

# Contents

<b>1</b>	<b>Introduction</b>	<b>1</b>
1.1	Properties of Elementary Charges	1
1.2	Charge Density in Molecules	4
1.2.1	Self Energy of Hydrogen Atom	4
1.2.2	Charge Density in Molecules	6
1.2.3	Charge Density in Hydrogen-Like Atom	8
1.2.4	Electric Dipole of Molecules	9
1.2.5	Van der Waals Potential.	14
1.3	Structure of Molecules	19
1.3.1	Adiabatic Approximation	22
1.3.2	Hydrogen Atom in Harmonic Oscillator	28
<b>2</b>	<b>Relativistic Wave Equations</b>	<b>33</b>
2.1	Unifying Equation	33
2.2	Homogeneous Equation	35
2.3	Inhomogeneous Equation	41
2.3.1	General Features	41
2.3.2	Electromagnetic Field	43
2.3.3	Klein-Gordon Equation	52
2.3.4	Dirac Equation	54
<b>3</b>	<b>Electrodynamics</b>	<b>67</b>
3.1	Basic Principles	67
3.2	Vector and Scalar Potentials	69
3.3	Electromagnetic Waves	74
3.3.1	General Features	74
3.3.2	Plane Waves	77
3.3.3	Short Pulses	80
3.3.4	Finite Width Waves	85
3.3.5	Beam Focusing (Paraxial Approximation)	91

<b>4 Charge in Electromagnetic Wave . . . . .</b>	101
4.1 Basic Effects . . . . .	101
4.1.1 Classical Dynamics . . . . .	101
4.1.2 Quantum Dynamics . . . . .	108
4.2 Very Short Electromagnetic Pulse . . . . .	119
4.2.1 Impact on Hydrogen Atom . . . . .	119
4.2.2 Impact On Atom . . . . .	125
4.3 Field Reaction . . . . .	127
<b>5 Confinement of Charge . . . . .</b>	133
5.1 General Remarks . . . . .	134
5.1.1 Uniform Velocity . . . . .	136
5.1.2 Decay of Two Particle System . . . . .	141
5.2 Confinement by Magnetic Field . . . . .	147
5.2.1 Time Dependent Magnetic Field . . . . .	150
5.3 Confinement with Electromagnetic Wave . . . . .	155
5.3.1 Classical Dynamics . . . . .	155
5.3.2 Charge in Standing Wave . . . . .	157
5.3.3 Generalized Standing Wave . . . . .	159
5.3.4 Gaussian Polarization . . . . .	162
5.3.5 Quantum Dynamics . . . . .	166
5.4 Extreme Confinement . . . . .	177
5.4.1 One Particle . . . . .	177
5.4.2 Two Particles . . . . .	181
5.4.3 Charge Density . . . . .	198
<b>6 Atom in Electromagnetic Field . . . . .</b>	217
6.1 General Remarks . . . . .	217
6.2 Atom in Electromagnetic Wave . . . . .	219
6.2.1 Basic Equation . . . . .	219
6.2.2 First Order Interaction . . . . .	223
6.2.3 Second Order Interaction . . . . .	236
<b>7 Radiation by Charge . . . . .</b>	239
7.1 Radiation Zone . . . . .	239
7.2 Radiation by Created Charge . . . . .	246
7.3 Radiation by a Bound Charge . . . . .	254
7.3.1 Hydrogen Atom . . . . .	254
7.3.2 Radiation by Rotating Molecule . . . . .	260
7.3.3 Radiation by Vibrating Molecule . . . . .	269
7.3.4 Spectral Line Shifts . . . . .	277
<b>Appendix A: Units . . . . .</b>	287
<b>Appendix B: Nonrelativistic Green Functions . . . . .</b>	291

<b>Appendix C: Useful Relationships . . . . .</b>	301
<b>Appendix D: System of N Particles . . . . .</b>	307
<b>References . . . . .</b>	329
<b>Index . . . . .</b>	331