

atomic, optical, and plasma physics

Pierre Meystre

# Atom Optics



Springer



# Atom Optics Springer Series On Atomic Optical And Plasma Physics

**Dirk Naujoks**



## **Atom Optics Springer Series On Atomic Optical And Plasma Physics:**

**Atom Optics** Pierre Meystre, 2001-09-21 Quantum mechanics does away with the distinction between particles and waves and one of the more interesting implications of the wave particle duality the discovery that atoms may be manipulated in ways analogous to the manipulation of light with lenses and mirrors has formed the basis for the relatively new field of atom optics Pierre Meystre's *Atom Optics* is the first book entirely devoted to this exciting area of research Reference links to the leading journals in the field links to research sites graphics and updates can be found online *Plasma Physics and Controlled Nuclear Fusion* Kenro Miyamoto, 2005-06-09 The primary objectives of this book are firstly to present the essential theoretical background needed to understand recent fusion research and secondly to describe the current status of fusion research for graduate students and senior undergraduates It will also serve as a useful reference for scientists and engineers working in the related fields In Part I Plasma Physics the author explains the basics of magneto hydrodynamics and kinetic theory in a simple and compact way and at the same time covers important new topics for fusion studies such as the ballooning representation instabilities driven by energetic particles and various plasma models for computer simulations Part II Controlled Nuclear Fusion attempts to review the big picture in fusion research Mathematical derivations are comprehensively explained to better enable readers to later concentrate on the physics All important phenomena and technologies are addressed with a particular emphasis on the topics of most concern in current research *Atom Tunneling Phenomena in Physics, Chemistry and Biology* Tetsuo Miyazaki, 2013-04-17 Atom tunneling phenomena are a new paradigm in the science of materials This book provides a wealth of interesting information about atom tunneling phenomena in physics chemistry and biology Topics include the theory of atom tunneling reactions conclusive evidence and controlling factors for such reactions in solid hydrogen tunneling dislocation motion coherent tunneling diffusion the production of interstellar molecules and semiconductors using tunneling reactions the effect of atom tunneling on molecular structure and crystalline structure the suppression of mutation and cancer by an atom tunneling reaction of vitamin C and atom tunneling reactions of vitamin E and of enzymes This book provides graduate students and nonspecialist readers with fascinating insights into the world of atom tunneling phenomena *Many-Particle Quantum Dynamics in Atomic and Molecular Fragmentation* Joachim Ullrich, V.P. Shevelko, 2013-06-29 This book aims to give a comprehensive view on the present status of a tremendously fast developing field the quantum dynamics of fragmenting many particle Coulomb systems In striking contrast to the profound theoretical knowledge achieved from extremely precise experimental results on the static atomic and molecular structure it was only three years ago when the three body fundamental dynamical problem of breaking up the hydrogen atom by electron impact was claimed to be solved in a mathematically consistent way Until now more complicated though still fundamental scenarios addressing the complete fragmentation of the simplest many electron system the helium atom under the action of a time dependent external force have withstood any consistent theoretical description Exceptions are the most

trivial situations where the breakup is induced by the impact of a single real photon or of a virtual photon under a perturbation caused by fast low charged particle impact Similarly the dissociation of the simplest molecular systems like H<sub>2</sub> or HD fragmenting in collisions with slow electrons or the H<sub>3</sub> molecule breaking apart into two or three pieces as a result of a single laser photon excitation establish a major challenge for state of the art theoretical approaches

**Relativistic Quantum Theory of Atoms and Molecules** Ian P Grant, 2007-04-15 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

Springer Handbook of Atomic, Molecular, and Optical Physics Gordon W. F. Drake, 2007-02-05 This Springer Handbook 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 Its 90 chapters written by about 120 authors all leaders in their respective disciplines together with a guide to the primary research literature It has been carefully edited to ensure a uniform coverage and style with extensive cross references It is intended to be both a source of information and inspiration for graduate students and other researchers new to the field 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

**Plasma-Material Interaction in Controlled Fusion** Dirk Naujoks, 2006-08-25 This book deals with the specific contact between the fourth state of matter i.e. plasma and the first state of matter i.e. a solid wall in controlled fusion experiments A comprehensive analysis of the main processes of plasma surface interaction is given together with an assessment of the most critical questions within the context of general criteria and operation limits It also contains a survey on other important aspects in nuclear fusion

