

Theoretical Femtosecond Physics Atoms And Molecules In Strong Laser Fields Graduate Texts In Physics

The goals of atomic, molecular, and optical physics (AMO physics) are to elucidate the fundamental laws of physics, to understand the structure of matter and how matter evolves at the atomic and molecular levels, to understand light in all its manifestations, and to create new techniques and devices. AMO physics provides theoretical and experimental methods and essential data to neighboring areas of science such as chemistry, astrophysics, condensed-matter physics, plasma physics, surface science, biology, and medicine. It contributes to the national security system and to the nation's programs in fusion, directed energy, and materials research. Lasers and advanced technologies such as optical processing and laser isotope separation have been made possible by discoveries in AMO physics, and the research underlies new industries such as fiber-optics communications and laser-assisted manufacturing. These developments are expected to help the nation to maintain its industrial competitiveness and its military strength in the years to come. This report describes the field, characterizes recent advances, and identifies current frontiers of research.

This book documents the recent vivid developments in the research field of ultrashort intense light pulses for probing and controlling ultrafast dynamics. The recent fascinating results in studying and controlling ultrafast dynamics in ever more complicated systems such as (bio-)molecules and structures of meso- to macroscopic sizes on ever shorter time-scales are presented. The book is written by some of the most eminent experimental and theoretical experts in the field. It covers the new groundbreaking research directions that were opened by the availability of new light sources such as fully controlled intense laser fields with durations down to a single oscillation cycle, short-wavelength laser-driven attosecond pulses and intense X-ray pulses from the upcoming free electron lasers. These light sources allowed the investigation of dynamics in atoms, molecules, clusters, on surfaces and very recently also in nanostructures and solids in new regimes of parameters which, in turn, led to the identification of completely new dynamics and methods for controlling it. Example topics covered by this book include the study of ultrafast processes in large molecules using attosecond pulses, control of ultrafast electron dynamics in solids with shaped femtosecond laser pulses, light-driven ultrafast plasmonic processes on surfaces and in nanostructures as well as research on atomic and molecular systems under intense X-ray radiation. This book is equally helpful for people who would like to step into this field (e.g. young researchers), for whom it provides a broad introduction, as well as for already experienced researchers who may enjoy the exhaustive discussion that covers the research on essentially all currently studied objects and with all available ultrafast pulse sources.

Commencing with a self-contained overview of atomic collision theory, this monograph presents recent developments of R-matrix theory and its applications to a wide-range of atomic molecular and optical processes. These developments include the electron and photon collisions with atoms, ions and molecules which are required in the analysis of laboratory and astrophysical plasmas, multiphoton processes required in the analysis of superintense laser interactions with atoms and molecules and positron collisions with atoms and molecules required in antimatter studies of scientific and technological importance. Basic mathematical results and general and widely used R-matrix computer programs are summarized in the appendices.

The emergence and spectacularly rapid evolution of the field of atomic and molecular clusters are among the most exciting developments in the recent history of natural sciences. The field

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of clusters expands into the traditional disciplines of physics, chemistry, materials science, and biology, yet in many respects it forms a cognition area of its own. This book presents a cross section of theoretical approaches and their applications in studies of different cluster systems. The contributions are written by experts in the respective areas. The systems discussed range from weakly (van der Waals) bonded, through hydrogen- and covalently bonded, to semiconductor and metallic clusters. The theoretical approaches involve high-level electronic structure computations, more approximate electronic structure treatments, use of semiempirical potentials, dynamical and statistical analyses, and illustrate the utility of both classical and quantum mechanical concepts.

