

## Atomic And Molecular Physics By Rajkumar

*This book, part of the seven-volume series Major American Universities PhD Qualifying Questions and Solutions contains detailed solutions to 483 questions/problems on atomic, molecular, nuclear and particle physics, as well as experimental methodology. The problems are of a standard appropriate to advanced undergraduate and graduate syllabi, and blend together two objectives — understanding of physical principles and practical application. The volume is an invaluable supplement to textbooks.*

*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.*

*This is the first volume of textbooks on atomic, molecular and optical physics, aiming at a comprehensive presentation of this highly productive branch of modern physics as an indispensable basis for many areas in physics and chemistry as well as in state of the art bio- and material-sciences. It primarily addresses advanced students (including PhD students), but in a number of selected subject areas the reader is lead up to the frontiers of present research. Thus even the active scientist is addressed. This volume 1 provides the canonical knowledge in atomic physics together with basics of modern spectroscopy. Starting from the fundamentals of quantum physics, the reader is familiarized in well structured chapters step by step with the most important phenomena, models and measuring techniques. The emphasis is always on the experiment and its interpretation, while the necessary theory is introduced from this perspective in a compact and occasionally somewhat heuristic manner, easy to follow even for beginners.*

*This introduction to Atomic and Molecular Physics explains how our present model of atoms and molecules has been developed over the last two centuries both by many experimental discoveries and, from the theoretical side, by the introduction of quantum physics to the adequate description of micro-particles. It illustrates the wave model of particles by many examples and shows the limits of classical description. The interaction of electromagnetic radiation with atoms and molecules and its potential for spectroscopy is outlined in more detail and in particular lasers as modern spectroscopic tools are discussed more thoroughly. Many examples and problems with solutions are offered to encourage readers to actively engage in applying and adapting the fundamental physics presented in this textbook to specific situations. Completely revised third edition with new sections covering all actual developments, like photonics, ultrashort lasers, ultraprecise frequency combs, free electron lasers, cooling and trapping of atoms, quantum optics and quantum information.*

*Data for Photon Absorption, Electron Scattering, and Vacancies Decay*

*Advances in Atomic, Molecular, and Optical Physics*

*Physics Through the 1990's*

*An Overview*

*Atomic, Molecular, and Optical Physics: Charged Particles*

The present edition of the book is revised as per the UGC syllabus. Questions and problems at the end of each chapter have been up-dated. Many new solved examples are included in this edition. Certain topic have been added so that students from some universities where the syllabus has been modified and upgraded may benefit. Besides being a text book we hope that this benefit students appearing at the IAS, AMIE and other Competitive Examinations.

A wide-ranging review of modern techniques in atomic and molecular spectroscopy. A brief description of atomic and molecular structure is followed by the relevant energy structure expressions. A discussion of radiative properties and the origin of spectra leads into coverage of X-ray and photoelectron spectroscopy, optical spectroscopy, and radiofrequency and microwave techniques. The treatment of laser spectroscopy investigates various tunable sources and a wide range of techniques characterized by high sensitivity and high resolution. Throughout this book, the relation between fundamental and applied aspects is shown, in particular by descriptions of applications to chemical analysis, photochemistry, surface characterisation, environmental and medical diagnostics, remote sensing and astrophysics.

Comprises a comprehensive reference source that unifies the entire fields of atomic molecular and optical (AMO) physics, assembling the principal ideas, techniques and results of the field. 92 chapters written by about 120 authors present the principal ideas, techniques and results of the field, together with a guide to the primary research literature (carefully edited to ensure a uniform coverage and style, with extensive cross-references). Along with a summary of key ideas, techniques, and results, many chapters offer diagrams of apparatus, graphs, and tables of data. From atomic spectroscopy to applications in comets, one finds contributions from over 100 authors, all leaders in their respective disciplines. Substantially updated and expanded since the original 1996 edition, it now contains several entirely new chapters covering current areas of great research interest that barely existed in 1996, such as Bose-Einstein condensation, quantum information, and cosmological variations of the fundamental constants. A fully-searchable CD- ROM version of the contents accompanies the handbook.

An Overview: Physics Through the 1990's is part of an eight-volume research assessment of the major fields of physics that reviews the developments that have taken place and highlights research opportunities. An Overview summarizes the findings of the panels discussed in the other seven volumes and addresses issues that broadly concern physics.

