

Atomic Physics and Lasers

- The idea of a photon
 - Black body radiation
 - Photoelectric Effect
- The structure of the atom
- How does a Laser work? Interaction of lasers with matter
 - Laser safety
- Applications
 - Spectroscopy, detection of art forgery, flow cytometry, eye surgery.

Atomic Physics Of Lasers

**Dimitri Batani, Charles J. Joachain, S.
Martellucci, Arthur N. Chester**



Atomic Physics Of Lasers:

Laser Physics at the Limits Hartmut Figger, 2001-11-02 Published on the occasion of Theodor H nsch s 60th Birthday emphasis is placed on precision related to results in a variety of fields such as atomic clocks frequency standards and the measurement of physical constants in atomic physics Furthermore illustrations and engineering applications of the fundamentals of quantum mechanics are widely covered It has contributions by Nobel prize winners Norman F Ramsey Steven Chu and Carl E Wieman Atomic Physics of Lasers Derek A. Eastham, 1986 *Atomic, Molecular and Laser Physics*, **The Physics of Laser-Atom Interactions** Dieter Suter, 1997-10-13 A thorough introduction to the interaction of atoms with optical and magnetic fields for graduate students and researchers *Laser Cooling and Trapping* Harold J. Metcalf, Peter Van der Straten, 1999 Intended for advanced undergraduates and beginning graduate students who have some basic knowledge of optics and quantum mechanics this text begins with a review of the relevant results of quantum mechanics before turning to the electromagnetic interactions involved in slowing and trapping atoms and ions in both magnetic and optical traps The concluding chapters discuss a broad range of applications from atomic clocks and studies of collision processes to diffraction and interference of atomic beams at optical lattices and Bose Einstein condensation

Laser Light Pressure on Atoms V.G. Minogin, V.S. Letokhov, 1987-01-01 Comprehensive single source for the theory on and status of current research into laser light pressure on atoms and atomic particles Part I presents the fundamentals of the theory of resonance light pressure analyzes the basic relations of the radiatio9n force acting on atomic particles discusses the properties of light pressure for fields of spatial and time structure Part II describes investigations into the control of atoms and atomic ions by laser pressure the cooling of atomic beams and localized atomic ions It also describes applications of cooled atoms and ions in atomic physics and spectroscopy **Super-Intense Laser—Atom Physics** A. L'Huillier, Bernard Piraux, Kazimierz Rzazewski, 2012-12-06 The rapid development of powerful pulsed lasers is at the origin of a considerable interest in studying the response of an atom a molecule or a solid to a strong electromagnetic field It is now possible to produce at the laboratory scale ultra short 13 pulses with a duration of 100 femtoseconds 10 second and a power of the order 12 of 1 terawatt 10 Watt Under these conditions very high peak intensities may be obtained and electric fields exceeding typical electron binding fields in atoms are generated The interaction of an atom or a molecule with such electromagnetic fields has a highly non linear character which leads to unexpected phenomena Amongst them above threshold ionization ATI i e the absorption of additional photons in excess of the minimal number necessary to overcome the ionization potential and its molecular counterpart above threshold dissociation ATD generation of very high harmonics of the driving field stabilization of one electron systems in strong fields These processes were the main topics of two international meetings which were held in 1989 and 1991 in the United States under the common name SILAP Super Intense Laser Atom Physics **Super-Intense Laser-Atom Physics IV** H.G. Muller, M.V. Fedorov, 1996-05-31 Atoms in strong radiation fields are interesting objects for

study and the research field that concerns itself with this study is a comparatively young one. For a long period after the discovery of the photoelectric effect it was not possible to generate electro magnetic fields that did more than perturb the atom only slightly and first order perturbation theory could perfectly explain what was going on at those low intensities. The development of the pulsed laser has changed this state of affairs in a rather dramatic way and fields can be applied that really have a large or even dominant influence on atomic structure. In the latter case we speak of super intense fields. Since the interaction between atoms and electromagnetic waves is characterized by many parameters other than the light intensity such as frequency, ionization potential, orbit time etc it is actually quite difficult to define what is exactly meant by the term super intense. Obviously the term does not have an absolute meaning and intensity should always be viewed in relation to other properties of the system. An atom in a radiation field can thus best be described in terms of various ratios of the quantities involved. The nature of the system sometimes drastically changes if the value of one of these parameters exceeds a certain critical value and the new regime could be called super intense with respect to that parameter.

Atoms, Solids, and Plasmas in Super-Intense Laser Fields Dimitri Batani, Charles J. Joachain, S. Martellucci, Arthur N. Chester, 2012-05-31

The recent development of high power lasers delivering femtosecond pulses of 10^{22} intensities up to 10^{14} W/cm² 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.

Introduction to the Theory of Laser-Atom Interactions Marvin H. Mittleman, 2013-11-21

In response to the explosion of theories and experiments since the appearance of the first edition the author has revised and expanded his basic text. New sections include up to date discussions of multiphoton ionization and electron atom and atom atom scattering in laser fields reaffirming the work's position as the standard introduction to the field.

