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Igor I. Sobel'man Leonid A. Vainshtein
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Excitation of Atoms and Broadening of Spectral Lines

Second Edition
With 21 Figures



Springer

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Preface to the Second Edition

In this new edition—as in the first one of 1981—the main goal is to present the theory of elementary processes responsible for the excitation and formation of atomic spectra. No attempt has been made to give a systematic and detailed treatment of the general theory of atomic collisions. Instead, stress is placed on efficient and comparatively simple approximate methods for the calculation of cross sections and rate coefficients. New results of importance and new understanding of many problems have appeared in recent years and require a significant revision of the original book.

The formulas for cross sections given in Chaps. 2 and 3 are derived and represented using the unified approach which is symmetrical with respect to orbital and spin quantum numbers. This allows us to give the final results in a more general form which is simpler and more convenient for computer programming.

Chapter 4 in which the collisions between heavy particles are considered, is slightly simplified and corrected. The references to recent sources and reviews on the subject are given.

The approximation of cross sections and rate coefficients by analytic formulas (Sect. 5.1) is considerably changed in this edition. All the numerical data given in Chap. 6, except Tables 6.2 and 6.3, are new. They have been calculated using the updated version of the computer code ATOM, which has substantially been extended and corrected during recent years.

Chapter 7 devoted to the broadening of spectral lines is slightly revised. In addition, references are added which communicate the progress in the field.

The authors are very grateful to Dr. Helmut Lotsch of Springer Verlag for encouragement and advices.

Moscow, April 1995

I. Sobelman
L. Vainshtein
E. Yukov

Preface to the First Edition

New applications of atomic spectroscopy in laser physics, laser spectroscopy, laser frequency and wavelength measurements, plasma physics, astrophysics, and some other related problems have been developed very intensively in the last years. As a result, the approximate methods of calculation of the transition probabilities and cross sections necessary for all these applications have become of vastly increased importance. At the same time, some new problems have arisen in the theory of spectral line broadening such as the shape of nonlinear resonances in the spectra of gas lasers, interference effects, and some other problems connected with various spectroscopic methods of plasma diagnostics.

This book is devoted to the systematic treatment of the theory of the elementary processes responsible for the excitation of atomic spectra and the theory of spectral line broadening. The choice of problems is significantly different from that traditional for books on the theory of atomic collisions. The main goal of the book is to present the most efficient and useful of comparatively simple approximate methods for the calculation and estimation of cross sections. Numerous tables containing the results of approximate cross section calculations for the most important elementary processes are included in the book. Comprehensive presentation of the theory of atomic collisions is out of the scope of this book and can be found elsewhere. However, the fundamentals of the general theory of collisions which are necessary for formulation of approximate methods are given in Chapter 2.

In dealing with the theory of spectral line broadening special attention is paid to the general approach to the problem based on the method of density matrix and quantum kinetic equation. This approach is of interest for some modern applications of broadening theory e.g. such as high-resolution laser spectroscopy.

We consider this book as complementary to I. Sobelman's *Atomic Spectra and Radiative Transitions* (first volume of present book-series). We wish to express our sincere gratitude to I.L. Beigman, who helped us to prepare Sects. 3.5, 5.4, to L.P. Presnyakov, who assisted us in Sects. 3.4, 4.1–3. We are grateful also to Prof H.-W. Drawin, Prof. H.R. Griem, Dr. V.S. Lisitsa and Prof. J.-P. Toennies, who have read the manuscript, for many valuable comments.

In conclusion we are particularly grateful to H.W. Drawin, H. Griem and J.P. Toennies for the final reading of the manuscript and their helpful suggestions.

Moscow, April 1980

*I. Sobelman
L. Vainshtein
E. Yukov*

Contents

1 Elementary Processes Giving Rise to Spectra	1
1.1 Cross Sections and Rate Coefficients	1
1.2 Populations of Atomic Levels in a Plasma; Rates of Direct and Reverse Processes	3
1.2.1 Thermodynamic Equilibrium	3
1.2.2 Rates of Direct and Reverse Processes	5
1.2.3 The Simplest Model	6
1.2.4 Coronal Limit	7
2 Theory of Atomic Collisions	9
2.1 Fundamentals of Scattering Theory	9
2.1.1 Elastic Scattering in a Central Field	9
2.1.2 Wave Functions ψ_k^+ , ψ_k^-	11
2.1.3 Quasi-Classical Approximation	13
2.1.4 Inelastic Scattering	15
2.2 Theory of Electron-Atom Collisions	17
2.2.1 General Formulas for Cross Sections	17
2.2.2 S-matrix and Collision Strength	22
2.2.3 Radial Equations	23
2.2.4 Integral Radial Equations	26
2.2.5 Polarization Potential	27
2.3 First-Order Approximation	29
2.3.1 General Formulas	29
2.3.2 List of Formulas for σ and Q -Factors	31
3 Approximate Methods for Calculating Cross Sections	36
3.1 Born Approximation	36
3.1.1 Collisions of Fast Electrons with Atoms; Multipole Expansion	36
3.1.2 Bethe Formula	40
3.1.3 Brief Description of Born Cross Sections	41
3.1.4 Ionization and Three-Body Recombination	45
3.2 Some Refinements of the Born Approximation	47
3.2.1 Distortion of Incident and Scattered Waves; Excitation of Ions	48
3.2.2 Allowance for Exchange	50
3.2.3 Normalization	54
3.2.4 Concluding Remarks: Generalized Born Approximation	57

