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MPHYS NOTES

# Advanced Quantum Mechanics

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*Based on a course by Dr. Yang Xian*

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# Chapter 1

## Symmetries in Quantum Mechanics

1.1 Unitary Operators

1.2 Rotations, Reflections, and Parity

1.3 Conservation Laws

1.4 Schrödinger vs. Heisenberg Pictures

## Chapter 2

# Time-Dependent Perturbation Theory

2.1 Fermi's Golden Rule

2.2 Selection Rules for Atomic Transitions

2.3 Emission and Absorption of Radiations

2.4 Finite Width of Excited States

2.5 Selection Rules for Hydrogen

# Chapter 3

## Coupling to Electromagnetic Fields

3.1 Minimal Coupling

3.2 Landau Levels

3.3 Gauge Invariance of Quantum Mechanics

3.4 The Pauli-Schrödinger Equation

# Chapter 4

## Relativistic Wave Equations

- 4.1 The Klein-Gordon Equation and Dirac Equation
- 4.2 Chirality and Helicity
- 4.3 Lorentz Invariance and the Non-Relativistic Limit
- 4.4 The Hydrogen Atom and Fine Structure
- 4.5 Graphene