Quantum Mechanics I (PHY 362)

Prof. Sera Cremonini

Instructor's Coordinates:

Office: Room 417, Physics Department
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Office Hours: **Thurs 3-4 or by appointment only** (email me to schedule a meeting time if you can't make it on Thursday)

Course Information:

PHY 362, Fall 2023
Time: Tue, Thurs 12:10 - 13:25
Location: Room 512, Lewis Lab (Physics)
Website: https://coursesite.lehigh.edu/

Your HW grader/TA:
Yuezhang (John) Tang, yut318@lehigh.edu. Room 302 (Lewis Lab), office hours: Mon, Wed 4:30-5:30

Course Description
PHY 362 is the first course of the two-semester introductory quantum mechanics sequence PHY 362–369. The course introduces the basic concepts of wave mechanics, the formalism of quantum mechanics, and applications to atomic, molecular, and condensed matter physics. The material is aimed at advanced undergraduate students. **Prerequisites:** PHY 31 (or CHM 341) and MATH 205.

Required Textbook
Introduction to Quantum Mechanics, David J. Griffiths and Darrell F. Schroeter (3rd edition, Cambridge University Press).

Course requirements and assessment criteria:

- **Homework** will be assigned on a weekly or by-weekly basis, depending on difficulty level.
- **Exams:** we will have **two in-class midterms and a final exam**.

The grades will be determined as follows:

- Homework 20%
- Midterm Exams 25% each
- Final Exam 30%
- Class participation will be taken into account for students on the border between two grades

Grading Scale
A = 88 – 100 B = 75 – 87 C = 60 – 74 D = 50 – 60

Initial competences:
Knowledge of classical mechanics, electromagnetism and modern physics. Familiarity with solving differential equations and with linear algebra concepts such as eigenstates and eigenvalues.

Course objective and final competences:

The students are expected to:

- Describe the quantum state of a system using state vectors in Dirac and matrix notation
- Predict the possible outcomes and probabilities of measurements on quantum systems
- Represent quantum states in different bases
- Use the eigenvalues and eigenstates of a Hermitian operator to predict the possible values of a physical quantity and the state of a quantum system after measurement
- Predict the time evolution of a quantum system using the Schrödinger equation
- Calculate the possible energy values of a quantum system
- Calculate the probability density of a particle from its spatial wavefunction
- Solve for stationary states in piecewise-constant potential wells
- Describe the state of a free particle using momentum eigenstates
- Predict the expectation value of momentum using the momentum operator
- Describe the state of a particle in terms of its orbital angular momentum
- Calculate the expectation values of quantities involving angular momentum
- Predict allowed states and transitions in hydrogen
- Calculate expectation values and probabilities of microscopic variables for hydrogen
- Calculate expectation values of position and momentum-dependent quantities for the harmonic oscillator using wavefunctions or ladder operators
- Approximate realistic systems (such as diatomic molecules) as quantum harmonic oscillators to estimate their properties

Accommodations for Students with Disabilities:

Lehigh University is committed to maintaining an equitable and inclusive community and welcomes students with disabilities into all of the University's educational programs. In order to receive consideration for reasonable accommodations, a student with a disability must contact Disability Support Services (DSS), provide documentation, and participate in an interactive review process. If the documentation supports a request for reasonable accommodations, DSS will provide students with a Letter of Accommodations. Students who are approved for accommodations at Lehigh should share this letter and discuss their accommodations and learning needs with instructors as early in the semester as possible. For more information or to request services, please contact Disability Support Services in person in Williams Hall, Suite 301, via phone at 610-758-4152, via email at indss@lehigh.edu, or online at https://studentaffairs.lehigh.edu/disabilities.

The Principles of Our Equitable Community:

Lehigh University endorses The Principles of Our Equitable Community [http://www.lehigh.edu/~inprv/initiatives/PrinciplesEquity_Sheet_v2_032212.pdf].

We expect each member of this class to acknowledge and practice these Principles. Respect for each other and for differing viewpoints is a vital component of the learning environment inside and outside the classroom.

Syllabus

The main topics will include:

- The wave function
    - The statistical interpretation and probability
    - Momentum
    - The uncertainty principle
- Solving the time-independent Schrödinger equation
    - The infinite and finite square wells
    - The harmonic oscillator
    - The delta function potential
- Formalism
    - Hilbert space
    - Observables, eigenfunctions of a Hermitian operator
    - Vectors and operators
- Quantum mechanics in three dimensions
    - The hydrogen atom
    - Angular momentum
    - Spin
    - Electromagnetic interactions
- Identical particles
    - Two-particle systems
    - Atoms
    - Solids
- Symmetries and conservation laws (if time allows)