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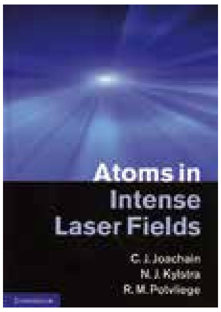

C. J. Joachain, N. J. Kylstra, R. M. Potvliege
Atoms in Intense Laser Fields
Cambridge University Press, Cambridge, 2012
pp. XII + 568; € 80.00, US$ 135.00
ISBN 978-0-521-79301-8

«Both a primer and an advanced text for studying the physics of the interaction of intense laser fields with atomic systems»

Charles Joachain, Emeritus Professor of Theoretical Physics at the University of Brussels, is well known for having written several books, which are real milestones of physical literature for their completeness and clarity. These include his books on "Theory of Electron-Atom Collisions" and "Photon and Electron Collisions With Atoms and Molecules" (both written with Philip G. Burke, respectively, in 1995 and in 1997), and the books on "Quantum Mechanics" and "Physics of Atoms and Molecules" both written with B.H. Bransden (2nd edition in 2000 and 2003, respectively).
In this recent book (published in December 2011), he and his coauthors (N. J. Kylstra research fellow at the University of Brussels, and R. M. Potvliege, Reader in Physics at the University of Durham) describe the physics of the interaction of atomic systems with intense laser fields. Strong-field laser physics is a quickly growing field, not least because it provides the foundation of the emerging attosecond physics. This is indeed the first book that provides a comprehensive account of the theoretical methods of the field.
The book and the topic are motivated by the development, in the last twenty years, of laser systems capable of producing very high-intensity pulses. Such technological development, based on the so-called '"chirped pulse amplification" method, has opened a new area in the study of light-matter interactions. The electric fields associated to the electromagnetic (laser) fields are so strong that they often can largely overcome the Coulomb forces inside the atom. While in the university courses on basic quantum mechanics we have all studied the theory of laser interaction with matter with a perturbative approach (the electromagnetic fields being the perturbation to the intra-atomic forces), here the situation is often reversed: it is the atomic field which is smaller, and almost a "perturbation" to the field associated to the laser wave. This brings to a wealthy of new physical phenomena, starting from multiphoton processes to high harmonic generation and attosecond pulse generation. In particular, these last constitute new exciting research fields which currently see a real "explosion" in terms of new discoveries, published papers, and number of laboratories and research group moving to these topics. High harmonic generation allows getting short coherent pulses well within the XUV spectral range, thereby allowing pump and probe experiments involving inner energy levels of atoms and molecules with very high temporal resolution. Attosecond pulses promise to provide new insight in the physics of atomic and molecular systems, allowing to better understand the basic physics of these systems, as well as promising novel applications, for instance in the so-called domain of femtochemistry.
In this respect, the book by Joachain, Kylstra and Potvliege is extremely timely since it offers a unified account of this rapidly developing field of physics.
The book is divided into three parts. The first one describes the fundamental phenomena occurring in intense laser-atom interactions and gives the basic theoretical framework, which is needed in order to describe them. It prepares the reader to the following, more specialized, parts while providing a simplified but complete analysis of the relevant phenomena.
The second part is more advanced and contains a detailed discussion of Floquet theory, describes how to numerically integrate the wave equations (and the results which are obtained), and also describes the approximation methods for the low- and high-frequency regimes. This part also describes the so-called "strong field approximation" (SFA), *i.e.* the case in which the photon energy is smaller than the ionization potential and the laser is very intense. In this case, ionization proceeds as if the electric field of the laser were quasi-static and the electron, after ionization, is assumed to interact only with the electric field and not with the parent atom. On the contrary if the photons have a frequency much larger than the ionization potential, the theory predicts a "stabilization" effect, *i.e.* the ionization rate decreases as the laser intensity increases.
The third and final part describes in more detail physical processes as multiphoton ionization, high-harmonic generation, attosecond pulse production. Of course, laser-assisted electron-atom collisions are also described in details, this being a "first love" of Joachain and co-authors.
The book is aimed at graduate students in atomic, molecular and optical physics, but will also be of interest to young (and less young…) researchers working on laser interactions with matter. The descriptions given by Joachain and co-authors are always extremely clear and complete and therefore this book will certainly remain a masterpiece in the field for several years. The emphasis of the book is theoretical, but indeed the book present also many experimental results and the references to the respective experiments are really numerous.
Finally it is also worth noticing how indeed the book is not only interesting for laser scientists and scientists interested in laser applications. The description of the high-intensity high-frequency regime makes indeed it very useful also for describing the interaction of atomic systems with beams produced by XFELS, a new emerging tool in physics, which, again, promises novel and very exciting results.

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