

## Atomic Physics Oxford Master Series In Physics

The purpose of this textbook is to explain the Standard Model of particle physics to a student with an undergraduate preparation in physics. Today we can claim to have a fundamental picture of the strong and weak subnuclear forces. Through an interplay between theory and experiment, we have learned the basic equations through which these forces operate, and we have tested these equations against observations at particle accelerators. The story is beautiful and full of surprises. Using a simplified presentation that does not assume prior knowledge of quantum field theory, this book begins from basic concepts of special relativity and quantum mechanics, describes the key experiments that have clarified the structure of elementary particle interactions, introduces the crucial theoretical concepts, and builds up to the full description of elementary particle interactions as we know them today.

This book describes how the arrangement and movement of atoms in a solid are related to the forces between atoms, and how they affect the behaviour and properties of materials. The book is intended for final year undergraduate students and graduate students in physics and materials science.

This text offers an introduction to the properties and behaviour of soft matter. It begins with a treatment of the underlying principles, then discusses how the properties of certain substances and systems are treated within this framework.

This book is addressed to upper-level undergraduate and graduate students involved in research in atomic, molecular, and optical physics. It will also be useful to researchers practising in this field. It gives an intuitive, yet sufficiently detailed and rigorous introduction to light-atom interactions with a particular emphasis on the symmetry aspects of the interaction, especially those associated with the angular momentum of atoms and light. The book will enable readers to carry out practical calculations on their own, and is richly illustrated with examples drawn from current research topics, such as resonant nonlinear magneto-opticals. The book comes with a software package for a variety of atomic-physics calculations and further interactive examples that is freely downloadable from the book's web page, as well as additional materials (such as power-point presentations) available to instructors who adopt the text for their courses.

Modern Classical Optics

Particle Physics in the LHC Era

Entropy, Order Parameters and Complexity

Gravitational Waves

Atoms and Molecules Interacting with Light

*The book describes classical (non-quantum) optical phenomena and the instruments and technology based on them. It includes many cutting-edge areas of modern physics and its applications which are not covered in many larger and more expensive books.*

*For final year undergraduates and graduate students in physics, this book offers an up-to-date treatment of the optical properties of solid state materials.*

*The book is an introduction to quantum field theory applied to condensed matter physics. The topics cover modern applications in electron systems and electronic properties of mesoscopic systems and nanosystems. The textbook is developed for a graduate or advanced undergraduate course with exercises which aim at giving students the ability to confront real problems.*

*This book describes atomic physics and the latest advances in this field at a level suitable for fourth year undergraduates. The numerous examples of the modern applications of atomic physics include Bose-Einstein condensation of atoms, matter-wave interferometry and quantum computing with trapped ions.*

*Atomic Physics and Human Knowledge*

*Quantum Optics*

*Quantum Information*

*Theoretical Microfluidics*

*Rydberg Atoms*

Microfluidics is a young and rapidly expanding scientific discipline, which deals with fluids and solutions in miniaturized systems, the so-called lab-on-a-chip systems. It has applications in chemical engineering, pharmaceuticals, biotechnology and medicine. As the lab-on-a-chip systems grow in complexity, a proper theoretical understanding becomes increasingly important. The basic idea of the book is to provide a self-contained formulation of the theoretical framework of microfluidics, and at the same time give physical motivation and examples from lab-on-a-chip technology. After three chapters introducing microfluidics, the governing equations for mass, momentum and energy, and some basic flow solutions, the following 14 chapters treat hydraulic resistance/compliance, diffusion/dispersion, time-dependent flow, capillarity, electro- and magneto-hydrodynamics, thermal transport, two-phase flow, complex flow patterns and acousto-fluidics, as well as the new fields of opto- and nano-fluidics. Throughout the book simple models with analytical solutions are presented to provide the student with a thorough physical understanding of order of magnitudes and various selected microfluidic phenomena and devices. The book grew out of a set of well-tested lecture notes. It is with its many pedagogical exercises designed as a textbook for an advanced undergraduate or first-year graduate course. It is also well suited for self-study.