*Theoretical Principles and Experimental Methods*

*Relativistic Quantum Theory of Atoms and Molecules*

*Atomic and Nuclear Physics*

*Atomic Spectra and Atomic Structure*

*Chaos in Atomic Physics*

*Nearly all information about the Universe comes from the study of light as it reaches us. However, understanding the information contained in this light requires both telescopes capable of resolving it into its*

*component colours and a detailed knowledge of the quantum mechanical behaviour of atoms and molecules. This book, which is based on a third-year undergraduate course taught by the author at University College London, presents the basic atomic and molecular physics necessary to understand and interpret astronomical spectra. It explains how and what kind of information can be extracted from these spectra. Contemporary astronomical spectra are used extensively to study the underlying atomic physics and illustrate the results. The Fundamentals of Atomic and Molecular Physics Springer Science & Business Media*

*the book has been revised to include the postgraduate physics syllabi of Indian Universities in addition to the undergraduate honours syllabi covered in the previous edition. Apart from the new addition made in the existing chapters have been added in this edition to deal with the quantum mechanical theories of atomic and molecular structure.*

*Volume 55 of the Advances in Atomic, Molecular, and Optical Physics Series contains seven contributions, covering a diversity of subject areas in atomic, molecular and optical physics. In their contribution, Stowe, Thorpe, Pe'er, Ye, Stalnaker, Gerginov, and Diddams explore recent developments in direct frequency comb spectroscopy. Precise phase coherence among successive ultrashort pulses of a frequency comb allows one to probe fast dynamics in the time domain and high-resolution structural information in the frequency domain for both atoms and molecules. The authors provide a detailed review of some of the current applications that exploit the unique features of frequency comb spectroscopy and discuss its future directions. Yurvsky, Olshanii and Weiss review theory and experiment of elongated atom traps that confine ultracold gases in a quasi-one-dimensional regime. Under certain conditions, these quasi-one-dimensional gases are well-described by integrable one-dimensional many-body models with exact quantum solutions. Thermodynamic and correlation properties of one such model that has been experimentally realized are reviewed. DePaola, Morgenstein and Andersen discuss magneto-optical trap recoil ion momentum spectroscopy (MOTRIMS), exploring collisions between a projectile and target resulting in charged target fragments. MOTRIMS combines the technology of laser cooling and trapping of target atoms with the momentum analysis of the charged fragments that recoil from the target. The authors review the different MOTRIMS experimental approaches and the spectroscopic and collisional investigations performed so far. Safronova and Johnson give an overview of atomic many-body perturbation theory and discuss why extensions of the theory are needed. They present "all-order results based on a linearized version of coupled cluster expansions and apply the theory to calculations of energies, transition matrix elements and hyperfine constants. Another contribution on atomic theory, authored by Fischer, explores the advantages of expanding the atomic radial wave functions in a B-spline basis. The differential equations are replaced by non-linear systems of equations and the problems of orthogonality requirements can be dealt with using projection operators. Electron-ion collisional processes are analyzed by Mueller, including descriptions of the experimental techniques needed to obtain cross section data and typical values for these cross sections. The present status of the field is discussed in relation to the detailed cross sections and rate coefficients that are needed for understanding laboratory or astrophysical plasmas. Finally, Duan and Monroe review ways to achieve scalable and robust quantum communication, state engineering, and quantum computation. Using radiation and atoms, ions, or atomic ensembles, they show that they can construct scalable quantum networks that are inherently insensitive to noise. Progress in experimental realization of their proposals is outlined.*

*International experts Comprehensive articles New developments*

*Atoms and Molecules*

*Atoms, Molecules and Photons*

*Lecture Notes on Atomic and Molecular Physics*

*Advances in Atomic Physics*

*Handbook of Theoretical Atomic Physics*

*Spectroscopy is the study of electromagnetic radiation and its interaction with solid, liquid, gas and plasma. It is one of the widely used analytical techniques to study the structure of atoms and molecules. The technique is also employed to obtain information about atoms and molecules as a result of their distinctive spectra. The fast-spreading field of spectroscopic applications has made a noteworthy influence on many disciplines, including energy research, chemical processing, environmental protection and medicine. This book aims to introduce students to the topic of spectroscopy. The author has avoided the mathematical aspects of the subject as far as possible; they appear in the text only when inevitable. Including topics such as time-dependent perturbation theory, laser action and applications of Group Theory in interpretation of spectra, the book offers a detailed coverage of the basic concepts and applications of spectroscopy.*

