PHYS 481: Quantum Mechanics

Spring 2025 (update in progress)

Prof. Tom Browder (WAT 233, Office Hrs: after class TuTh or by appointment)
Grader Ammar Bayyari

Quantum Mechanics Part II

The course will meet Tu-Th 12:00-1:20 pm in WAT114, and follow the textbook of David H McIntyre "Quantum Mechanics, A Paradigms Approach", Cambridge University Press (Chapters 8-14).
Recommended Reading: David J. Griffiths, An Introduction to Quantum Mechanics, 3rd edition, Cambridge University Press

We will have some problem solving/tutorial sessions on Friday afternoon led by the grader (TBC).
After covering the basics, will try to adjust the schedule to include the EPR paradox and entangled states in the course.

- Tuesday, Jan 14; Angular momentum operators, commutation relations (Chapter 7 & notes)
- Thursday, Jan 16; Angular momentum: raising/lowering operators, ladder of states (Chapter 7 & Notes)
- Tuesday Jan 21; Hydrogen atom I: solve radial equation (Chapter 8)
- Thursday Jan 23; Hydrogen atom II: radial equation solution, continued using power series method (Chapter 8)
- Tuesday Jan 28; Hydrogen atom III: summary. Quantum numbers and their meaning. Finding probability of a given electron radius.
  Fine structure constant. Normalization in spherical coordinates (Chapter 8)
- Thursday Jan 30; QM Harmonic Oscillator I. Raising and Lowering Operators. (Chapter 9)
- Tuesday Feb 4, QM Harmonic Oscillator II. Normalization of states. Notation on Hermitian conjugation. Raising/lowering operator for expectation values. (Chapter 9)
- Thursday Feb 6, Math Methods: Integrating x^2exp(-x^2).
  Useful identities for raising/lowering operators. Hermitian conjugation.
  Homework hints. Even vs odd functions. (Chapter 9)
- Tuesday Feb 11: QM Harmonic Oscillator III: Diatomic Molecules, Ehrenfest's Theorem (Chapter 9)
  Start Perturbation theory (Chapter 10)

- Thursday Feb 13: Perturbation theory overview and goals (Chapter 10)
- Tuesday Feb 18: Perturbation Theory I. Non-degenerate. Start of degeneracy (Chapter 10)
- Thursday Feb 20: Degenerate Perturbation Theory (Chapter 10)
- Tuesday Feb 25: Variational Principle I (Chapter 10)
- Thursday Feb 27, Variational Principle II: applied to kinked functions. Adiabatic approx. Sudden approximation
- Tuesday, March 4, Review for Midterm 1 (Practice problems, review hydrogen atom and SHO)
- Thursday, March 6, Midterm 1
- Tuesday, March 11, Perturbation applied to the Hydrogen Atom. Overview and Fine Structure Relativistic Corrections.
- Thursday, March 13, Finish Relativistic Corrections. Ground State of Helium, Part I
- **March 17-21, Spring Break**
- Tuesday March 25, Ground state energy of Helium, part II
- Thursday March 27, Ground State of Helium, part III. Nuclear shielding and Z_eff for helium.
- Tuesday April 1, Addition of angular momenta and spin-orbit coupling for hydrogen. Coupled vs uncoupled basis. Finding H' = S*L and how to evaluate.
- Thursday April 3, Angular momentum reminder. Constructing spin operators.
- Tuesday April 8, Addition of angular momentum. Sping 1/2 Clebsch Gordon coefficients.
- Thursday April 10, midterm II (perturbation theory, H fine structure and angular momentum)
- Tuesday April 15, Time dependent perturbation theory, part I. Electric Dipole radiation. Selection Rules.
- Thursday April 17, Time dependent perturbation, part II.
  Multiparticle systems. How to write a multiparticle wave function.
  Symmetry requirements. Elementary particles in the Standard Model and their spins, connection to symmetry requirements. Particle exchange operator.
- Tuesday April 22, Three particles in an infinite square well, connection to thermodynamics notation
- Thursday April 24, WKB approximation
- Tuesday April 29, WKB approximation

- Thursday May 1 WKB approximation and Scattering Theory
- Tuesday May 6, Scattering Theory, Born Approximation

There will be two midterms, and a final exam.
For the two midterms and final, a calculator and a notecard are allowed.

Grading weights:
Homework Problems (25%)
Two Midterms (30%)
Tutorial participation and in-class exercises (15\%)
Final (30%)

Midterm exam I: Thursday March 6
(Covers Chapters 9-10, bring one standard size notecard and calculator)

Midterm exam II: Thursday April 10
(Cover Chapters TBA, bring one standard size notecard and calculator)

Final exam, TBA, before May 12th (US-Japan meeting in Sapporo)
Bring crib sheet and calculator

Substitutes Feb 20 - March 6; Belle II upgrade meeting, Belle II General Meeting, e+e- Factory workshop.

Last modified: Feb 6, 2025

(Check frequently for updates)

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