nonideal gases and plasmas. A concluding chapter is included, which presents a short account of the kinetic theory of chemically reacting systems and of partially ionized plasmas, in order to espouse further studies in the field. Physicists, scientific researchers, professors, and graduate students in various fields will find the text of good use.
The study of kinetic equations related to gases, semiconductors, photons, traffic flow, and other systems has developed rapidly in recent years because of its role as a mathematical tool in areas such as engineering, meteorology, biology, chemistry, materials science, nanotechnology, and pharmacy. Written by leading specialists in their respective fields, this book presents an overview of recent developments in the field of mathematical kinetic theory with a focus on modeling complex systems, emphasizing both mathematical properties and their physical meaning. Transport Phenomena and Kinetic Theory is an excellent self-study reference for graduate students, researchers, and practitioners working in pure and applied mathematics, mathematical physics, and engineering. The work may be used in courses or seminars on selected topics in transport phenomena or applications of the Boltzmann equation.
Studies in the Application of the Quantum Hypothesis to the Kinetic Theory of Gases and to the Theory of Their Infra-red Absorption Bands
MCTDH Theory and Applications
Introduction to Thermodynamics and Kinetic Theory of Matter
The Relativistic Boltzmann Equation: Theory and Applications
Kinetic Boltzmann, Vlasov and Related Equations
In,1872, Boltzmann published a paper which for the first time provided a precise mathematical basis for a discussion of the approach to equilibrium. The paper dealt with the approach to equilibrium of a dilute gas and was based on an equation - the Boltzmann equation, as we call it now - for the velocity distribution function of such - gas. The Boltzmann equation still forms the basis of the kinetic theory of gases and has proved fruitful not only for the classical gases Boltzmann had in mind, but als- if properly generalized - for the electron gas in a solid and the excitation gas in a superfluid. Therefore it was felt by many of us that the Boltzmann equation was of sufficient interest, even today, to warrant a meeting, in which a review of its present status would be undertaken. Since Boltzmann had spent a good part of his life in Vienna, this city seemed to be a natural setting for such a meeting. The first day was devoted to historical lectures, since it was generally felt that apart from their general interest, they would furnish a good introduction to the subsequent scientific sessions. We are very much indebted to Dr. D.
Covering essential areas of thermal physics, this book includes kinetic theory, classical thermodynamics, and quantum thermodynamics. The text begins by explaining fundamental concepts of the kinetic theory of gases, viscosity, conductivity, diffusion, and the laws of thermodynamics and their applications. It then goes on to discuss applications of thermodynamics to problems of physics and engineering. These applications are explained with the help of P-V and P-S-H diagrams where necessary and are followed by a large number of solved examples and unsolved exercises. The book includes a dedicated chapter on the applications of thermodynamics to chemical reactions. Each application is explained by taking the example of an appropriate chemical reaction, where all technical terms are explained and complete mathematical derivations are worked out in steps starting from the first principle.
This book covers a variety of topics related to kinetic theory in neutral gases and magnetized plasmas, with extensions to other systems such as quantum plasmas and granular flows. A comprehensive presentation is given for the Boltzmann equations and other kinetic equations for a neutral gas, together with the derivations of compressible and incompressible fluid dynamical systems, and their rigorous justification. Several contributions are devoted to collisionless magnetized plasmas. Rigorous results concerning the well-posedness of the Vlasov-Maxwell system are presented. Special interest is devoted to asymptotic regimes where the scales of variation of the electromagnetic field are clearly separated from those associated with the gyromotion of the particles. This volume collects lectures given at the Short Course and Workshop on Kinetic Theory organized at the Fields Institute of Mathematical Sciences in Toronto during the Spring of 2004.
This book develops new mathematical methods and tools to model living systems. The material it presents can be used in such real-world applications as immunology, transportation engineering, and economics. The first part of the book deals with deriving general evolution equations that can be customized to particular systems of interest in the applied sciences. The second part of the book deals with various models and applications. The book will be a valuable resource to all involved in modeling complex social systems and living matter in general.
An Hydrodynamic Approach
Quantum Theory
Classical and Quantum Thermal Physics
With Applications in Astrophysics and Cosmology
Basic Concepts, Kinetic Theory
This book presents fundamentals, equations, and methods of solutions of relativistic kinetic theory, with applications in astrophysics and cosmology.
This book discusses quantum theory as the theory of random (Brownian) motion of small particles (electrons etc.) under external forces. Implying that the Schrödinger equation is a complex-valued evolution equation and the Schrödinger function is a complex-valued evolution function, important applications are given. Readers will learn about new mathematical methods (theory of stochastic processes) in solving problems of quantum phenomena. Readers will also learn how to handle stochastic processes in analyzing physical phenomena.
This book goes beyond the scope of other works in the field with its thorough treatment of applications in a wide variety of disciplines. The third edition features a new section on constants of motion and symmetry and a new appendix on the Lorentz-Legendre expansion.
Part I. The Fundamental Postulates
Quantum Kinetic Theory
Modeling and Computational Methods for Kinetic Equations
On the Application of the Quantum Theory to Atomic Structure
Contemporary Kinetic Theory of Matter