Theoretical investigations of atoms and molecules interacting with pulsed or continuous wave lasers up to atomic field strengths on the order of 10^{16} W/cm² are leading to an understanding of many challenging experimental discoveries. This book deals with the basics of femtosecond physics and goes up to the latest applications of new phenomena. The book presents an introduction to laser physics with mode-locking and pulsed laser operation. The solution of the time-dependent Schrödinger equation is discussed both analytically and numerically. The basis for the non-perturbative treatment of laser-matter interaction in the book is the numerical solution of the time-dependent Schrödinger equation. The light field is treated classically, and different possible gauges are discussed. Physical phenomena, ranging from Rabi-oscillations in two-level systems to the ionization of atoms, the generation of high harmonics, the ionization and dissociation of molecules as well as the control of chemical reactions are presented and discussed on a fundamental level. In this way the theoretical background for state of the art experiments with strong and short laser pulses is given. The text is augmented by more than thirty exercises, whose worked-out solutions are given in the last chapter. Some detailed calculations are performed in the appendices. Furthermore, each chapter ends with references to more specialized literature.

This volume offers theoretical investigations of atoms and molecules interacting with pulsed or continuous wave lasers. Theoretical background is included, and the text incorporates several exercises. Additional calculations are performed in the appendices.

The last few years have seen some remarkable advances in the understanding of atomic phenomena. It is now possible to isolate atomic systems in traps, measure in coincidence the fragments of collision processes, routinely produce, and study multicharged ions. One can look at bulk matter in such a way that the fundamental atomic character is clearly evident and work has begun to tease out the properties of anti matter. The papers in this book reflect many aspects of modern Atomic Physics. They correspond to the invited talks at a conference dedicated to the study of "New Directions in Atomic Physics," which took place in Magdalene College, Cambridge in July of 1998. The meeting was designed as a way of taking stock of what has been achieved and, it was hoped, as a means of stimulating new research in new areas, along new lines. Consequently, an effort was made to touch on as many directions as we could in the four days of the meeting. We included some talks which overviewed whole subfields, as well as quite a large number of research contributions. There is a unity to Physics and we tried to avoid any artificial division between theory and experiment. We had roughly the same number of talks from those who are primarily concerned with making measurements, and from those who spend their lives trying to develop the theory to describe the experiments. Atomic and molecular physics underlie a basis for our knowledge of fundamental processes in nature and technology and in such applications as solid state physics, chemistry and biology. In recent years, atomic and molecular physics has undergone a revolutionary change due to great achievements in computing and experimental techniques. As a result, it has become possible to obtain information both on atomic and molecular characteristics and on dynamics of atomic and molecular processes. This e-book highlights the present state of investigations in the field of atomic and molecular physics. Recent theoretical developments as well as new

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discoveries and observations are discussed. the Book should be of interest to students studying atomic and molecular physics and specialists in related fields of science and technology.

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.

Angle and spin resolved Auger emission physics deals with the theoretical and numerical description, analysis and interpretation of such types of experiments on free atoms and molecules. This monograph derives the general theory applying the density matrix formalism and, in terms of irreducible tensorial sets, so called state multipoles and order parameters, for parameterizing the atomic and molecular systems, respectively. It is the first book on angle and spin-resolved Auger emission.

The study of atomic systems exposed to super-intense laser fields de fines an important area in atomic, molecular and optical physics. Although the concept of super-intense field has no absolute meaning, it is now usual to call an electromagnetic field super-intense when it exceeds the atomic binding field. In the case of the simplest atomic system, hydrogen in its $1s$ ground state, this occurs above an intensity of $3.5 \times 10^{16} \text{ W/cm}^2$ which is the atomic unit of intensity. Presently at the laboratory scale and in extremely short and tightly focussed laser pulses, the electric field strength 10^{18} V/m reaches peak values which are of the order of 10^{16} W/cm^2 in the infrared frequency regime, the prospect being that such peak intensities may be reached within a few years in a regime of much higher frequencies (XUV or even X). The interaction of such electromagnetic fields with an atomic system has a highly non-linear character which has led to the observation of to tally unexpected phenomena. There are three fundamental processes which have marked the beginning of an intensive research in the field of super intense laser-atom physics (SILAP). These processes which only involve one atomic electron are (i) the so-called above-threshold ionisation i. e.

A unified account of the rapidly developing field of high-intensity laser-atom interactions, suitable for both graduate students and researchers.