Laser Physics at Relativistic Intensities A.V. Borovsky, A.L. Galkin, O.B. Shiryayev, T. Auguste, 2013-04-17 One of the major accomplishments of laser technology that took place during the last 15 years is the possibility of generating coherent radiation that can be focused so that its intensity reaches the magnitude of 10<sup>18</sup> W/cm<sup>2</sup> Even higher intensities result from nonlinear self focusing of such radiation in matter The unique character of these magnitudes is illustrated by the fact that these intensities are substantially higher than those occurring inside the Sun A range of previously unexplored physical mechanisms come into play as laser pulses interact with matter under the conditions of an extreme concentration of laser energy In particular free electrons of plasma formed by rapid

nonlinear ionization of gases and solid targets during the pulse rise time are driven by a laser radiation electric field at velocities comparable to the speed of light and the corresponding relativistic increase in their masses entails a modification of the plasma's optical properties. Laser radiation intensities at which the above effect occurs are called relativistic. This book is intended to provide an introduction to the field of laser physics at relativistic intensities. Extensive theoretical and experimental studies have been performed in this area in the last decade. At present laser physics at relativistic intensities can be considered a new and rapidly evolving area of modern physics. Important basic new phenomena and concepts of applications are associated with it among them relativistic and charge displacement self channeling wake field particle acceleration generation of free electron harmonics and X rays and fast ignition.

**Quantum Statistics of Nonideal Plasmas**  
Dietrich Kremp, Manfred Schlanges, Wolf-Dietrich Kraeft, 2005-12-11 During the last decade impressive development and significant advance of the physics of nonideal plasmas in astrophysics and in laboratories can be observed creating new possibilities for experimental research. The enormous progress in laser technology but also ion beam techniques has opened new ways for the production and diagnosis of plasmas under extreme conditions relevant for astrophysics and inertially confined fusion and for the study of laser matter interaction. In shock wave experiments the equation of state and further properties of highly compressed plasmas can be investigated. This experimental progress has stimulated the further development of the statistical theory of nonideal plasmas. Many new results for thermodynamic and transport properties for ionization kinetics dielectric behavior for the stopping power laser matter interaction and relaxation processes have been achieved in the last decade. In addition to the powerful methods of quantum statistics and the theory of liquids numerical simulations like path integral Monte Carlo methods and molecular dynamic simulations have been applied.

**Charged Particle Traps**  
Fouad G. Major, Viorica N. Gheorghe, Günter Werth, 2005 This book provides an introduction and guide to modern advances in charged particle and antiparticle confinement by electromagnetic fields. Confinement in different trap geometries the influence of trap imperfections classical and quantum mechanical description of the trapped particle motion different methods of ion cooling to low temperatures and non neutral plasma properties including Coulomb crystals are the main subjects. They form the basis of such applications of charged particle traps as high resolution optical and microwave spectroscopy mass spectrometry atomic clocks and potentially quantum computing.

**Plasma Kinetics in Atmospheric Gases**  
M. Capitelli, C.M. Ferreira, B.F. Gordiets, A.I. Osipov, 2013-03-09 Investigation of the kinetic processes occurring in the atmospheric gases and low temperature plasmas of such gases is of great interest for numerous areas of modern physics and chemistry. These include discharge and laser physics physics of the ionosphere chemistry and optics of the atmosphere laser and plasma chemistry and nonequilibrium gas dynamics. Further nonequilibrium gaseous media and low temperature plasmas formed from  $N_2/O_2$  or  $N_2/O_2$  mixtures are rich in active components such as  $O$ ,  $N$  and  $H$  atoms and excited metastable species which fostered the utilization of such nonequilibrium systems in a variety of new technologies. At present

several monographs devoted to the analysis of kinetic processes in molecular gases and plasmas are available in the literature. However, most of these works deal only with general physical-chemical kinetic aspects and do not provide an analysis of basic kinetic theory and detailed investigation of kinetic processes in  $N_2$ ,  $O_2$  and their mixtures. A monograph devoted to such a thorough analysis for the atmospheric gases is still lacking in the literature. The present book was written to fill in this gap. The book can be considered as a natural development of two former monographs: *Non-Equilibrium Vibrational Kinetics* ed by M. Capitelli, Springer Verlag, 1986 and *Kinetic Processes in Gases and Lasers* B. Gordiets, A. I. Osipov and L. A. Shelepin, Gordon and Breach, 1988. *Atom, Molecule, and Cluster Beams II* Hans Pauly, 2000-09-27. This book completes the physical foundations and experimental techniques described in volume 1 with an updated review of the accessory equipment indispensable in molecular beam experiments. It extends the subject to cluster beams and beams of hyperthermal and subthermal energies. As in volume 1, a special effort is made to outline the physical foundations of the various experimental techniques. Hence, this book is intended not only as a reference standard for researchers in the field but also to bring the flavor of current molecular beam research to advanced undergraduates and graduate students and to enable them to gain a solid background in the field and its technique. **Atomic and Molecular Spectroscopy** Sune

