Contents

	Preface		<i>page</i> xi	
	List of symbols		xiii	
1	Scope, motivation, and orientation			
Pa	Part I Classical theory			
2	A cł	7		
	2.1 The inhomogeneous Maxwell–Lorentz equations			
	2.2	Newton's equations of motion	12	
	2.3	Coupled Maxwell's and Newton's equations	13	
	2.4	The Abraham model	17	
	2.5	The relativistically covariant Lorentz model	22	
		2.5.1 The four-current density	24	
		2.5.2 Relativistic action, equations of motion	27	
3	Hist	orical notes	33	
	3.1	Extended charge models (1897–1912)	33	
	3.2	Nonrelativistic quantum electrodynamics	36	
	3.3	The point charge	37	
	3.4	Wheeler–Feynman electrodynamics	41	
4	The energy-momentum relation		44	
	4.1	The Abraham model	44	
	4.2	The Lorentz model	48	
	4.3	The limit of zero bare mass	51	
5	Long-time asymptotics		54	
	5.1	Radiation damping and the relaxation of the acceleration	55	
	5.2	Convergence to the soliton manifold	59	
	5.3	Scattering theory	61	

6	Adiabatic limit		65
	6.1	Scaling limit for external potentials of slow variation	66
		6.1.1 Appendix 1: How small is ε ?	71
		6.1.2 Appendix 2: Adiabatic protection	72
	6.2	Comparison with the hydrodynamic limit	74
	6.3	Point-charge limit, negative bare mass	75
7	Self-f	orce	80
	7.1	Memory equation	81
	7.2	Taylor expansion	83
	7.3	How can the acceleration be bounded?	86
8	Comparison dynamics		91
	8.1	An example for singular perturbation theory	94
	8.2	The critical manifold	95
	8.3	Tracking of the true solution	97
	8.4	Electromagnetic fields in the adiabatic limit	100
	8.5	Larmor's formula	101
9	The L	orentz–Dirac equation	106
	9.1	Critical manifold, the Landau–Lifshitz equation	107
	9.2	Some applications	109
	9.3	Experimental status of the Lorentz–Dirac equation	114
10	Spinning charges		119
	10.1	Effective spin dynamics of the Lorentz model	119
	10.2	The Abraham model with spin	121
	10.3	Adiabatic limit and the gyromagnetic ratio	125
11	Many charges		130
	11.1	Retarded interaction	130
	11.2	Limit of small velocities	132
	11.3	The Vlasov–Maxwell equations	138
	11.4	Statistical mechanics	139
12	Sumn	nary and preamble to the quantum theory	145
Part	tII (Quantum theory	147
13	Quant	tizing the Abraham model	149
	13.1	Lagrangian and Hamiltonian rewriting of the Abraham model	150
	13.2	The Pauli–Fierz Hamiltonian	153
	13.3	Fock space, self-adjointness	160
	13.4	Energy and length scales	164
	13.5	Conservation laws	167
	13.6	Boundary conditions and the Casimir effect	169
	13.7	Dipole and single-photon approximation	171

viii

		Contents	ix
14	The statistical mechanics connection		177
	14.1	Functional integral representation	177
	14.2	Integrating out the Maxwell field	187
	14.3	Some applications	191
15	States of lowest energy: statics		200
	15.1	Bound charge	201
	15.2	Energy-momentum relation, effective mass	204
		15.2.1 Appendix: Properties of $E(p)$	211
	15.3	Two-fold degeneracy in the case of spin	216
16	States of lowest energy: dynamics		220
	16.1	The time-adiabatic theorem	221
	16.2	The space-adiabatic limit	224
	16.3	Matrix-valued symbols	228
	16.4	Adiabatic decoupling, effective Hamiltonians	232
	16.5	Semiclassical limit	236
	16.6	Spin precession and the gyromagnetic ratio	239
17	Radia	ation	247
	17.1	N-level system in the dipole approximation	248
	17.2	The weak coupling theory	250
	17.3	Resonances	257
	17.4	Fluorescence	263
	17.5	Scattering theory	268
18	Relaxation at finite temperatures		279
	18.1	Bounded quantum systems, Liouvillean	280
	18.2	Equilibrium states and their perturbations, KMS condition	283
	18.3	Spectrum of the Liouvillean and relaxation	285
	18.4	The Araki–Woods representation of the free photon field	288
	18.5	Atom in interaction with the photon gas	290
	18.6	Complex translations	293
	18.7	Comparison with the weak coupling theory	297
19	Beha	vior at very large and very small distances	300
	19.1	Infrared photons	301
	19.2	Energy renormalization in Nelson's scalar field model	304
	19.3	Ultraviolet limit, energy and mass renormalization	312
		19.3.1 Self-energy	313
		19.3.2 Effective mass	316
		19.3.3 Binding energy	319
		19.3.4 Lamb shift and line width	321
		19.3.5 <i>g</i> -factor of the electron	322

Published online by Cambridge University Press

20	Many charges, stability of matter		326
	20.1	Stability of atoms and molecules	328
	20.2	Quasi-static limit	331
	20.3	H-stability	334
	Refere	nces	339
	Index		358

Published online by Cambridge University Press

х