Contemporary research in atomic and molecular physics concerns itself with studies of interactions of electron, positron, photons, and ions with atoms, molecules, and clusters; interactions of intense ultrashort laser interaction with atoms, molecules, and solids; laser assisted atomic collisions, optical, and magnetic traps of neutral atoms to produce ultracold and dense samples; high resolution atomic spectroscopy and experiments by using synchrotron radiation sources and ion storage rings. In recent years, important advances have been made in the experimental as well as theoretical understanding of atomic and molecular physics. The advances in atomic and molecular physics have helped us to understand many other fields, like astrophysics, atmospheric physics, environmental science, laser physics, surface physics, computational physics, photonics, and electronics. XII National Conference on Atomic and Molecular Physics was held at the Physics Department, M. 1. S. University, Udaipur from 29th Dec. 1998 to 2nd Jan. 1999 under the auspices of the Indian Society of Atomic and Molecular Physics. This volume is an outcome of the contributions from the invited speakers at the conference. The volume contains 24 articles contributed by the distinguished scientists in the field. The contributors have covered a wide range of topics in the field in which current research is being done. This also reflects the trend of research in this field in Indian universities and research institutes. We are grateful to the national programme committee, national, and local organizing committees, and members of the Physics Department and Computer Centre, M. 1.

This established text contains an advanced presentation of quantum mechanics adapted to the requirements of modern atomic physics. The third edition extends the successful second edition with a detailed treatment of the wave motion of atoms, and it also contains an introduction to some aspects of atom optics that are relevant for current and future experiments involving ultra-cold atoms. Included: Various problems with complete solutions.

The recent development of high power lasers, delivering femtosecond pulses of 10^{12} intensities up to 10 W/cm^2 , has led to the discovery of new phenomena in laser interactions with matter. At these enormous laser intensities, atoms, and molecules are exposed to extreme conditions and new phenomena occur, such as the very rapid multi photon ionization of atomic systems, the emission by these systems of very high order harmonics of the exciting laser light, the Coulomb explosion of molecules, and the acceleration of electrons close to the velocity of light. These phenomena generate new behaviour of bulk matter in intense laser fields, with great potential for wide ranging applications which include the study of ultra-fast processes, the development of high-frequency lasers, and the investigation of the properties of plasmas and condensed matter under extreme conditions of temperature and pressure. In particular, the concept of the "fast ignitor" approach to inertial confinement fusion (ICF) has been proposed, which is based on the separation of the compression and the ignition phases in laser-driven ICF. The aim of this course on "Atom, Solids and Plasmas

in Super-Intense Laser fields" was to bring together senior researchers and students in atomic and molecular physics, laser physics, condensed matter and plasma physics, in order to review recent developments in high-intensity laser-matter interactions. The course was held at the Ettore Majorana International Centre for Scientific Culture in Erice from July 8 to July 14, 2000.

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Volume 54 of the Advances in Atomic, Molecular, and Optical Physics Series contains ten contributions, covering a diversity of subject areas in atomic, molecular and optical physics. The article by Regal and Jin reviews the properties of a Fermi degenerate gas of cold potassium atoms in the crossover regime between the Bose-Einstein condensation of molecules and the condensation of fermionic atom pairs. The transition between the two regions can be probed by varying an external magnetic field. Sherson, Julsgaard and Polzik explore the manner in which light and atoms can be entangled, with applications to quantum information processing and communication. They report on the result of recent experiments involving the entanglement of distant objects and quantum memory of light. Recent developments in cold Rydberg atom physics are reviewed in the article by Choi, Kaufmann, Cubel-Liebisch, Reinhard, and Raithel. Fascinating experiments are described in which cold, highly excited atoms ("Rydberg atoms) and cold plasmas are generated. Evidence for a collective excitation of Rydberg matter is also presented. Griffiin and Pindzola offer an account of non-perturbative quantal methods for electron-atom scattering processes. Included in the discussion are the R-matrix with pseudo-states method and the time-dependent close-coupling method. An extensive review of the R-matrix theory of atomic, molecular, and optical processes is given by Burke, Noble, and Burke. They present a systematic development of the R-matrix method and its applications to various processes such as electron-atom scattering, atomic photoionization, electron-molecule scattering, positron-atom scattering, and atomic/molecular multiphoton processes. Electron impact excitation of rare-gas atoms from both their ground and metastable states is discussed in the article by Boffard, Jung, Anderson, and Lin. Excitation cross sections measured by the optical method are reviewed with emphasis on the physical interpretation in terms of electronic structure of the target atoms. Ozier and Moazzen-Ahmadi explore internal rotation of symmetric top molecules. Developments of new experimental methods based on high-resolution torsional, vibrational, and molecular beam spectroscopy allow accurate determination of internal barriers for these symmetric molecules. The subject of attosecond and angstrom science is reviewed by Niikura and Corkum. The underlying physical mechanisms allowing one to generate attosecond radiation pulses are described and the technology needed for the preparation of such pulses is discussed. LeGouët, Bretenaker, and Lorgeré describe how rare earth ions embedded in crystals can be used for processing optically carried broadband radio-frequency signals. Methods for reaching tens of gigahertz instantaneous bandwidth with submegahertz resolution using such devices are analyzed in detail and demonstrated experimentally. Finally, in the article by Illing, Gauthier, and Roy, it is shown that small perturbations applied to optical systems can be used to suppress or control optical chaos, spatio-temporal dynamics, and patterns. Applications of these techniques to communications, laser stabilization, and improving the sensitivity of low-light optical switches are explored. International experts Comprehensive articles New developments