Svanberg, 2012-12-06. Atomic and Molecular Spectroscopy is a wide-ranging review of modern spectroscopic techniques such as X-ray photoelectron optical and laser spectroscopy as well as radiofrequency and microwave techniques. On the fundamental side, it focuses on physical principles and the impact of spectroscopy on our understanding of the building blocks of matter, while in the area of applications, particular attention is paid to chemical analysis, photochemistry, surface characterisation, environmental and medical diagnostics, remote sensing and astrophysics. The third edition also provides the reader with an update on laser cooling and trapping, Bose-Einstein condensation, ultrafast spectroscopy, high-power laser-matter interaction, satellite-based astronomy and spectroscopic aspects of laser medicine. Laser Spectroscopy Hidetoshi Katori, 2010. The XIX International Conference on Laser Spectroscopy, one of the leading conferences in the very diverse and still growing field of laser spectroscopy, was held in Hokkaido, Japan, on June 7-12, 2009. This volume, comprising a collection of invited contributions presented at the conference, will report on the latest developments in the area of laser spectroscopy and related fields: cold atoms and molecules, degenerate quantum gases, quantum optics, quantum information processing, precision measurements, atomic clock, ultra-fast lasers and strong-field phenomena, and novel spectroscopic applications.

Reference Data on Atomic Physics and Atomic Processes Boris M. Smirnov, 2008-09-03. 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

**Quantum Squeezing** Peter D. Drummond, Zbigniew Ficek, 2013-03-14 The concept of squeezing is intimately related to the idea of vacuum fluctuations once thought to place an absolute limit to the accuracy of measurement However vacuum fluctuations are not unchangeable By recognizing that these quantum fluctuations always occur in two complementary observables physicists have been able to make an intriguing trade off Reduced fluctuations in one variable can be realized at the expense of increased fluctuations in another according to Heisenberg This Heisenberg horse trade originally predicted by theorists was first accomplished experimentally by R Slusher in 1985 Since then the various techniques and applications of quantum squeezing have metamorphosed into a central tool in the wider field of quantum information This book is a summary of the main ideas methods and applications of quantum squeezing written by those responsible for some of the chief developments in the field The book is divided into three parts to recognize that there are three areas in this research These are the fundamental physics of quantum fluctuations the techniques of generating squeezed radiation and the potential applications Part I of the book giving the fundamentals is arranged as follows Chapter 1 introduces the basic ideas about what squeezing of quantum fluctuations is from the quantized free field perspective This chapter establishes the definitions and notations used throughout Chapter 2 explains how to quantize radiation in a dielectric which is the basic technique that is used to make squeezed radiation

*Young-Type Interferences with Electrons* François Frémont, 2013-08-26 Since the discovery that atomic size particles can be described as waves many interference experiments have been realized with electrons to demonstrate their wave behavior In this book after describing the different steps that led to the present knowledge we focus on the strong link existing between photon and electron interferences highlighting the similarities and the differences For example the atomic centers of a hydrogen molecule are used to mimic the slits in the Young's famous interference experiment with light We show however that the basic time dependent ionization theories that describe these Young type electron interferences are not able to reproduce the experiment This crucial point remains a real challenge for theoreticians in atomic collision physics

**Analysis of Excitation and Ionization of Atoms and Molecules by Electron Impact** Afzal Chaudhry, Hans Kleinpoppen, 2010-10-17 The content of this book describes in detail the results of the present measurements of the partial and total doubly differential cross sections for the multiple ionization of rare gas atoms by electron impact These measurements show beside other trends the role of Auger transitions in the production of multiply ionized atoms in the region where the incident electron energy is sufficient to produce inner shell ionization Other processes like Coster Kronig transitions and shake off also contribute towards increasing the charge of the

ions The incident electron having energy of 6 keV for example in a collision with xenon atom can remove up to nine electrons X ray ion coincidence spectroscopy of the electron xenon atom collisions is also described The present measurements of doubly differential cross sections for the dissociative and non dissociative ionization of hydrogen sulfur dioxide and sulfur hexa fluoride molecular gases by electron impact are also described in the text of this book The results of the measurements for sulfur dioxide molecule show how this major atmospheric pollutant can be removed from the atmosphere by electron impact dissociation of this molecule The present results of the measurements for sulfur hexa fluoride give an insight into the dissociation properties of this molecular gas which is being so widely used as a gaseous insulator in the electrical circuits The book also describes the present measurements of the polarization parameters of the fluorescence radiation emitted by the electron impact excited atoms of sodium and potassium In these investigations the target atoms are polarized therefore the measurements of the polarization parameters give information about the electron atom interaction in terms of the interference direct and exchange interaction channels

