Atoms in strong laser fields and multiphoton ionization

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The book is a member of the well-known series *Lecture Notes in Physics* published by Springer-Verlag. Many of the books in this series are compiled on the basis of materials of European and international conferences on timely problems of modern physics.

The book under review includes a reprint of papers presented at the seminar "Fundamentals of Laser Interactions" which was held in Austria 26 February–4 March 1989. The greater part of the book is occupied by the texts of lectures given by invited leading scientists.

The subject of the lectures is devoted to the rapidly developing field of physics on the interaction of strong laser fields with atoms, ions and molecules and includes the following questions: processes of multiphoton ionization, atoms in intense laser fields, electron correlations in radiative processes, Rydberg atoms in external fields and other laser interactions.

The successful qualitative and quantitative theoretical description of experimental data on multiphoton ionization of alkali atoms towards the middle of the 1970's created an impression that even if there remain some unsolved problems, they are associated not with the qualitative understanding of the processes occurring as a result of the interaction of radiation with atoms, but with the quantitative description of the experimental data being obtained. However already at the end of the 1970's experimentally a number of new phenomena was discovered which did not fit within the framework of the existing concepts. Among these phenomena one should point to the effects of formation of multiply charged ions in the case of multiphoton ionization, observation of multi-peak structure in energy spectra of the ejected electrons (here in strong fields the amplitudes of successive maxima begin to exceed the amplitudes of the preceeding maxima), the generation of high harmonics of laser radiation in the case of interaction with gas media, etc. The more essential features characterizing the experimental situation have in recent years been associated with using radiation of high power density and an expansion of the spectral and temporal range of pulses. Along with the laser pulses of visible and near infrared range recently laser fields of ultraviolet, infrared and microwave ranges have been used.

The lectures enable one to obtain a complete idea of the theoretical and experimental situation in this field of investigation. In its structure the course of lectures consists of five parts. In the first part a detailed presentation is given of the theoretical models describing multiphoton ionization in the field of powerful light pulses, comparisons are made with experimental data and an explanation is given of a number of effects: multi-peak structure of the energy spectrum, angular characteristics of electrons as a function of the density of the laser field and the wavelength of the radiation. The second part contains extensive experimental and theoretical material on the generation of harmonics of radiation in different gases, and on the energy spectra in the case of one-electron and two-electron multiphoton ionization. The influence of ponderomotive forces on the angular characteristics of the ejected electron is analyzed. The third part is devoted to an investigation of the correlation characteristics of the processes of multiphoton ionization and generation of harmonics. Models are presented which take into account the different channels of multiphoton ionization, and the resonance multiphoton excitation of autoionization states. The fourth part examines questions of the behavior of Rydberg atoms (atoms excited to high energy levels) in laser fields. Here results are presented of investigations of ionization of atoms by radiation of several pulses, of the role of coherent effects in the case of photoionization of atoms, of the behavior of Rydberg atoms in microwave fields, and of the localization properties of excited atoms in a noisy microwave field. The fifth part studies the interaction of hydrogen atoms with a high frequency superpowerful laser field and analytic and experimental results on photoionization and dissociation of triatomic hydrogen molecules are presented. At the end of the book abstracts of papers are published which enable one to obtain an idea of research carried out in different scientific centers.

The book is very useful because of the breadth of the information collected, of the variety of experimental data and of the critical discussion of different analytical models. On the whole, the articles included in the collection are devoted to one of the most interesting fields of physics, and acquaintance with them will be useful to a wide circle of specialists of this profile.