3.3	More Accurate Methods of Calculation of Excitation Cross Sections	58
3.3.1	Transitions Via Virtual States	59
3.3.2	Use of the K matrix	62
3.3.3	Polarization Potential	63
3.3.4	Close-Coupling Method	64
3.4	Excitation of Highly Charged Atoms	66
3.4.1	Coulomb Green's Function	68
3.4.2	Potential and Resonance Scattering	69
3.4.3	Discussion and Examples	72
3.5	Transitions Between Highly Excited Levels	74
3.5.1	Born Approximation	74
3.5.2	Transitions Between Highly Excited Levels in the Quasi-Classical Approximation	80
3.5.3	Transitions Between Adjacent Levels $\Delta n = 1$	83
4	Collisions Between Heavy Particles	88
4.1	Impact-Parameter Method	88
4.1.1	General Formulas	88
4.1.2	Two-State Approximation	90
4.2	Transitions Caused by a Multipole Interaction	93
4.2.1	Two-State Approximation	93
4.2.2	Two-Levels and Rotating-Axis Approximations	98
4.2.3	Treatment of the Coulomb Repulsion of Nuclei	100
4.3	Charge Exchange	101
4.3.1	Special Features of Charge Exchange Processes	101
4.3.2	Resonance Charge Exchange	102
4.3.3	Contribution of Inner Shells	103
4.3.4	Charge Exchange in the Case of Multicharged Ions	106
5	Some Problems of Excitation Kinetics	108
5.1	Rate Coefficients for Elementary Processes in a Plasma. Approximation of Cross Sections and Rate Coefficients by Analytic Formulas	108
5.1.1	Excitation of Atoms and Ions	108
5.1.2	Ionization	112
5.1.3	Recombination	113
5.1.4	Semiempirical Formulas for the Rates of Excitation, Ionization and Dielectronic Recombination	116
5.2	Dielectronic Recombination	120
5.2.1	Electron Capture and Underthreshold Resonances (Simplified Model)	120
5.2.2	General Case	124
5.2.3	Formulas for Autoionization Probability	126

5.2.4 Some Inaccuracies of the Simplified Model. 127

5.2.5 Numerical Calculations and Analytical
Approximation Formulas. 130

5.3 Satellites of Resonance Lines in Spectra of Highly
Charged Atoms 130

5.3.1 Excitation by Means of DR 130

5.3.2 Direct Inner-Shell Excitation 134

5.4 Populations of Excited Levels in a Plasma 136

5.4.1 Populations of the Hydrogen Levels at Low Plasma Density. . 137

5.4.2 Intermediate Density. Collisional-Radiative Model of a Plasma 140

5.4.3 Quasi-Stationary Approach for Hydrogen 141

5.4.4 Hydrogenlike Ions 148

5.4.5 Population Densities of Highly Excited Levels at High
Density; Steady-Flow Regime 150

6 Tables and Formulas for the Estimation of Effective Cross

Sections. 154

6.1 Tables of Numerical Results 154

6.1.1 Methods of Calculations and Survey of the Tables 154

6.1.2 Excitation Cross Sections for Neutral Hydrogen.
Transitions $n_0 - n_1$ 157

6.1.3 Born Cross Sections Calculated in the Bates–Damgaard
Approximation for Atomic Wave Functions 158

6.1.4 Normalized Cross Sections for Specific Atoms and Ions. 203

6.1.5 Transitions Between Closely Spaced Levels 218

6.1.6 Ionization Cross Sections 218

6.1.7 Dielectronic Recombination Rate Coefficients 223

6.2 Formulas Defining the Angular Factors. 225

6.2.1 Rules for the Addition of Cross Sections 225

6.2.2 *LS* Coupling; Q_k for Transitions between Levels *LSJ* 225

6.2.3 *LS* Coupling; Q_k for Transitions between Terms *LS* 227

6.2.4 *jl* Coupling 229

6.3 *3nj* Symbols and Fractional Parentage Coefficients 231

7 Broadening of Spectral Lines 237

7.1 Model of a Classical Oscillator 237

7.1.1 Formulation of the Problem 237

7.1.2 Impact Broadening. 239

7.1.3 Quasi-Static Broadening 241

7.1.4 Relationship and Limits of Applicability of the Impact and
Quasi-Static Approximations 242

7.1.5 Doppler Effect. 245

7.1.6 Convolution of the Doppler and Lorentzian Distributions 250

X Contents

7.2	General Theory of Impact Broadening	251
7.2.1	Density Matrix Method in the Quasi-Classical Approximation	251
7.2.2	Degeneracy of Levels.	256
7.2.3	Quantum Theory	259
7.2.4	Quantum Kinetic Equation Method	263
7.2.5	Absorption Spectrum	268
7.2.6	Interference Effects: Narrowing of Spectral Lines.	269
7.3	Broadening of Lines of the Hydrogen Spectrum in a Plasma.	273
7.3.1	Preliminary Estimates.	273
7.3.2	Ion Broadening: Holtzmark Theory	274
7.3.3	Correction for Thermal Motion	279
7.3.4	Electron Broadening.	279
7.3.5	Combined Effect of Electrons and Ions.	283
7.3.6	New Approaches to the Theory of Stark Broadening	284
7.3.7	Highly Excited States.	284
7.4	Line Broadening of Nonhydrogenlike Spectra in a Plasma	286
7.4.1	Preliminary Estimates.	286
7.4.2	Electron Broadening.	286
7.5	Broadening by Uncharged Particles	289
7.5.1	Perturbation by Foreign Gas Atoms (Van der Waals Interaction)	289
7.5.2	Self-Broadening.	291
7.6	Spectroscopic Methods of Investigating Elastic Scattering of Slow Electrons	293
7.6.1	Perturbation of Highly Excited States.	293
7.6.2	Fermi Formula	296
	References	297
	List of Symbols	306
	Subject Index	308