This book presents the latest developments in Femtosecond Chemistry and Physics for the study of ultrafast photo-induced molecular processes. Molecular systems, from the simplest H₂ molecule to polymers or biological macromolecules, constitute central objects of interest for Physics, Chemistry and Biology, and despite the broad range of phenomena that they exhibit,

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they share some common behaviors. One of the most significant of those is that many of the processes involving chemical transformation (nuclear reorganization, bond breaking, bond making) take place in an extraordinarily short time, in or around the femtosecond temporal scale (1 fs = 10^{-15} s). A number of experimental approaches - very particularly the developments in the generation and manipulation of ultrashort laser pulses - coupled with theoretical progress, provide the ultrafast scientist with powerful tools to understand matter and its interaction with light, at this spatial and temporal scale. This book is an attempt to reunite some of the state-of-the-art research that is being carried out in the field of ultrafast molecular science, from theoretical developments, through new phenomena induced by intense laser fields, to the latest techniques applied to the study of molecular dynamics.

Ever since 1911, the Solvay Conferences have shaped modern physics. The 25th edition held in October 2011 in Brussels and chaired by David Gross continued this tradition and celebrated the first centennial of this illustrious series of conferences. The development and applications of quantum mechanics have always been the main threads in the history of the Solvay Conferences, hence the 25th Solvay conference gathered many of the leading figures working on a wide variety of profound problems in physics where quantum mechanical effects play a central role. The conference addressed some of the most pressing open questions in the field of physics. The proceedings contain the OC rapporteur talksOCO which give a broad overview with unique insights by distinguished and renowned scientists. These lectures cover the seven sessions: OC History and ReflectionsOCO, OC Foundations of Quantum Mechanics and Quantum ComputationOCO, OC Control of Quantum SystemsOCO, OC Quantum Condensed MatterOCO, OC Particles and FieldsOCO, OC Quantum Gravity and String TheoryOCO and it ended with a general discussion attempting to arrive at a synthesis. In the Solvay tradition, the proceedings also include the prepared comments to the rapporteur talks. The discussions among the participants OCo some of which quite lively and involving dramatically divergent points of view OCo have been carefully edited and are reproduced in full.