Advances in nanotechnology have allowed physicists and engineers to miniaturize electronic structures to the limit where finite-size related phenomena start to impact their properties. This book discusses such phenomena and models made for their description. The book starts from the semiclassical description of nonequilibrium effects, details the scattering theory used for quantum transport calculations, and explains the main interference effects. It also describes how to treat fluctuations and correlations, how interactions affect transport through small islands, and how superconductivity modifies these effects. The last two chapters describe new emerging fields related with graphene and nanoelectromechanics. The focus of the book is on the phenomena rather than formalism, but the book still explains in detail the main models constructed for these phenomena. It also introduces a number of electronic devices, including the single-electron transistor, the superconducting tunnel junction refrigerator, and the superconducting quantum bit.

This text gives an introduction to particle physics at a level accessible to advanced undergraduate students. It is based on lectures given to 4th year physics students over a number of years, and reflects the feedback from the students. The aim is to explain the theoretical and experimental basis of the Standard Model (SM) of Particle Physics with the simplest mathematical treatment possible. All the experimental discoveries that led to the understanding of the SM relied on particle detectors and most of them required advanced particle accelerators. A unique feature of this book is that it gives a serious introduction to the fundamental accelerator and detector physics, which is currently only available in advanced graduate textbooks. The mathematical tools that are required such as group theory are covered in one chapter. A modern treatment of the Dirac equation is given in which the free particle Dirac equation is seen as being equivalent to the Lorentz transformation. The idea of generating the SM interactions from fundamental gauge symmetries is explained. The core of the book covers

the SM. The tools developed are used to explain its theoretical basis and a clear discussion is given of the critical experimental evidence which underpins it. A thorough account is given of quark flavour and neutrino oscillations based on published experimental results, including some from running experiments. A simple introduction to the Higgs sector of the SM is given. This explains the key idea of how spontaneous symmetry breaking can generate particle masses without violating the underlying gauge symmetry. A key feature of this book is that it gives an accessible explanation of the discovery of the Higgs boson, including the advanced statistical techniques required. The final chapter gives an introduction to LHC physics beyond the standard model and the techniques used in searches for new physics. There is an outline of the shortcomings of the SM and a discussion of possible solutions and future experiments to resolve these outstanding questions. For updates, new results, useful links as well as corrections to errata in this book, please see the book website maintained by the authors: <https://pplhcera.physics.ox.ac.uk/>

An introduction to Einstein's general theory of relativity, this work is structured so that interesting applications, such as gravitational lensing, black holes and cosmology, can be presented without the readers having to first learn the difficult mathematics of tensor calculus.

Theory and Computation

Structure and Dynamics

Laser Physics

A First Course on Integrability and the Bethe Ansatz

This book discusses many advances in optical physics and is intended mainly for experimentalists. The interaction of electromagnetic radiation with free atoms is introduced using classical or semi-classical calculations wherever possible. Topics discussed include the spontaneous emission of radiation, and atomic beam magnetic resonance experiments.

Atomic Physics Oxford University Press

An important task of theoretical quantum physics is the building of idealized mathematical models to describe the properties of quantum matter. This book provides an introduction to the arguably most important method for obtaining exact results for strongly interacting models of quantum matter - the Bethe ansatz. It introduces and discusses the physical concepts and mathematical tools used to construct realistic models for a variety of different fields, including condensed matter physics and quantum optics. The various forms of the Bethe ansatz - algebraic, coordinate, multicomponent, and thermodynamic Bethe ansatz, and Bethe ansatz for finite systems - are then explained in depth and employed to find exact solutions for the physical properties of the integrable forms of strongly interacting quantum systems. The Bethe ansatz is one of the very few methodologies which can calculate physical properties non-perturbatively. Arguably, it is the only such method we have which is exact. This means, once the model has been set up, no further approximations or assumptions are necessary, and the relevant physical properties of the model can be computed exactly. Furthermore, an infinite set of conserved quantities can be obtained. The quantum mechanical model under consideration is fully integrable. This makes the search for quantum models which are amenable to an exact solution by the Bethe ansatz, and which are quantum integrable, so important and rewarding. The exact solution will provide benchmarks for other models, which do not admit an exact solution. Bethe ansatz techniques provide valuable insight into the physics of strongly correlated quantum matter.

