

# Quantum Statistical Mechanics

Fall 2024

INSTRUCTOR: Congjun Wu (Office: E4-235)

Email: wucongjun@westlake.edu.cn

TA: Mr. Dai, Jiale

Time/Place: Tuesday 9:50am-12:15pm/E10-312

Text Books:

1. Kerson Huang *Statistical Mechanics*, Wiley; 2nd edition (January 16, 1991).
2. L. D. Landau, and E. M. Lifshitz, *Statistical Physics, Part (I)*, Butterworth-Heinemann; 3rd edition (January 15, 1980).

Grade:

30% problem sets, 35% midterm, 35% final exam.

# Class Schedule

## Part I: Thermodynamics and kinetic theory

1. Lecture 1: The law of thermodynamics  
Lecture 2: Entropy
2. Lecture 3: Phase transitions  
Lecture 4: Boltzmann transport equation
3. Lecture 5: Boltzmann's  $H$ -theorem  
Lecture 6: Transport Phenomenon, Viscosity, hydrodynamics

## Part II: Quantum Statistics

4. Lecture 7: Classic Statistical Mechanics  
Lecture 8: Canonical and Grand canonical ensemble
5. Lecture 9: Phase transitions, Lee-Yang Circle Theorem  
Lecture 10: Fermi systems (I)
6. Lecture 11: Fermi systems (II)  
Lecture 12: Fermi systems (III)
7. Lecture 13: Bose systems (I)  
Lecture 14: Bose systems (II)
8. Lecture 15: Bose systems (III)  
Lecture 16: Bose systems (IV)

## Part (III) Advanced topics

9. Lecture 17: Superfluid (I)  
Lecture 18: Superfluid (II)
10. Lecture 19: Ising model (I)  
Lecture 20: Ising model (II)
11. lecture 21: Onsager Solution (I)  
lecture 22: Onsager Solution (II)
12. lecture 23: Critical Phenomena  
lecture 24: Landau mean-field theory
13. lecture 25: Scaling hypothesis  
lecture 26: Renormalization group (I)

- 14. lecture 27: Renormalization group (II)
- lecture 28: Renormalization group (III)

**Part IV: Numerical methods**

- 15. lecture 29: Monte-Carlo method
- lecture 30: Quantum Monte-Carlo
- 16. lecture 31: Density-matrix-renormalization group (I)
- lecture 32: Density-matrix-renormalization group (II)