Scattering of Photons by Many-Electron Systems Alexey N. Hopersky, Victor A. Yavna, 2009-11-03 The quantum physics of photon scattering processes in atoms atomic ions and simple molecules are discussed in this unique approach Focusing on this topic from a theoretical perspective this volume fulfills a need for researchers and students in the field

*Density Matrix Theory and Applications* Karl Blum, 2012-01-13 Written in a clear pedagogic style this book deals with the application of density matrix theory to atomic and molecular physics The aim is to precisely characterize states by a vector and to construct general formulas and proofs of general theorems The basic concepts and quantum mechanical fundamentals reduced density matrices entanglement quantum correlations are discussed in a comprehensive way The discussion leads up to applications like coherence and orientation effects in atoms and molecules decoherence and relaxation processes This third edition has been updated and extended throughout and contains a completely new chapter exploring nonseparability and entanglement in two particle spin 1 2 systems The text discusses recent studies in atomic and molecular reactions A new chapter explores nonseparability and entanglement in two particle spin 1 2 systems

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### **Table of Contents Atom Optics Springer Series On Atomic Optical And Plasma Physics**

1. Understanding the eBook Atom Optics Springer Series On Atomic Optical And Plasma Physics
  - The Rise of Digital Reading Atom Optics Springer Series On Atomic Optical And Plasma Physics
  - Advantages of eBooks Over Traditional Books
2. Identifying Atom Optics Springer Series On Atomic Optical And Plasma Physics
  - Exploring Different Genres
  - Considering Fiction vs. Non-Fiction
  - Determining Your Reading Goals
3. Choosing the Right eBook Platform
  - Popular eBook Platforms
  - Features to Look for in an Atom Optics Springer Series On Atomic Optical And Plasma Physics
  - User-Friendly Interface
4. Exploring eBook Recommendations from Atom Optics Springer Series On Atomic Optical And Plasma Physics
  - Personalized Recommendations

- Atom Optics Springer Series On Atomic Optical And Plasma Physics User Reviews and Ratings
- Atom Optics Springer Series On Atomic Optical And Plasma Physics and Bestseller Lists
- 5. Accessing Atom Optics Springer Series On Atomic Optical And Plasma Physics Free and Paid eBooks
  - Atom Optics Springer Series On Atomic Optical And Plasma Physics Public Domain eBooks
  - Atom Optics Springer Series On Atomic Optical And Plasma Physics eBook Subscription Services
  - Atom Optics Springer Series On Atomic Optical And Plasma Physics Budget-Friendly Options
- 6. Navigating Atom Optics Springer Series On Atomic Optical And Plasma Physics eBook Formats
  - ePub, PDF, MOBI, and More
  - Atom Optics Springer Series On Atomic Optical And Plasma Physics Compatibility with Devices
  - Atom Optics Springer Series On Atomic Optical And Plasma Physics Enhanced eBook Features
- 7. Enhancing Your Reading Experience
  - Adjustable Fonts and Text Sizes of Atom Optics Springer Series On Atomic Optical And Plasma Physics
  - Highlighting and Note-Taking Atom Optics Springer Series On Atomic Optical And Plasma Physics
  - Interactive Elements Atom Optics Springer Series On Atomic Optical And Plasma Physics
- 8. Staying Engaged with Atom Optics Springer Series On Atomic Optical And Plasma Physics
  - Joining Online Reading Communities
  - Participating in Virtual Book Clubs
  - Following Authors and Publishers Atom Optics Springer Series On Atomic Optical And Plasma Physics
- 9. Balancing eBooks and Physical Books Atom Optics Springer Series On Atomic Optical And Plasma Physics
  - Benefits of a Digital Library
  - Creating a Diverse Reading Collection Atom Optics Springer Series On Atomic Optical And Plasma Physics
- 10. Overcoming Reading Challenges
  - Dealing with Digital Eye Strain
  - Minimizing Distractions
  - Managing Screen Time
- 11. Cultivating a Reading Routine Atom Optics Springer Series On Atomic Optical And Plasma Physics
  - Setting Reading Goals Atom Optics Springer Series On Atomic Optical And Plasma Physics
  - Carving Out Dedicated Reading Time
- 12. Sourcing Reliable Information of Atom Optics Springer Series On Atomic Optical And Plasma Physics
  - Fact-Checking eBook Content of Atom Optics Springer Series On Atomic Optical And Plasma Physics

- Distinguishing Credible Sources
- 13. Promoting Lifelong Learning
  - Utilizing eBooks for Skill Development
  - Exploring Educational eBooks
- 14. Embracing eBook Trends
  - Integration of Multimedia Elements
  - Interactive and Gamified eBooks

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