This book discusses the computational approach in modern statistical physics, adopting simple language and an attractive format with many illustrations, tables and printed algorithms. The style will appeal to students, teachers and researchers in the physical sciences. The focus is on orientation, with implementation details kept to a minimum.

An Exploration Through Problems and Solutions

A Student's Guide to Atomic Physics

Optical Properties of Solids

Relativity, Gravitation and Cosmology

Laser Cooling and Trapping

"First published by Cappella Archive in 2008."

This textbook series has been designed for final year undergraduate and first year graduate students, providing an overview of the entire field showing how specialized topics are part of the wider whole, and including references to current areas of literature and research.

This book provides a comprehensive description of the physics of Rydberg atoms, highlighting their remarkable properties by reference to their behavior in a wide range of physical situations. Following an overview of the basic properties of Rydberg atoms, their interactions with electric and magnetic fields are analyzed in detail. The collisions of Rydberg atoms with neutral and charged species are described, and the use of multichannel quantum defect theory in the study of Rydberg atomic systems is discussed.

Intended for advanced undergraduates and beginning graduates with some basic knowledge of optics and quantum mechanics, this text begins with a review of the relevant results of quantum mechanics, before turning to the electromagnetic interactions involved in slowing and trapping atoms and ions, in both magnetic and optical traps. The concluding chapters discuss a broad range of applications, from atomic clocks and studies of collision processes, to diffraction and interference of atomic beams at optical lattices and Bose-Einstein condensation.

A Modern Introduction to Quantum Field Theory

Optically Polarized Atoms

Atomic Physics 7

The Physics of Nanoelectronics

Relativistic Quantum Theory of Atoms and Molecules

***In each generation, scientists must redefine their fields: abstracting, simplifying and distilling the previous standard topics to make room for new advances and methods. Sethna's book takes this step for statistical mechanics - a field rooted in physics and chemistry whose ideas and methods are now central to information theory, complexity, and modern biology. Aimed at advanced undergraduates and early graduate students in all of these fields, Sethna limits his main presentation to the topics that future mathematicians and biologists, as well as physicists and chemists, will find fascinating and central to their work. The amazing breadth of the field is reflected in the author's large supply of carefully crafted exercises, each an***

**introduction to a whole field of study: everything from chaos through information theory to life at the end of the universe.**

**This collection of articles, which were first published in 1958 and written on various occasions between 1932 and 1957, forms a sequel to Danish physicist Niels Bohr's earlier essays in *Atomic Theory and the Description of Nature* (1934). "The theme of the papers is the epistemological lesson which the modern development of atomic physics has given us and its relevance for analysis and synthesis in many fields of human knowledge. "The articles in the previous edition were written at a time when the establishment of the mathematical methods of quantum mechanics had created a firm foundation for the consistent treatment of atomic phenomena, and the conditions for an unambiguous account of experience within this framework were characterized by the notion of complementarity. In the papers collected here, this approach is further developed in logical formulation and given broader application."**

**Soft matter (polymers, colloids, surfactants, liquid crystals) are an important class of materials for modern and future technologies. They are complex materials that behave neither like a fluid nor a solid. This book describes the characteristics of such materials and how we can understand such characteristics in the language of physics.**

**The aim of this book is to become a major reference text for gravitational-wave physics, covering in detail both the experimental and the theoretical aspects. The book brings the reader to the forefront of present-day research, and assumes no previous knowledge of gravitational-wave physics.**

**Transport and Fluctuation Phenomena at Low Temperatures**

**The Physics of Quantum Mechanics**

**Band Theory and Electronic Properties of Solids**

**Superconductivity, Superfluids and Condensates**

**Understanding light-atom interactions**

This book is a concise and clearly written introduction to the modern theory of polymer physics. The book describes concepts and methods of investigating the statistical properties of the assembly of chain-like molecules. The topics include scaling theory, concentration fluctuation, gels, and reptation. Both graduate students and researchers in physics, chemistry, chemical engineering, and materials science will find this an extremely useful textbook and reference work. This is a first undergraduate textbook in Solid State Physics or Condensed Matter Physics. While most textbooks on these subjects are extremely dry, this book is written to be much more exciting, inspiring, and entertaining.

