

Contents

1	Introduction: Dispersion Forces	1
1.1	Physical Origin: Two Points of View	1
1.2	Definition and Terminology	4
1.3	Dispersion Forces Across the Sciences	6
1.4	Calculating Dispersion Forces	9
1.4.1	Van der Waals Forces	9
1.4.2	Casimir–Polder Forces	14
1.4.3	Casimir Forces	18
1.5	Measuring Dispersion Forces	24
1.5.1	Van der Waals and Casimir–Polder Forces	24
1.5.2	Casimir Forces	27
	References	30
2	Macroscopic Quantum Electrodynamics	45
2.1	Elements of Classical Electrodynamics	45
2.1.1	Electrodynamics in free Space	45
2.1.2	Electrodynamics in the Presence of Charged Particles	50
2.1.3	Electrodynamics in Media	56
2.1.4	Duality	68
2.2	Field Quantisation in free Space	73
2.3	Field Quantisation in Media	76
2.4	Atom–Field Interactions	87
2.4.1	Minimal Coupling	91
2.4.2	Multipolar Coupling	95
2.4.3	Multiple Atoms	101
2.4.4	Magnetic Atoms	103
	References	106

3 Casimir Forces Between Bodies	109
3.1 Lorentz-Force Approach	111
3.2 Stress-Tensor Approach	120
3.3 Casimir Force Between Two Plates	125
3.3.1 Perfectly Reflecting Plates	130
3.3.2 Semi-Infinite Half Spaces	134
References	145
4 Casimir-Polder Forces on Ground-State Atoms	147
4.1 Minimal Coupling	149
4.2 Multipolar Coupling.	159
4.3 Magnetic Atoms	163
4.3.1 Paramagnetic Atoms	163
4.3.2 Diamagnetic Atoms.	165
4.4 Electromagnetic Atoms	167
4.5 Chiral Molecules	168
4.6 Atom Within Planar Multilayer Systems	170
4.6.1 Perfectly Reflecting Plate.	172
4.6.2 Half Space	179
4.6.3 Plate of Finite Thickness	187
4.6.4 Planar Cavity	193
4.7 Atom Next to a Sphere	196
4.7.1 Perfectly Conducting Sphere	199
4.7.2 Large or Small Sphere.	202
References	206
5 Van der Waals Forces Between Ground-State Atoms	209
5.1 Electric Atoms	211
5.2 Magnetic Atoms	222
5.2.1 Paramagnetic Atoms	222
5.2.2 Diamagnetic Atoms.	227
5.3 Electromagnetic Atoms	238
5.4 Two Atoms in Free Space	240
5.5 Body-Assisted Interactions	252
5.5.1 Two Atoms in Front of a Plate.	254
5.5.2 Two Atoms Next to a Sphere.	273
References	288
Appendix A: Calculation of Field Commutators	291
Appendix B: The Green's Tensor	295
Index	325