The breadth, scope and volume of research in atomic, molecular and optical (AMO) physics have increased enormously in the last few years. Following the widespread use of pulsed lasers, certain newly emerging areas as well as selected mature subfields are ushering in a second renaissance. This volume focuses on current research in these crucial areas: cold atoms and BoseOCO Einstein condensates, quantum information and quantum computation, and new techniques for investigating collisions and structure. The topics covered include: the multireference coupled cluster method in quantum chemistry and the role of electronic correlation in nanosystems; laser cooling of atoms and theories of the BoseOCO Einstein condensate; and quantum computing and quantum information transfer using cold atoms and shaped ultrafast pulses. Other articles deal with recent findings in heavy ion collisions with clusters, time-of-flight spectroscopy techniques, and a specific example of a chaotic quantum system. The contributions will greatly assist in the sharing of specialized knowledge among experts and will also be useful for postgraduate students striving to obtain an overall picture of the current research status in the areas covered. Sample Chapter(s). Chapter 1: Ultrafast Dynamics of Nano and Mesoscopic Systems Driven by Asymmetric Electromagnetic Pulses (1,314 KB). Contents: Ultrafast Dynamics of Nano and Mesoscopic Systems Driven by Asymmetric Electromagnetic Pulses (A Matos-Abiague et al.); Experimenting with Topological States of BoseOCO Einstein Condensates (C Raman); PairOCO Correlation in BoseOCO Einstein Condensate and Fermi Superfluid of Atomic Gases (B Deb); A FeynmanOCO Kac Path Integral Study of Rb Gas (S Dutta); Quantum Information Transfer in AtomOCO Photon Interactions in a Cavity (A S Majumder et al.); MRCPA: Theory and Application to Highly Correlating System (K Tanaka); Estimation of Ion Kinetic Energies from Time-of-Flight and Momentum Spectra (B Bapat); Study of AtomOCO Surface Interaction Using Magnetic Atom Mirror (A K Mohapatra);

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and other papers. Readership: Academics, researchers and research students in physics." Advances in Atomic, Molecular, and Optical Physics publishes reviews of recent developments in a field which is in a state of rapid growth, as new experimental and theoretical techniques are used on many old and new problems. Topics covered include related applied areas, such as atmospheric science, astrophysics, surface physics and laser physics. Articles are written by distinguished experts, and contain both relevant review material and detailed descriptions of important recent developments. International experts Comprehensive articles New developments

This series, established in 1965, is concerned with recent developments in the general area of atomic, molecular, and optical physics. The field is in a state of rapid growth, as new experimental and theoretical techniques are used on many old and new problems. Topics covered also include related applied areas, such as atmospheric science, astrophysics, surface physics, and laser physics. Articles are written by distinguished experts who are active in their research fields. The articles contain both relevant review material and detailed descriptions of important recent developments.

This is the first comprehensive treatment of the interaction of femtosecond laser pulses with solids at nonrelativistic intensity. It connects phenomena from the subtle atomic motion on the nanoscale to the generation of extreme pressure and temperature in the interaction zone confined inside a solid. The femtosecond laser-matter interaction has already found numerous applications in industry, medicine, and materials science. However, there is no consensus on the interpretation of related phenomena. With mathematics kept to a minimum, this is a highly engaging and readable treatment for students and researchers in science and engineering. The book avoids complex mathematical formulae, and hence the content is accessible to nontechnical readers. Useful summaries after each chapter provide compressed information for quick estimates of major parameters in planned or performed experiments. The book connects the basic physics of femtosecond laser-solid interactions to a broad range of applications. Throughout the text, basic assumptions are derived from the first principles, and new results and ideas are presented. From such analyses, a qualitative and predictive framework for the field emerges, the impact of which on applications is also discussed. Plasma Atomic Physics provides an overview of the elementary processes within atoms and ions in plasmas, and introduces readers to the language of atomic spectra and light emission, allowing them to explore the various and fascinating radiative properties of matter. The book familiarizes readers with the complex quantum-mechanical descriptions of electromagnetic and collisional processes, while also developing a number of effective qualitative models that will allow them to obtain adequately comprehensive descriptions of collisional-radiative processes in dense plasmas, dielectronic satellite emissions and autoionizing states, hollow ion X-ray emissions, polarized atoms and ions, hot electrons, charge exchange, atomic population kinetics, and radiation transport. Numerous applications to plasma spectroscopy and experimental data are presented, which concern magnetic confinement fusion, inertial fusion, laser-produced plasmas, and X-ray free-electron lasers interaction with matter. Particular highlights include the development of quantum kinetics to a level surpassing the almost exclusively used quasi-classical approach in atomic population kinetics, the introduction of the recently developed Quantum-F-Matrix-Theory (QFMT) to study the impact of plasma microfields on atomic populations, and the Enrico Fermi equivalent photon method to develop the Plasma Atom, where the response properties and oscillator strength distribution are represented with the help of a local plasma frequency of the atomic electron density. Based on courses held by the authors, this material will assist students and scientists studying the complex processes within atoms and ions in different kinds of plasmas by developing relatively simple but highly effective models. Considerable attention is paid to a number of qualitative models that deliver physical transparency, while extensive tables and formulas promote the

