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Atoms, Cavities, and Photons
An Introduction to Atomic-, Molecular- and Quantum Physics
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The Science of Atoms, Molecules, and Photons
Physics of Atoms and Molecules

Lectures on Atomic Physics
Ideas of Quantum Chemistry
An Interim Report
A Natural History of the Vacuum
Controlling the Quantum World of Atoms, Molecules, and Photons

RAIDEN SIMPSON

Atoms, Cavities, and Photons Springer Science & Business Media
Atomic, molecular, and optical (AMO) science illustrates powerfully the ties of fundamental physics to society. Its very name comes from three of the twentieth century's greatest advances: the establishment of the atom as the building block of matter; the development of quantum mechanics, which made it possible to understand the inner workings of atoms and molecules; and the invention of the laser. Advances made possible by the scientists in this field touch almost every sphere of societal importance in the past century. Navigation by the stars gave way to navigation by clocks, which in turn has given way to today's navigation by atomic clocks. Laser surgery has replaced the knife for the most delicate operations. Homeland security relies on a multitude of screening technologies based on AMO research to detect toxins in the air and hidden weapons in luggage or on persons, to name a few. New drugs are now designed with the aid of x-ray scattering to determine their structure at the molecular level using AMO-based precision measurement techniques. And the global economy depends critically on high-speed telecommunication by laser light sent over thin optical fibers encircling the globe. AMO scientists are proud of their central role in science and society in the twentieth century, and they have been rewarded with numerous Nobel prizes over the past decade, including the 2005 prize in physics. But in this report we look to the future. The National Research Council of the National Academies has undertaken a study of opportunities in atomic, molecular, and optical (AMO) science and technology over roughly the next decade. The committee carrying out the AMO 2010 study, has been asked to assess the state of AMO science, emphasizing recent accomplishments and identifying new and compelling scientific questions. The six grand challenges, summarized below, will each form a chapter of the committee's final report: What is the nature of physical law? What happens at the lowest temperatures in the universe? What happens when we turn up the power? Can we control the inner workings of a molecule? How will we control and exploit the nanoworld? What lies beyond Moore's law? Controlling the Quantum World of Atoms, Molecules, and Photons: An Interim Report provides a preview of the final document. It summarizes the committee's opinion on the key opportunities in forefront AMO science and in closely related critical technologies and discusses some of the broad-scale conclusions of the final report. It also identifies how AMO science supports national R&D priorities.
An Introduction to Atomic-, Molecular- and Quantum Physics Springer Science & Business Media
Experimental Quantum Chemistry is a comprehensive account of experimental quantum chemistry and covers topics ranging from basic quantum theory to atoms and ions, photons, electrons, and positrons. Nuclei, molecules, and free radicals are also discussed. This volume is comprised of eight chapters and begins with an overview of the basic experiments and ideas leading to the development of quantum theory, with special emphasis on the problems of chemistry. The main properties of electromagnetic radiation are then considered, along with the most important relations of electrons and positrons in chemistry; the quantum theory of isolated atoms and ions; the structure of nuclei and the main applications to organic chemistry; and the chemical structure and reactivity of molecules. The theoretical and experimental aspects of interpreting free radical structures on the basis of the molecular orbital and valence bond theories are also explored. The final chapter is devoted to the chemistry of the organic solid state, paying particular attention to the structure and molecular mobilities of organic solids, collective crystal states (excitons, phonons, and polaritons), energy transfer processes, and reactions in the solid state. This book should be of interest to physicists and organic chemists.
Order from Force National Academies Press
The field of atomic, molecular, and optical (AMO) science underpins many technologies and continues to progress at an exciting pace for both scientific discoveries and technological innovations. AMO physics studies the fundamental building blocks of functioning matter to help advance the understanding of the universe. It is a foundational discipline within the physical sciences, relating to atoms and their constituents, to molecules, and to light at the quantum level. AMO physics combines fundamental research with practical application, coupling fundamental scientific discovery to rapidly evolving technological advances, innovation and commercialization. Due to the wide-reaching intellectual, societal, and economical impact of AMO, it is important to review recent advances and future opportunities in AMO physics. Manipulating Quantum Systems: An Assessment of Atomic, Molecular, and Optical Physics in the United States assesses opportunities in AMO science and technology over the coming decade. Key topics in this report include tools made of light; emerging phenomena from few- to many-body systems; the foundations of quantum information science and technologies; quantum dynamics in the time and frequency domains; precision and the nature of the universe, and the broader impact of AMO science.
An Assessment of Atomic, Molecular, and Optical Physics in the United States Springer Science & Business Media
Atoms, Molecules and PhotonsAn Introduction to Atomic-, Molecular- and Quantum PhysicsSpringer Science & Business Media
Atoms and Molecules Interacting with Light Springer
Starting from multi-dimensional potential energy surfaces and the Schrödinger equation of nuclear motion, this text elucidates the achievements in calculating photodissociation cross sections and fragment state distributions from first principles.

