

# Modern Physics of Quantum Criticality

## 1. Phase transitions

- 1.1. The Ising model
- 1.2. Mean field of the Ising model
- 1.3. Symmetries
- 1.4. Universality and critical exponents
- 1.5. Scale invariance
- 1.6. Landau theory
- 1.7. Finite size scaling

## 2. The renormalization group

- 2.1. Real space renormalization group
- 2.2. Real space renormalization group of the 1D Ising model
- 2.3. Fixed points
  - 2.3.1. Critical surface
  - 2.3.2. Scaling variables
  - 2.3.3. Classification

## 3. Quantum phase transitions

- 3.1. Generic phase diagram
- 3.2. Quantum Ising model
- 3.3. Quantum to classical mapping
- 3.4. Quantum critical scaling

## 4. Topological phases & phase transitions

- 4.1. Berezinskii-Kosterlitz-Thouless transition
- 4.2. Symmetry protected topological phases (SPT)
  - 4.2.1. Characteristics
  - 4.2.2. Order parameters for SPTs
  - 4.2.3. Quantum phase transitions out of SPT
- 4.3. Symmetry protected topological phases (SPT)
  - 4.3.1. Fractional quantum Hall effect
  - 4.3.2. The Topical code
  - 4.3.3. Order parameters for intrinsic topological order
  - 4.3.4. Ising gauge theory
- 4.4. Quantum spin liquids

## 5. Deconfined quantum criticality

## 6. Quantum phase transitions in (Dirac) metals

7. Fractonic Quantum phase transitions
8. Dynamical quantum phase transitions
9. Many-body localisation transition & disorder