Preface to first edition Preface to second edition 1. Introduction 2. The hydrogen atom- gross structure 3. Radiative transitions 4. The hydrogen atom- fine structure 5. Two-electron system 6. The central-field approximation 7. Angular problems in many-electron atoms 8. Interaction with static external fields 9. Hyperfine structure and isotope shift Appendix A. Some theorems of quantum mechanics Appendix B. Results of time-independent perturbation theory Appendix C. Notes on angular momentum Appendix D. Ground states of the elements Appendix E. Units Index

Written as a collection of problems, hints and solutions, this book should provide help in learning about both fundamental and applied aspects of this vast field of knowledge, where rapid and exciting developments are taking place.

Volume 1: Theory and Experiments

Atomic and Laser Spectroscopy

The Oxford Solid State Basics

Atomic Physics

Introduction to Polymer Physics

An understanding of the quantum mechanical nature of magnetism has led to the development of new magnetic materials which are used as permanent magnets, sensors, and information storage. Behind these practical applications lie a range of fundamental ideas, including symmetry breaking, order parameters, excitations, frustration, and reduced dimensionality. This superb new textbook presents a logical account of these ideas, starting from basic concepts in electromagnetism and quantum mechanics. It outlines the origin of magnetic moments in atoms and how these moments can be affected by their local environment inside a crystal. The different types of interactions which can be present between magnetic moments are described. The final chapters of the book are devoted to the magnetic properties of metals, and to the complex behaviour which can occur when competing magnetic interactions are present and/or the system has a reduced dimensionality. Throughout the text, the theoretical principles are applied to real systems. There is substantial discussion of experimental techniques and current research topics. The book is copiously illustrated and contains detailed appendices which cover the fundamental principles.

"This book provides accounts of non-quantum optical phenomena and of instruments and technology based on them. While covering the conventional topics such as diffraction, coherence, thin films and holography, the book also extends to the less conventional topics: Gaussian beams and laser cavities (supporting laser physics), etendue, CD readers and confocal microscopes. Even the conventional material is given a fresh presentation, with standard calculations tidied, common errors avoided, and insightful connections made with other parts of physics. Problems offer opportunities for testing the reader's basic understanding, taking a careful route through reasoning, and checking orders of magnitude. In addition, many of the problems contain exploratory and critical material, such as

investigating possible alternative approaches, asking searching questions about fundamentals, or solving apparent paradoxes."--BOOK JACKET.

Quantum information is an area of science, which brings together physics, information theory, computer science & mathematics. This book, which is based on two successful lecture courses, is intended to introduce readers to the ideas behind new developments including quantum cryptography, teleportation & quantum computing.

Written primarily for advanced undergraduate and masters level students in physics, this text includes a broad range of topics in applied quantum optics such as laser cooling, Bose-Einstein condensation and quantum information processing.

Models of Quantum Matter

An Introduction

Many-Body Quantum Theory in Condensed Matter Physics

Statistical Mechanics

Atomic Physics for the Laser Era

The importance and the beauty of modern quantum field theory resides in the power and variety of its methods and ideas, which find application in domains as different as particle physics, cosmology, condensed matter, statistical mechanics and critical phenomena. This book introduces the reader to the modern developments in a manner which assumes no previous knowledge of quantum field theory. Along with standard topics like Feynman diagrams, the book discusses effective lagrangians, renormalization group equations, the path integral formulation, spontaneous symmetry breaking and non-abelian gauge theories. The inclusion of more advanced topics will also make this a most useful book for graduate students and researchers.

