

V.P. Shevelko

# Atoms and Their Spectroscopic Properties

With 69 Figures and 74 Tables



Springer

# Contents

<b>Introduction</b> .....	1
<b>1 Atomic Structure and Spectra</b> .....	3
1.1 Classification of Spectral Lines .....	3
1.1.1 Notations .....	3
1.1.2 Spectral Series of Hydrogen Atom .....	4
1.1.3 Spectra of Alkali Elements .....	6
1.2 Coupling Schemes .....	7
1.3 Ionization Potentials and Binding Energies .....	9
1.4 Electron Affinity .....	14
1.5 Fine and Hyperfine Structure .....	14
1.6 Isotope Shift .....	18
1.7 Lamb Shift .....	27
1.8 Radial Analytical Wave Functions .....	33
1.8.1 Hydrogen-like Wave Functions .....	33
1.8.2 The Slater Wave Functions and Potential .....	37
1.8.3 Bates-Damgaard Approximation .....	39
<b>2 Oscillator Strengths and Transition Probabilities</b> .....	40
2.1 Basic Relations .....	40
2.2 Selection Rules .....	41
2.3 Oscillator Strengths and Transition Probabilities .....	44
2.3.1 Three Representations of the Oscillator Strength. Sum Rules .....	44
2.3.2 Recommended Data for Wavelengths, Energy Levels and Transition Probabilities .....	45
2.3.3 Tables for $f$ and $W$ in H, He and Light Atoms .....	48
2.3.4 Oscillator Strengths in Alkali Atoms .....	51
2.4 Lifetimes of Excited States .....	52
2.5 Autoionizing States .....	61
2.6 Asymptotic Formulas .....	70
2.6.1 Quasiclassical Formulas .....	70
2.6.2 Bates-Damgaard Tables for Dipole and Quadrupole Matrix Elements .....	71
2.7 Angular Coefficients .....	84
2.7.1 $LS$ -coupling .....	84

2.7.2 <i>jl</i> -coupling .....	88
2.7.3 Arbitrary Coupling .....	89
<b>3 Radiative Characteristics</b> .....	90
3.1 Photoionization and Radiative Recombination .....	90
3.2 The Kramers Formulas and the Gaunt Factor .....	101
3.3 Polarizabilities .....	104
3.3.1 Dipole Polarizability. Basic Relations .....	105
3.3.2 Static Dipole Polarizabilities of Atoms and Ions .....	108
3.3.3 Multipole Static Polarizabilities. Boundary Radii .....	108
3.4 Bremsstrahlung .....	116
3.4.1 Basic Formulas .....	117
<b>4 Electron-Atom Collisions</b> .....	120
4.1 Excitation .....	120
4.1.1 Basic Relations .....	120
4.1.2 Transitions in Hydrogen .....	122
4.1.3 Transitions in Helium .....	122
4.1.4 Dipole Transitions. Model Potentials .....	126
4.1.5 Transitions Between Rydberg States .....	135
4.1.6 Intercombination Transitions .....	137
4.2 Single Ionization .....	141
4.2.1 General Properties .....	142
4.2.2 Approximation Formulas .....	146
4.2.3 Fitting Parameters for H-like Ions. High-Energy Behavior .....	149
4.3 Multiple Ionization .....	153
<b>5 Ion-Atom Collisions</b> .....	161
5.1 Excitation .....	161
5.2 Ionization .....	166
5.2.1 Single Ionization .....	166
5.2.2 Double Ionization of He .....	168
5.2.3 Multiple Ionization .....	170
5.3 Electron Capture .....	173
5.4 Collisions Involving $H^-$ ions .....	181
5.4.1 $H^+ + H^-$ Collisions .....	182
5.4.2 $H^- + H^-$ Collisions .....	183
5.4.3 Collisions of $H^-$ with Multicharged Ions .....	184
<b>References</b> .....	189
<b>Subject Index</b> .....	200