*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.*

*"This book introduces the fundamental quantum physics of atoms and molecules. Divided into three parts, the*

*first provides a historical perspective leading to the contemporary view of atomic and molecular physics, outlining the principles of non-relativistic quantum mechanics. The second part covers the physical description of atoms and their interaction with radiation, whilst the third part deals with molecular physics."* -- *Prové de l'editor.*

*This volume continues the tradition of the Advances series. It contains contributions from experts in the field of atomic, molecular, and optical (AMO) physics. The articles contain some review material, but are intended to provide a comprehensive picture of recent important developments in AMO physics. Both theoretical and experimental articles are included in the volume. • International experts • Comprehensive articles • New developments*

*Atoms and Molecules Interacting with Light*

*Advances in Atomic and Molecular Physics*

*A Student's Guide to Atomic Physics*

*Atomic And Molecular Physics - Proceedings Of The 3rd Us/mexico Symposium*

*Atomic Physics for the Laser Era*

This introduction to Atomic and Molecular Physics explains how our present model of atoms and molecules has been developed during the last two centuries by many experimental discoveries and from the theoretical side by the introduction of quantum physics to the adequate description of micro-particles. It illustrates the wave model of particles by many examples and shows the limits of classical description. The interaction of electromagnetic radiation with atoms and molecules and its potential for spectroscopy is outlined in more detail and in particular lasers as modern spectroscopic tools are discussed more thoroughly. Many examples and problems with solutions should induce the reader to an intense active cooperation.

The problems are judiciously selected and are given topic and section-wise. The approach is straight forward and step-by step solutions are elaborately provided. More importantly the relevant formulas used for solving the problems can be located in the beginning of each chapter. There are number of diagrams for illustration. Chapter 1 in the book is devoted to Atomic Structure. Chapter 2 is basically concerned One Valence Electron Systems. Chapter 3 is concerned with Two Valence Electron Systems. Chapter 4 is basically related to Zeeman Effect. Chapter 5 is related to X-Ray Spectroscopy. Chapter 6 is concerned with Molecular Spectroscopy and Chapter 7 dealt with Raman Spectroscopy.

Covers quantum scattering theories, experimental and theoretical calculations and applications in a comprehensive manner.

The study of atomic and molecular physics is a key component of undergraduate courses in physics, because of its fundamental importance to the understanding of many aspects of modern physics. The aim of this new edition is to provide a unified account of the subject within an undergraduate framework, taking the opportunity to make improvements based on the teaching experience of users of the first edition, and cover important new developments in the subject." " " " "Key features of this new edition:

" " " Revised material on molecular structure and spectra Extended material on electronic and atomic collisions A new chapter describing applications based on the use of the maser and the laser, including laser spectroscopy, laser cooling and trapping of atoms, Bose-Einstein condensation, atom lasers and atomic systems in intense laser fields A new chapter describing other applications, including magnetic resonance, atom optics, atoms in cavities, ions in traps, atomic clocks and astrophysics Revised appendices include new material on molecules and updated tables of physical constants Solutions of selected problems B.H. Bransden is Emeritus Professor of Theoretical Physics at the University of Durham. C.J. Joachain is Professor of Theoretical Physics at the University of Brussels. They are co-authors of "Quantum Mechanics, "also published by Prentice Hall. "

ATOMIC AND MOLECULAR PHYSICS

Illustrated Handbook of Atomic and Molecular Physics

A Primer

Springer Handbook of Atomic, Molecular, and Optical Physics

This book aims to present a unified account of the physics of atoms and molecules from a modern viewpoint. It is based on courses given by the authors at Middle East Technical University, Ankara and Georgia Institute of Technology, Atlanta. It is suitable for study at third and fourth year levels of an undergraduate course. Students should be able to read this book and understand its contents without the need to supplement it by referring to more detailed discussions. The whole book covered in this volume is expected to be finished in one semester. Contents: Atomic Models Radiation and Matter Wave Equations for Simple Quantum Systems Perturbation Theory and Radiative Transitions Quantum Theory of One-Electron Atoms Many-Electron Atoms Molecular Structure Approximation Methods for Many-Electron Systems Readership: Students of physics and chemistry. keywords:

After a brief review of quantum mechanics and a summary of conventional atomic theory, H. Friedrich discusses the structure of atomic spectra on the basis of quantum defect theory, which is treated for the first time at such a basic level in a textbook. Special attention is given to highly excited states and to the influence of external fields, which can cause interesting and interesting effects in seemingly simple systems. After a chapter on reaction theory the final chapter treats special topics such as multiphoton absorption and chaos. The book contains the kind of advanced quantum mechanics needed for applications in modern atomic physics. The presentation is kept deliberately simple and avoids abstract formalism as far as possible.