Super-Intense Laser-Atom Physics Bernard Piraux, Kazimierz Rzazewski, 2001-03-31

The study of atomic systems exposed to super intense laser fields defines 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 reaches peak values which are of the order of 10^{10} 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 totally 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 *Lasers in Atomic, Molecular, and Nuclear Physics* V. S. Letokhov,1986 **Lasers and Nuclei** Heinrich Schwoerer,Joseph Magill,Burgard Beleites,2006-08-29 *Lasers and Nuclei* describes the generation of high energy particle radiation with high intensity lasers and its application to nuclear science A basic introduction to laser matter interaction at high fields is complemented by detailed presentations of state of the art laser particle acceleration and elementary laser nuclear experiments The text also discusses future applications of lasers in nuclear science for example in nuclear astrophysics isotope generation nuclear fuel physics and proton and neutron imaging **Atoms and Molecules Interacting with Light** Peter van der Straten,Harold Metcalf,2016-02-04 *Focusing on atom light interactions and containing numerous exercises* this in depth textbook prepares students for research in a fast growing field **Atomic and Laser Spectroscopy** Alan Corney,2006-10-05 This book discusses many advances in optical physics and is intended mainly for experimentalists The interaction of electromagnetic radiation with free atoms is introduced using classical or semi classical calculations wherever possible Topics discussed include the spontaneous emission of radiation and atomic beam magnetic resonance experiments [The Physics of Laser Plasmas and Applications - Volume 2](#) Hideaki Takabe,2024-03-28 This open access book Volume 2 is part of the series *The Physics of Laser Plasmas and Applications* It serves as an introduction to the physics of compressible hydrodynamics which is used to describe the temporal evolution of plasmas generated by intense laser irradiation of solid surfaces For the benefit of students and young researchers the book presents the fundamental equations and provides a comprehensible explanation of solutions to intricate fluid phenomena It builds upon the concept of plasma generation through the heating of matter via the classical absorption of a laser as expounded in Volume 1 The high temperature plasma resulting from the laser interaction manifests in diverse hydrodynamic occurrences like shock waves and expansion waves The initial sections of this book expound the essentials of compressible hydrodynamics magnetohydrodynamics MHD and the physics of shock waves The transfer of laser energy within an expanding plasma towards regions of higher density is achieved through electron and X ray transport mechanisms In both instances conventional diffusion models prove inadequate

necessitating mathematical frameworks founded on the Boltzmann equation The conveyed energy engenders ablation pressure equivalent to tens of millions of atmospheres on the solid surface This pressure initiates powerful shock waves propagating through the solid material The propagation of these shock waves is delineated for scenarios involving planar and spherical geometries The text also introduces various solutions pertaining to convergent and divergent shocks in spherical geometries using self similar models The discourse then shifts towards ionization and related atomic processes which govern the dynamics of plasmas created by laser irradiation of mid Z and high Z solids The quantum mechanics of partially ionized atoms and their associated atomic processes are elucidated Concluding the book is an exploration of the physics of warm dense matter WDM an electron system characterized by quantum mechanical many body interactions The study of high density plasmas featuring temperatures around 1 eV is undertaken through the lens of density functional theory DFT The theoretical breakdown of experimental data acquired via the X ray free electron laser X FEL is also provided In essence this second volume of the series amalgamates a comprehensive understanding of compressible hydrodynamics shock wave physics ionization processes energy transfer and the realm of warm dense matter It equips readers to delve into the intricacies of plasma physics and laser interactions while utilizing modern theoretical frameworks and experimental methodologies This is an open access book

Lasers in Atomic, Molecular, and Nuclear Physics V. S. Letokhov,1989

Atoms, Molecules and Lasers K. P. Rajappan Nair,2006 This work presents advances in experimental and theoretical nuclear phenomena by leading physicists Topics include a study of hexadecapole deformation in rare earth nuclei and influence of Entrance Channel and Nuclear Structure on fusion fission reactions

Laser Physics Simon Hooker,Colin Webb,2010-08-05 An up to date perspective on laser technology for students at advanced undergraduate or introductory graduate level The principles of operation and applications of modern laser systems are analysed in detail The text has over 300 diagrams and each chapter is accompanied with questions solutions available on application

Atoms in Intense Laser Fields C. J. Joachain,N. J. Kylstra,R. M. Potvliege,2011-12-15 The development of lasers capable of producing high intensity pulses has opened a new area in the study of light matter interactions The corresponding laser fields are strong enough to compete with the Coulomb forces in controlling the dynamics of atomic systems and give rise to multiphoton processes This book presents a unified account of this rapidly developing field of physics The first part describes the fundamental phenomena occurring in intense laser atom interactions and gives the basic theoretical framework to analyze them The second part contains a detailed discussion of Floquet theory the numerical integration of the wave equations and approximation methods for the low and high frequency regimes In the third part the main multiphoton processes are discussed multiphoton ionization high harmonic and attosecond pulse generation and laser assisted electron atom collisions Aimed at graduate students in atomic molecular and optical physics the book will also interest researchers working on laser interactions with matter

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