

Contents

1	SINGLE CHANNEL PROBLEMS	1
1.1	Potential Scattering	1
1.1.1	<i>Coordinate Frames</i>	1
1.1.2	<i>Boundary Conditions</i>	3
1.1.3	<i>Cross Sections</i>	5
1.1.4	<i>Partial Waves</i>	10
1.1.5	<i>Coulomb Scattering</i>	17
1.1.6	<i>Units</i>	25
1.2	Resonance Phenomena	27
1.2.1	<i>Bound States</i>	27
1.2.2	<i>Virtual States</i>	34
1.2.3	<i>Decaying States</i>	36
1.2.4	<i>Resonance Widths</i>	39
1.2.5	<i>Resonance Shapes</i>	44
1.2.6	<i>Resonances in Cross Sections</i>	49
1.3	Static Field Approximation	50
1.3.1	<i>Electron and Positron Scattering by H-atoms</i>	50
1.3.2	<i>Collisions of 100 keV Electrons with Au and Ag Atoms</i>	52
1.3.3	<i>Differential Elastic Scattering of Molecular Beams</i>	53
1.3.4	<i>The Low-Temperature Properties of Gases</i>	55
1.3.5	<i>The WKB Approximation</i>	56
1.4	Second Order Ordinary Differential Equations	60
1.4.1	<i>Numerov Method</i>	60
1.4.2	<i>Starting the Solution</i>	65
1.4.3	<i>Matching Procedure for Bound States</i>	68
1.4.4	<i>Asymptotic Expansion</i>	71
1.4.5	<i>Runge-Kutta Method</i>	76

1.5	Photon-Atom Reactions	85
2	MANY CHANNEL PROBLEMS	96
2.1	Eigenfunction Expansion Method	96
2.1.1	<i>Open and Closed Channels</i>	96
2.1.2	<i>Derivation of Radial Equations</i>	101
2.1.3	<i>The S Matrix</i>	103
2.1.4	<i>Autoionization</i>	107
2.1.5	<i>Resonance Mechanisms</i>	111
2.2	Racah Algebra	119
2.2.1	<i>Clebsch-Gordan Coefficients</i>	119
2.2.2	<i>Racah Coefficients</i>	121
2.2.3	<i>Matrix Elements of r_{12}^{-1}</i>	125
2.2.4	<i>9j Coefficients</i>	131
2.2.5	<i>Coefficients of Fractional Parentage</i>	134
2.3	Cross Section Formulae	140
2.3.1	<i>The Scattering Amplitude</i>	140
2.3.2	<i>Differential and Total Cross Sections</i>	144
2.3.3	<i>Density Matrices and Spin Polarization</i>	146
2.3.4	<i>Many Channel Photoionization</i>	159
2.4	Numerical Methods for Coupled Differential Equations	173
2.4.1	<i>Matching Algorithm</i>	173
2.4.2	<i>Constraints on the Radial Functions</i>	178
2.4.3	<i>Separable Kernels in Integro-Differential Equations</i>	185
2.4.4	<i>Asymptotic Solutions</i>	192
2.5	Close-Coupling Approximation	194
2.5.1	<i>Electron-Atom</i>	194
2.5.2	<i>Atom-Atom</i>	199
2.5.3	<i>Scattering by Diatomic Molecules</i>	206
	INDEX	213