This book provides a coherent introduction to the manifestations of chaos in atoms and molecules.

For beginners and specialists in other fields: the Nobel Laureate's introduction to atomic spectra and their relationships to atomic structures, stressing basics in a physical, rather than mathematical, treatment. 80 illustrations.

Problems and Solutions on Atomic, Nuclear and Particle Physics

## Molecular Physics

Astronomical Spectroscopy: An Introduction To The Atomic And Molecular Physics Of Astronomical Spectra (2nd Edition)

Journal of Physics

## Atomic and Molecular Spectroscopy

With this volume, *Methods of Experimental Physics* becomes *Experimental Methods in the Physical Sciences*, a name change which reflects the evolution of today's science. This volume is the first of three which will provide a comprehensive treatment of the key experimental methods of atomic, molecular, and optical physics; the three volumes as a set will form an excellent experimental handbook for the field. The wide availability of tunable lasers in the past several years has revolutionized the field and led to the introduction of many new experimental methods that are covered in these volumes. Traditional methods are also included to ensure that the volumes will be a complete reference source for the field.

*Atoms and Molecules* describes the basic properties of atoms and molecules in terms of group theoretical methods in atomic and molecular physics. The book reviews mathematical concepts related to angular momentum properties, finite and continuous rotation groups, tensor operators, the Wigner-Eckart theorem, vector fields, and vector spherical harmonics. The text also explains quantum mechanics, including symmetry considerations, second quantization, density matrices, time-dependent, and time-independent approximation methods. The book explains atomic structure, particularly the Dirac equation in which its nonrelativistic approximation provides the basis for the derivation of the Hamiltonians for all important interactions, such as spin-orbit, external fields, hyperfine. Along with multielectron atoms, the text discusses multiplet theory, the Hartree-Fock formulation, as well as the electromagnetic radiation fields, their interactions with atoms in first and higher orders. The book explores molecules and complexes, including the Born-Oppenheimer approximation, molecular orbitals, the self-consistent field method, electronic states, vibrational and rotational states, molecular spectra, and the ligand field theory. The book can prove useful for graduate or advanced students and academicians in the field of general and applied physics.

Combined with the other two volumes, this text is a comprehensive treatment of the key experimental methods of atomic, molecular, and optical physics, as well as an excellent experimental handbook for the field. The wide availability of tunable lasers in the past several years has revolutionized the field and led to the introduction of many new experimental methods that are covered in these volumes. Traditional methods are also included to ensure that the volumes will be a complete reference source for the field. The richly illustrated book comprehensively explains the important principles of diatomic and polyatomic molecules and their spectra in two separate, distinct parts. The first part concentrates on the theoretical aspects of molecular physics, such as the vibration, rotation, electronic states, potential curves, and spectra of molecules. The different methods of approximation for the calculation of electronic wave functions and their energy are also covered. The introduction of basic terms used in group theory and their meaning in molecular physics enables an elegant description of polyatomic molecules and their symmetries. Molecular spectra and the dynamic processes involved in their excited states are given its own chapter. The theoretical part then concludes with a discussion of the field of Van der Waals molecules and clusters. The second part is devoted entirely to experimental techniques, such as laser, Fourier, NMR, and ESR spectroscopies, used in the fields of physics, chemistry, biology, and material science. Time-resolved measurements and the influence of chemical reactions by coherent controls are also treated. A list of general textbooks and specialized literature is provided for further reading. With specific examples, definitions, and notes integrated within the text to aid understanding, this is suitable for undergraduates and graduates in physics and chemistry with a knowledge of atomic physics and familiar with the basics of quantum mechanics.

