

Contents

1. Review of Quantum Mechanics and Basic Principles of Field Theory	1
1.1 Single-Particle Quantum Mechanics	1
1.2 Many-Particle Quantum Mechanics: Second Quantization	12
1.3 The Variation Principle and the Noether Theorem	18
1.4 Quantization of the Electromagnetic Field	23
2. Quantization with Path Integral Methods	27
2.1 Single-Particle Quantum Mechanics and Path Integrals	27
2.2 The Path Integral for Bosons	37
2.3 The Path Integral for Fermions	42
2.4 The Path Integral for the Gauge Field	45
2.5 The Path Integral for the Spin System	47
3. Symmetry Breaking and Phase Transition	51
3.1 Spontaneous Symmetry Breaking	51
3.2 The Goldstone Mode	60
3.3 Kosterlitz–Thouless Transition	68
3.4 Lattice Gauge Theory and the Confinement Problem	78
4. Simple Examples for the Application of Field Theory	91
4.1 The RPA Theory of a Coulomb Gas	91
4.2 The Bogoliubov Theory of Superfluidity	102
5. Problems Related to Superconductivity	113
5.1 Superconductivity and Path Integrals	113
5.2 Macroscopic Quantum Effects and Dissipation: The Josephson Junction	133
5.3 The Superconductor–Insulator Phase Transition in Two Dimensions and the Quantum Vortices	146

6. Quantum Hall Liquid and the Chern–Simons Gauge Field	161
6.1 Two-Dimensional Electron System	161
6.2 Effective Theory of a Quantum Hall Liquid	167
6.3 The Derivation of the Laughlin Wave Function	186
Appendix	193
A. Fourier Transformation	193
B. Functionals and the Variation Principle	195
C. Quantum Statistical Mechanics	199
References	201
Index	205



<http://www.springer.com/978-3-540-65537-4>

Quantum Field Theory in Condensed Matter Physics

Nagaosa, N.

1999, X, 206 p., Hardcover

ISBN: 978-3-540-65537-4