This book traces the evolution of Atomic Physics from precision spectroscopy to the manipulation of atoms at a billionth of a degree above absolute zero. Quantum worlds can be simulated and fundamental theories, such as General Relativity and Quantum Electrodynamics, can be tested with table-top experiments.

This book provides an introduction to band theory and the electronic properties of materials at a level suitable for final-year undergraduates or first-year graduate students. It sets out to provide the vocabulary and quantum-mechanical training necessary to understand the electronic, optical and structural properties of the materials met in science and technology and describes some of the experimental techniques which are used to study band structure today. In order to leave space for recent developments, the Drude model and the introduction of quantum statistics are treated synoptically. However, Bloch's theorem and two tractable limits, a very weak periodic potential and the tight-binding model, are developed rigorously and in three dimensions. Having introduced the ideas of bands, effective masses and holes, semiconductor and metals are treated in some detail, along with the newer ideas of artificial structures such as super-lattices and quantum wells, layered organic substances and oxides. Some recent 'hot topics' in research are covered, e.g. the fractional Quantum Hall Effect and nano-devices, which can be understood using the techniques developed in the book. In illustrating examples of e.g. the de Haas-van Alphen effect, the book focuses on recent experimental data, showing that the field is a vibrant and exciting one. References to many recent review articles are provided, so that the student can conduct research into a chosen topic at a deeper level. Several appendices treating topics such as phonons and crystal structure make the book self-contained introduction to the fundamentals of band theory and electronic properties in condensed matter physics today.

Atomic Physics 7 presents the manuscripts of the invited talks delivered at the Seventh International Conference of Atomic Physics, held at M.I.T. August 4-8, 1980. This conference continues the tradition of the earlier conferences by reviewing broad areas of fundamental atomic physics and related subjects. In addition to the invited talks, one hundred and ninety contributed papers were presented in poster sessions. Abstracts of the contributed papers have been printed separately in a small volume. Three hundred and fifty participants from thirteen nations attended the conference. One of the highlights of the conference was an historical talk by Professor Abraham Pais of Rockefeller University entitled "The Birth of the Quantum Theory: Planck". The manuscript of this talk will be published elsewhere. Dr. John Bailey presented a talk on the proton-antiproton system at low energy, but was unable to provide a manuscript for this volume. Also omitted from these Proceedings, but one of the highlights of the Conference, are the comments by Professor I. I. Rabi, an active participant who chaired one session and spent an evening discussing science, history and public policy with graduate students at the Conference.

An Atomic View of Materials

Elementary Atomic Structure

Atomic Physics: Precise Measurements and Ultracold Matter

Soft Condensed Matter

A Basic Introduction

**This concise and accessible book provides a detailed introduction to the fundamental principles of atomic physics at an undergraduate level. Concepts are explained in an intuitive way and the book assumes only a basic knowledge of quantum mechanics and electromagnetism. With a compact format specifically designed for students, the first part of the book covers the key principles of the subject, including the quantum theory of the hydrogen atom, radiative transitions, the shell model of multi-electron atoms, spin-orbit coupling, and the effects of external fields. The second part provides an introduction to the four key applications of atomic physics: lasers, cold atoms, solid-state spectroscopy and astrophysics. This highly pedagogical text includes worked examples and end of chapter problems to allow students to test their knowledge, as well as numerous diagrams of key concepts, making it perfect for undergraduate students looking for a succinct primer on the concepts and applications of atomic physics.**

**An up-to-date perspective on laser technology for students at advanced undergraduate or introductory graduate level. The principles of operation and applications of modern laser systems are analysed in detail. The text has over 300 diagrams and each chapter is accompanied with questions (solutions available on application).**

**Focusing on atom-light interactions and containing numerous exercises, this in-depth textbook prepares students for research in a fast-growing field.**

**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.**

**Magnetism in Condensed Matter**

**Statistical Mechanics: Algorithms and Computations**

**Concepts of Elementary Particle Physics**

**Soft Matter Physics**