Theory and Applications

Basic Concepts and Applications

Atomic, Molecular, and Optical Physics: Atoms and Molecules

Atomic Physics

The Fundamentals of Atomic and Molecular Physics

## Advances in Atomic and Molecular Physics

**This book presents a comprehensive overview of the spectacular advances seen in atomic physics during the last 50 years. The authors explain how such progress was possible by highlighting connections between developments that occurred at different times. They discuss the new perspectives and the new research fields that look promising. The emphasis is placed, not on detailed calculations, but rather on physical ideas. Combining both theoretical and experimental considerations, the book will be of interest to a wide range of students, teachers and researchers in**

quantum and atomic physics. Contents: General Introduction General Background "Light: A Source of Information on Atoms: "Optical Methods Linear Superpositions of Internal Atomic States Resonance Fluorescence Advances in High Resolution Spectroscopy" Atom-Photon Interactions: A Source of Perturbations for Atoms Which Can Be Useful: "Perturbations Due to a Quasi Resonant Optical Excitation Perturbations Due to a High Frequency Excitation" Atom-Photon Interactions: A Simple System for Studying Higher Order Effects: "Multiphoton Processes Between Discrete States Photoionization of Atoms in Intense Laser fields" Atom-Photon Interactions: A Tool for Controlling and Manipulating Atomic Motion: "Radiative Forces Exerted on a Two-Level Atom at Rest Laser Cooling of Two-Level Atoms Sub-Doppler Cooling. Sub-Recoil Cooling Trapping of Particles" Ultracold Interactions and Their Control: "Two-Body Interactions at Low Temperatures Controlling Atom-Atom Interactions" Exploring Quantum Interferences with Few Atoms and Photons: "Interference of Atomic de Broglie Waves Ramsey Fringes Revisited and Atomic Interferometry Quantum Correlations. Entangled States" Degenerate Quantum Gases: "Emergence of Quantum Effects in a Gas The Long Quest for Bose-Einstein Condensation Mean Field Description of a Bose-Einstein Condensate Coherence Properties of Bose-Einstein Condensates Elementary Excitations and Superfluidity in Bose-Einstein Condensates" Frontiers of Atomic Physics: "Testing Fundamental Symmetries. Parity Violation in Atoms Quantum Gases as Simple Systems for Many-Body Physics Extreme Light General Conclusion Readership: Graduate students, researchers and academics interested in quantum and atomic physics.

The Fundamentals of Atomic and Molecular Physics is intended as an introduction to the field for advanced undergraduates who have taken quantum mechanics. Each chapter builds upon the previous, using the same tools and methods throughout. As the students progress through the book, their ability to use these tools will steadily increase, along with their confidence in their efficacy. The book treats the two-electron atom as the simplest example of the many-electron atom—as opposed to using techniques that are not applicable to many-electron atoms—so that it is unnecessary to develop additional equations when turning to multielectron atoms, such as carbon. External fields are treated using both perturbation theory and direct diagonalization and spontaneous emission is developed from first principles. Only diatomic molecules are considered with the hydrogen molecular ion and neutral molecule treated in some detail. This comprehensive coverage of the quantum mechanics of complex atoms and simple diatomic molecules, developed from the very basic components, is extremely useful for students considering graduate studies in any area of physics.

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

**Atomic And Molecular Physics**

**An Introduction to Atomic-, Molecular- and Quantum Physics**

**Basic Aspects and Practical Applications**

**Theoretical Atomic Physics**

**Advances in atomic and molecular physics**

The aim of this book is to present highly accurate and extensive theoretical Atomic data and to give a survey of selected calculational methods for atomic physics, used to obtain these data. The book presents the results of calculations of cross sections and probabilities of a broad variety of atomic processes with participation of photons and electrons, namely on photoabsorption, electron scattering and accompanying effects. Included are data for photoabsorption and electron scattering cross-sections and probabilities of vacancy decay formed for a large number of atoms and ions. Attention is also given to photoionization and vacancy decay in endohedrals and to positron-atom scattering. The book is richly illustrated. The methods used are one-electron Hartree-Fock and the technique of Feynman diagrams that permits to include many-electron correlations. This is done in the frames of the Random Phase approximation with exchange and the many-body perturbation theory. Newly obtained and previously collected atomic data are presented. The atomic data are useful for investigating the electronic structure and physical processes in solids and liquids, molecules and clusters, astronomical objects, solar and planet atmospheres and atomic nucleus. Deep understanding of chemical reactions and processes is reached by deep and accurate knowledge of atomic structure and processes with participation of atoms. This book is useful for theorists performing research in different domains of contemporary physics, chemistry and biology, technologists working on production of new materials and for experimentalists performing research in the field of photon and electron interaction with atoms, molecules, solid bodies and liquids.

**Atomic and molecular physics. B**

**Physics of Atoms and Molecules**

**Atoms and Spectroscopy**

**Atoms, Molecules and Optical Physics 1**

**Theory and Computation**