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practical and useful application of complex theories and provide effective tools for non-specialist readers.

Praise for Previous Volumes "This volume maintains the authoritative standards of the series...The editors and publishers are to be congratulated" - M.S. CHILD in PHYSICS BULLETIN "Maintains the high standards of earlier volumes in the series...All the series are written by experts in the field, and their summaries are most timely...Strongly recommended." - G. HERZBERG in AMERICAN SCIENTIST

During the last two decades the explorations of different processes accompanying ion-atom collisions at high-impact energies have been a subject of much interest. This interest was generated not only by the advent of accelerators of relativistic heavy ions which enabled one to investigate these collisions in an experiment and possible applications of obtained results in other fields of physics, but also by the variety of physical mechanisms underlying the atomic collisional phenomena at high impact energies. Often highly charged projectiles produced at accelerators of heavy ions are not fully stripped ions but carry one or more very tightly bound electrons. In collisions with atomic targets, these electrons can be excited or lost and this may occur simultaneously with electronic transitions in the target. The present book concentrates on, and may serve as an introduction to, theoretical methods which are used to describe the projectile-electron transitions occurring in high-energy collisions between ions and neutral atoms. Special attention is given to relativistic impact energies and highly charged projectiles. Experimental results are used merely as illustrations and tests for theory. This book will be useful to graduate students and professional scientists who are interested in studying atomic collisions occurring at high-impact energies. It assumes that the reader possesses the basic knowledge in classical electrodynamics and nonrelativistic and relativistic quantum mechanics.

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

Most textbooks explain quantum mechanics as a story where each step follows naturally from the one preceding it. However, the development of quantum mechanics was exactly the opposite. It was a zigzagging route full of personal disputes where scientists were forced to abandon well-established classical concepts and to explore new and imaginative routes. This book demonstrates the huge practical utility of another of these routes in explaining quantum phenomena in various research fields. Bohmian mechanics—the formulation of the quantum theory pioneered by Louis de Broglie and David Bohm—offers an alternative mathematical formulation of quantum phenomena in terms of quantum trajectories. It sheds light on the limits and extensions of our present understanding of quantum mechanics toward other paradigms, such as relativity or cosmology.

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.

This volume presents the latest advancements and future perspectives of atomic, molecular and optical (AMO) physics and its vital role in modern sciences and technologies. The chapters are devoted to a wide range of quantum systems, with an emphasis on the understanding of ionization, high-harmonic generation, molecular orbital imaging and coherent control phenomena originating from light-matter interactions. The book overviews current research landscape and highlight major scientific trends in AMO physics interfacing with interdisciplinary sciences. It may be particularly interesting for young researchers working on establishing their scientific interests and goals.

Readers of this volume can take a tour around the research locations in Belgium which are active in theoretical and computational chemistry. Selected researchers from Belgium present research highlights of their work. Originally published in the journal *Theoretical Chemistry Accounts*, these outstanding contributions are now available in a hardcover print format. This volume will be of benefit in particular to those research groups and libraries that have chosen to have only electronic access to the journal. It also provides valuable content for all researchers in theoretical chemistry.