Engineering the Atom-Photon Interaction Springer Science & Business Media
This book provides a comprehensive view of the contemporary methods for quantum-light engineering. In particular, it addresses different technological branches and therefore allows the reader to quickly identify the best technology - application match. Non-classical light is a versatile tool, proven to be an intrinsic part of various quantum technologies. Its historical significance has made it the subject of many text books written both from theoretical and experimental point of view. This book takes another perspective by giving an insight to modern technologies used to generate and manipulate quantum light.
Atomic Structure Theory OUP Oxford
Electrons, Atoms, and Molecules in Inorganic Chemistry: A Worked Examples Approach builds from fundamental units into molecules, to provide the reader with a full understanding of inorganic chemistry concepts through worked examples and full color illustrations. The book uniquely discusses failures as well as research success stories. Worked problems include a variety of types of chemical and physical data, illustrating the interdependence of issues. This text contains a bibliography providing access to important review articles and papers of relevance, as well as summaries of leading articles and reviews at the end of each chapter so interested readers can readily consult the original literature. Suitable as a professional reference for researchers in a variety of fields, as well as course use and self-study. The book offers valuable information to fill an important gap in the field. Incorporates questions and answers to assist readers in understanding a variety of problem types Includes detailed explanations and developed practical approaches for solving real chemical problems Includes a range of example levels, from classic and simple for basic concepts to complex questions for more sophisticated topics Covers the full range of topics in inorganic chemistry: electrons and wave-particle duality, electrons in atoms, chemical binding, molecular symmetry, theories of bonding, valence bond theory, VSEPR theory, orbital hybridization, molecular orbital theory, crystal field theory, ligand field theory, electronic spectroscopy, vibrational and rotational spectroscopy
New Trends in Atomic and Molecular Physics Simon and Schuster
An understanding of the collisions between micro particles is of great importance for the number of fields belonging to physics, chemistry, astrophysics, biophysics etc. The present book, a theory for electron-atom and molecule collisions is developed using non-relativistic quantum mechanics in a systematic and lucid manner. The scattering theory is an essential part of the quantum mechanics course of all universities. During the last 30 years, the author has lectured on the topics presented in this book (collisions physics, photon-atom collisions, electron-atom and electron-molecule collisions, "electron-photon delayed coincidence technique", etc.) at many institutions including Wayne State University, Detroit, MI, The University of Western Ontario, Canada, and The Meerut University, India. The present book is the outcome of those lectures and is written to serve as a textbook for post-graduate and pre-PhD students and as a reference book for researchers.
Theory and Computation National Academies Press
Presents a unique approach to grasping the concepts of quantum theory with a focus on atoms, clusters, and crystals Quantum theory of atoms and molecules is vitally important in molecular physics, materials science, nanoscience, solid state physics and many related fields. Introductory Quantum Mechanics with MATLAB is designed to be an accessible guide to quantum theory and its applications. The textbook uses the popular MATLAB programming language for the analytical and numerical solution of quantum mechanical problems, with a particular focus on clusters and assemblies of atoms. The textbook is written by a noted researcher and expert on the topic who introduces density functional theory, variational calculus and other practice-proven methods for the solution of quantum-mechanical problems. This important guide: -Presents the material in a didactical manner to help students grasp the concepts and applications of quantum theory -Covers a wealth of cutting-edge topics such as clusters, nanocrystals, transitions and organic molecules -Offers MATLAB codes to solve real-life quantum mechanical problems Written for master's and PhD students in physics, chemistry, material science, and engineering sciences, Introductory Quantum Mechanics with MATLAB contains an accessible approach to understanding the concepts of quantum theory applied to atoms, clusters, and crystals.
Controlling the Quantum World of Atoms, Molecules, and Photons Cambridge University Press
Motivated by a revision of the classical equations of electromagnetism that allow for the inclusion of solitary waves in the solution space, the material collected in this book examines the consequences of adopting the modified model in the description of atomic structures. The possibility of handling 'photons' in a deterministic way indeed gives a chance to review the foundations of quantum physics. Atoms and molecules are described as aggregations of nuclei and electrons joined through organized photon layers resonating at various frequencies, explaining how matter can absorb or emit light quanta. Some established viewpoints are subverted, offering an alternative scenario. The analysis seeks to provide an answer to many technical problems in physical chemistry and, at the same time, to raise epistemological questions.
Physics in the Modern World Academic Press
The field of Atomic and Molecular Physics (AMP) has reached significant advances in high–precision experimental measurement techniques. The area covers a wide spectrum ranging from conventional to new emerging multi-disciplinary areas like physics of highly charged ions (HCI), molecular physics, optical science, ultrafast laser technology etc. This book includes the important topics of atomic structure, physics of atomic collision, photoexcitation, photoionization processes, Laser cooling and trapping, Bose Einstein condensation and advanced technology applications of AMP in the fields of astronomy, astrophysics, fusion, biology and nanotechnology. This book is useful for researchers, professors, graduate, postgraduate and PhD students dealing with atomic and molecular physics. The book has a wide scope with applications in neighboring fields like plasma physics, astrophysics, cold collisions, nanotechnology and future fusion energy sources like ITER (international Thermonuclear Experimental Reactor) Tokomak plasma machine, which need accurate AMP data.
Problems and Solutions on Atomic, Nuclear and Particle Physics Springer
Case Studies in Atomic Physics IV presents a collection of six case studies in atomic physics. The first study deals with the correspondence identities associated with the Coulomb potential: the Rutherford scattering identity, the Bohr-Sommerfeld identity, and the Fock identity. The second paper reviews advances in recombination. This is followed by a three-part study on relativistic self-

