

# Contents

<i>Preface</i>	x
<i>Symbols</i>	xii
<b>1 Classical theory of radiation</b>	<b>1</b>
1.1 Electromagnetic equations and fields from moving charges	2
1.2 Emission of radiation	3
1.3 Absorption by harmonic oscillators	4
1.4 Radiation damping	6
1.5 Scattering of radiation	7
1.6 Optical refractivity	9
<b>2 Quantum theory of radiation</b>	<b>11</b>
2.1 Quantum theory of particles and fields	11
2.2 Radiative transition probabilities	14
2.3 Density of final states of the radiation field and normalization of the vector potential	17
2.4 Spontaneous emission	18
2.5 Absorption	20
2.6 Induced emission	22
2.7 Natural line broadening	23
2.8 Scattering of radiation	27
2.9 Resonance fluorescence	30
2.10 Optical refractivity	33
<b>3 Oscillator and line strengths</b>	<b>35</b>
3.1 Relative line strengths	37
3.2 Absolute line strengths for one-electron atoms	39
3.3 Line strengths for two- and more-electron atoms	43
3.4 Sum rules	45
3.5 Plasma effects on oscillator and line strengths	49
3.6 Measurements of radiative transition probabilities	52

<b>4</b>	<b>Spectral line broadening</b>	<b>54</b>
4.1	General theory of pressure broadening	57
4.2	Electron scattering theory of line broadening	66
4.3	Ion microfields	68
4.4	Plasma screening of electron collisions	78
4.5	Kinetic theory models of dynamical ion effects	83
4.6	Collisional narrowing and correlations between Doppler and Stark broadening	88
4.7	Stark broadening calculations	90
4.8	Effects of neutral perturbers	100
4.9	Line profile and width measurements	105
4.10	Line shift and asymmetry measurements	116
4.11	Effects of plasma wave fields	122
<b>5</b>	<b>Continuous spectra</b>	<b>132</b>
5.1	Photoionization cross sections	134
5.2	Approximate calculations of photoionization cross sections	136
5.3	Continuum absorption coefficients	140
5.4	Continuum emission coefficients	144
5.5	High density effects	147
5.6	Experiments	151
<b>6</b>	<b>Cross sections and level kinetics</b>	<b>156</b>
6.1	Kinetic models	158
6.2	Collisional ionization and three-body recombination	167
6.3	Collisional excitation and deexcitation	172
6.4	Autoionization and dielectronic recombination	177
6.5	Heavy particle collisions	183
<b>7</b>	<b>Thermodynamic equilibrium relations</b>	<b>187</b>
7.1	Thermodynamic equilibrium and statistical mechanics	188
7.2	Ionization equilibrium equations	192
7.3	High density corrections	193
7.4	Partition functions	203
7.5	Equations of state for dense plasmas	210
7.6	Validity conditions for local thermodynamic equilibrium	212
<b>8</b>	<b>Radiative energy transfer</b>	<b>221</b>
8.1	Effective absorption coefficients	222
8.2	Effective emission coefficients and redistribution functions	225
8.3	Radiative transfer equation and source function	230
8.4	Transient problems and escape factors	235
8.5	Reconstruction of source distributions from intensities	239

<b>9</b>	<b>Radiation losses</b>	<b>244</b>
9.1	Bremsstrahlung losses	245
9.2	Recombination radiation losses	248
9.3	Line radiation losses	250
9.4	Numerical calculations of radiation losses	252
<b>10</b>	<b>Spectroscopic density measurements</b>	<b>258</b>
10.1	Densities from spectral line widths and profiles	259
10.2	Densities from absolute continuum intensities	268
10.3	Densities from absolute line intensities	271
10.4	Electron densities from relative line intensities	273
<b>11</b>	<b>Spectroscopic temperature measurements</b>	<b>279</b>
11.1	Relative intensities of lines of the same atom or ion	281
11.2	Relative line intensities of subsequent ionization stages of the same element	283
11.3	Lines from isoelectronic transitions of different elements	287
11.4	Relative continuum intensities	290
11.5	Ratios of line and continuum intensities	291
11.6	Intensities from optically thick layers	292
11.7	Line intensities in rapidly ionizing plasmas	296
11.8	Doppler profiles	297
<b>12</b>	<b>Other diagnostic applications of plasma spectroscopy</b>	<b>300</b>
12.1	Charge exchange recombination spectroscopy	301
12.2	Beam emission spectroscopy (BES)	306
12.3	Polarization spectroscopy	312
12.4	Magnetic field measurements	314
12.5	Electric field measurements	318
12.6	Effective charge measurements	320
	<i>References</i>	324
	<i>Index</i>	362