Each scientist works with certain information and collects it in the course of professional activity. In the same manner, the author collected data for atomic physics and atomic processes. This information was checked in the course of the author's professional activity and was published in the form of appendices to the corresponding books on atomic and plasma physics. Now it has been decided to publish these data separately. This book contains atomic data and useful information about atomic particles and atomic systems including molecules, nanoclusters, metals and condensed systems of elements. It also gives information about atomic processes and transport processes in gases and plasmas. In addition, the book deals with general concepts and simple models for these objects and processes. We give units and conversion factors for them as well as conversion factors for spread formulas of general physics and the physics of atoms, clusters and ionized gases since such formulas are used in professional practice by each scientist of this area.

Femtosecond Physics: Laser-Matter Interaction Theory examines various theories related to femtosecond physics including an extensive overview of interaction theory and related

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concepts. It includes definitions of time-dependent Schrödinger equation, field-matter interaction in quantum two-level systems and atoms and molecules. Provides the reader with insights into the development of its knowledge, so as to understand the different theories and applications of femtosecond physics.

The aim of this volume is twofold. First, it is an attempt to simplify and clarify the relativistic theory of the hydrogen-like atoms. For this purpose we have used the mathematical formalism, introduced in the Dirac theory of the electron by David Hestenes, based on the use of the real Clifford algebra $Cl(M)$ associated with the Minkowski space-time M , that is, the Euclidean 4-R space of signature $(1,3)$. This algebra may be considered as the extension to this space of the theory of the Hamilton quaternions (which occupies an important place in the resolution of the Dirac equation for the central potential problem). The clarity comes from the real form given by D. Hestenes to the electron wavefunction that replaces, in a strict equivalence, the Dirac spinor. This form is directly inscribed in the frame of the geometry of the Minkowski space in which the experiments are necessarily placed. The simplicity derives from the unification of the language used to describe the mathematical objects of the theory and the data of the experiments. The mathematics concerning the definition and the use of the algebra $Cl(M)$ are not very complicated. Anyone who knows what a vector space is will be able to understand the geometrical implications of this algebra. The lecture will be perhaps more difficult for the readers already acquainted with the complex formalism of the matrices and spinors, to the extent that the new language will appear different from the one that they have used. But the correspondence between the two formalisms is ensured in the text at each stage of the theory.

This expanded and updated well-established textbook contains an advanced presentation of quantum mechanics adapted to the requirements of modern atomic physics. It includes topics of current interest such as semiclassical theory, chaos, atom optics and Bose-Einstein condensation in atomic gases. In order to facilitate the consolidation of the material covered, various problems are included, together with complete solutions. The emphasis on theory enables the reader to appreciate the fundamental assumptions underlying standard theoretical constructs and to embark on independent research projects. The fourth edition of *Theoretical Atomic Physics* contains an updated treatment of the sections involving scattering theory and near-threshold phenomena manifest in the behaviour of cold atoms (and molecules). Special attention is given to the quantization of weakly bound states just below the continuum threshold and to low-energy scattering and quantum reflection just above. Particular emphasis is laid on the fundamental differences between long-ranged Coulombic potentials and shorter-ranged potentials falling off faster than $1/r^2$ at large distances r . The new sections on tunable near-threshold Feshbach resonances and on scattering in two spatial dimensions also address problems relevant for current and future research in the field of cold (and ultra-cold) atoms. Graduate students and researchers will find this book a valuable resource and comprehensive reference alike.

This volume presents multidisciplinary treatments of important areas and new developments within precision physics. It concentrates on new topics and those not treated in the previous volumes about the precision physics of simple atoms, all published in LNP. For example, it concentrates on the proton structure and its effects on the energy levels, on simple molecules, on atoms somewhat more complicated than hydrogen (such as lithium), on exotic atoms and atoms with exotic nuclei.

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consistently reliable, authoritative, informed, and relevant. The content of Issues in General Physics Research: 2011 Edition has been produced by the world's leading scientists, engineers, analysts, research institutions, and companies. All of the content is from peer-reviewed sources, and all of it is written, assembled, and edited by the editors at ScholarlyEditions™ and available exclusively from us. You now have a source you can cite with authority, confidence, and credibility. More information is available at <http://www.ScholarlyEditions.com/>.

This book constructs all the transport properties of the system within the framework of linear irreversible thermodynamics. This includes a systematic study of all possible cross effects as well as the famous H-theorem.

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