consistent field (SCF) calculations. The first part considers relativistic SCF calculations in general, and in particular discusses different configurational averaging techniques and various statistical exchange approximations. The second part reviews the relativistic theory of hyperfine structure. The third part makes a number of comparisons between experimental results and values obtained in different SCF schemes, with exact as well as approximate exchange. The next case study on pseudopotentials compares the results of model potential and pseudopotential calculations. The final study reviews, on a kinetic basis, the behavior of low density ion swarms in a neutral gas.

An Introduction to Atomic-, Molecular- and Quantum Physics CRC Press

This introduction to nuclear physics and particle physics provides an accessible and clear treatment of the fundamentals. Starting with the structure of nuclei and explaining instability of nuclei, this textbook enables the reader to understand all basics in nuclear physics. The text is written from the experimental physics point of view, giving numerous real-life examples and applications of nuclear forces in modern technology. This highly motivating presentation deepens the reader's knowledge in a very accessible way. The second part of the text gives a concise introduction to elementary particle physics, again together with applications and instrumentation. Nuclear fusion, fission, radionuclides in medicine and particle accelerators are amongst the many examples explained in detail. Numerous problems with solutions are perfect for self-study.

A Worked Examples Approach World Scientific Publishing Company

This is the second 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 2 introduces lasers and quantum optics, while the main focus is on the structure of molecules and their spectroscopy, as well as on collision physics as the continuum counterpart to bound molecular states. 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.

The Quantum Theory of Atoms, Molecules and Photons Halsted Press

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.

From Atoms, Molecules, Nuclei and Bulk Matter Springer Science & Business Media

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

Atoms, Molecules and Photons Morgan & Claypool Publishers

This book describes the methods of experimental spectroscopy and their use in the study of physical phenomena. The applications of optical spectroscopy may be grouped under three broad headings: chemical analysis, elucidation of atomic and molecular structure, and investigations of the interactions of radiating atoms and molecules with their environment. I have used the word 'Spectro physics' for the third of these by analogy with spectrochemistry for the first and in preference to 'quantitative spectroscopy'. A number of textbooks treat atomic and molecular structure at varying levels of profundity, but elementary spectrophysics is not, so far as I am aware, covered in anyone existing book. There is moreover a lack of up-to-date books on experimental techniques that treat in a fairly elementary fashion interfero metric, Fourier transform and radiofrequency methods as well as prism and grating spectroscopy. In view of the importance of spectrophysics in astrophys ics and plasma physics as well as in atomic and molecular spectroscopy there seemed a place for a book describing both the experimental methods and their spectrophysical applications.

Experimental Quantum chemistry Elsevier

This book provides a hands-on experience with atomic structure calculations. Material covered includes angular momentum methods, the central field Schrödinger and Dirac equations, Hartree-Fock and Dirac-Hartree-Fock equations, multiplet structure, hyperfine structure, the isotope shift, dipole and multipole transitions, basic many-body perturbation theory, configuration interaction, and correlation corrections to matrix elements. The book also contains numerical methods for solving the Schrödinger and Dirac eigenvalue problems and the (Dirac)-Hartree-Fock equations.

Atoms, Molecules and Optical Physics 2 Elsevier

The counter-intuitive aspects of quantum physics have been long illustrated by thought experiments, from Einstein's photon box to Schrödinger's cat. These experiments have now become real, with single particles - electrons, atoms, or photons - directly unveiling the strange features of the quantum. State superpositions, entanglement and complementarity define a novel quantum logic which can be harnessed for information processing, raising great hopes for applications. This book describes a class of such thought experiments made real. Juggling with atoms and photons confined in cavities, ions or cold atoms in traps, is here an incentive to shed a new light on the basic concepts of quantum physics. Measurement processes and decoherence at the quantum-classical boundary are highlighted. This volume, which combines theory and experiments, will be of interest to students in quantum physics, teachers seeking illustrations for their lectures and new problem sets, researchers in quantum optics and quantum information.

Manipulating Quantum Systems Elsevier
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.