

# Contents

<i>Preface</i>	<i>page vii</i>
<b>Part I Atomic and Few-Body Physics</b>	
<b>1 A Single Atom</b>	<b>3</b>
1.1 Electronic Structure	3
1.2 Magnetic Structure	10
1.3 Light Shift	14
1.4 Stimulated Raman Adiabatic Passage	26
Exercises	29
<b>2 Two-Body Interaction</b>	<b>31</b>
2.1 Scattering Length	32
2.2 Zero-Range Models	39
2.3 Spin-Dependent Interaction	44
2.4 Feshbach Resonance	49
2.5 Confinement-Induced Resonance	58
2.6 Efimov Effect	61
2.7 From Few to Many	65
Exercises	68
<b>Part II Interacting Bose Gas</b>	
<b>3 Interaction Effects</b>	<b>73</b>
3.1 Bose–Einstein Condensation	74
3.2 Hydrodynamic Theory	78
3.3 Bogoliubov Theory	88
3.4 One-Dimensional Bosons	99
3.5 Phase Coherence and Fragmentation	103
Exercises	116
<b>4 Topology and Symmetry</b>	<b>118</b>
4.1 Soliton	118
4.2 Vortex	122
4.3 Spinor Condensate	132

4.4	Topological Excitations in Spinor Condensate	139
4.5	Spin-Orbit-Coupled Condensate	146
	Exercises	152
<b>Part III Degenerate Fermi Gases</b>		153
<b>5</b>	<b>The Fermi Liquid</b>	155
5.1	Free Fermions	155
5.2	Fermi Polaron	163
	Exercises	171
<b>6</b>	<b>The Fermi Superfluid</b>	172
6.1	BCS Pairing	172
6.2	BCS-BEC Crossover	183
	Exercises	199
<b>Part IV Optical Lattices</b>		201
<b>7</b>	<b>Noninteracting Bands</b>	203
7.1	Basic Band Theory	203
7.2	Dirac Semimetal	213
7.3	Topological Band Insulator	221
7.4	Periodical-Driven Lattice	233
7.5	Lattice from Cavity	241
	Exercises	245
<b>8</b>	<b>The Hubbard Model</b>	247
8.1	Bose–Hubbard Model	247
8.2	Fermi–Hubbard Model	261
8.3	Thermalization and Entanglement	273
	Exercises	284
	<i>References</i>	285
	<i>Index</i>	298