M2 Quantum Physics
Academic year 2025-2026

**Quantum-condensed-matter field theory**

**Recommended reading**

(this page will be updated as the lectures progress)

**1) Path integral in quantum mechanics:** Sec. 1.1.1 (chapter 1) of the lecture notes

1.1) Classical particle
1.2) Canonical quantization
1.3) Path integral
1.4) Euclidean formalism
1.5) Many-particle systems

**2) Second quantization:** 1.2

2.1) Fock space
2.2) Creation and annihilation operators
2.3) Operators in second-quantized form
2.4) Green functions

**3) Coherent-state functional integral (bosons)**

3.1) Coherent states: 1.3.1
3.2) Functional integral: 1.4.1
3.3) Non-interacting particles: 1.4.2
3.4) Perturbation theory and Feynman diagrams: 1.5.1–1.5.3 (optional: 1.6.2.2)

**4) Interacting boson systems**

4.1) Dilute classical gas: Sec. "Quantum ideal gas" in 1.C.5
4.2) Superfluid transition: 7.4.3
4.3) Gross-Pitaevskii theory: 7.3.1 (optional 7.3.2-7.3.3)

**5) Coherent-state functional integral (fermions)**

5.1) Grassmann variables: 1.3.2 and 1.E
5.2) Coherent states: 1.3.3
5.3) Functional integral: 1.4.1
5.4) Non-interacting particles: 1.4.2
5.5) Perturbation theory and Feynman diagrams: 1.5.1–1.5.3 (optional: 1.6.2.2)

**6) Fermi-liquid theory**

6.1) The quasi-particle concept: 4.1 and 4.4.1
6.2) Landau's phenomenological theory: 4.1–4.3.3.2 (optional: full Sec. 4.3)