

Book Review

Excitation of atoms and broadening of spectral lines

By I. I. SOBELMAN, L. A. VAINSHTEIN, E. A. YUKOV

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[pp. i-x + 315, 40 tables, with 34 figures]

Achievements and results of atomic spectroscopy have found many new applications in laser physics, statistical thermodynamics, measurements of wavelength, plasma physics (mainly in diagnostics of plasma) and other related areas. A wide application of theory of both atomic spectra and processes leading to excitation of those spectra, has induced many monographs and papers dealing with atomic collisions. *Excitation of atoms and broadening of spectral lines* is considered by authors as a complimentary book to I. SOBELMAN'S *Atomic spectra and radiative transitions* (Vol. 1 in the present book-series). In the reviewer's opinion the monograph discussed here is also an advanced study on the selected problems connected with elementary processes responsible for the excitation of atoms and ions and for the spectral line broadening.

Four main topics can be marked out in this monograph:

- theory of collisions (chapters 2 and 4),
- calculations of cross sections (chapters 3 and 6),
- some problems of excitation kinetics (chapter 5),
- broadening of spectral lines (chapter 7).

Short chapter 1 entitled *Elementary processes giving rise to spectra* seems to be devoted to some fundamental definitions, laws and formulas, concerning mainly plasma rather than to provide an introduction to the processes leading to spectra.

Collisions of heavy particles (e.g., atoms, ions) with electrons and collisions between heavy particles are discussed in chapters 2 (*Theory of atomic collisions*) and 4 (*Collisions between heavy particles*), respectively. The chapter 2 presents fundamentals of scattering theory (elastic and inelastic scattering), and scattering electrons on atoms and ions, considering complex system of an n -electron atom and an incident electron. Formulas for cross-sections are listed. Questions of the collision theory are limited to those which are necessary for studying and solving problems of cross-sections. Collisions between heavy particles are considered using the impact-parameter approximation. Cross-sections of charge exchange are also analyzed.

Formulas and analysis of approximate methods of the calculation of the excitation and ionization cross-sections are of main interest of this book. In chapter 3 (*Approximate methods for calculating cross-sections*) the methods for calculating the cross sections of excitation and ionization by an electron impact are considered. The following methods are discussed: Born approximation and its modifications (based on first-order approximation), the second Born approximation, the method of polarization potential and the close-coupling method. Attention is also paid to highly charged atoms and highly excited levels. Chapter 6 (*Tables and formulas for the estimation of effective cross-sections*) contains numerous examples and tabulated results of numerical calculations. The cross-sections and rate coefficients are presented as products of angular and radial factors. Expressions for the angular factors which are necessary for employing the tables are reported.

Chapter 5 deals with chosen problems of plasma. The main discussion is devoted to rate coefficients, dielectronic recombination and population of excited levels.

Various phenomena of spectral line broadening are analyzed in chapter 7. Different approaches are presented. General theory of impact broadening is based upon the density-matrix and quantum kinetic equation methods. The presentation is connected with a broad application of line shapes to plasma diagnostics and laser spectroscopy.

As written in preface it is intended by the authors to concentrate on the cross-sections but the selection and arrangements of some problems may cause some questions.

The book should be of interest and very useful for physicists and spectroscopists especially for scientists studying elementary processes in plasma and investigating electronic structure and spectra of atoms. References to basic monographs and recent papers will facilitate both the comprehension and extension of the considered problems. Nevertheless the book may be recommended rather to advanced readers who are familiar with quantum mechanics and atomic spectroscopy.

Wiesław Żyrnicki

Institute of Inorganic Chemistry
and Metallurgy of Rare Elements
Technical University of Wrocław
Wrocław, Poland