

# Physics 5250: QUANTUM MECHANICS - I

Fall 2007

MWF 11-11:50 am, Duane G2B47, Instructor: Prof. Leo Radzihovsky

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Office Hours: Mon, Wed 2-3pm (or by appointment), Gamow Tower, Rm F623,  
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Course Description: This graduate course will cover standard topics in nonrelativistic quantum mechanics, as outlined below

Pre/Corequisites: electricity and magnetism, classical mechanics, basic mathematical physics; interest and desire to learn

Text: *Principles of Quantum Mechanics*, R. Shankar, Springer

Additional suggested reading/references:

- *Modern Quantum Mechanics*, J. J. Sakurai, Addison Wesley
- *Quantum Mechanics*, L. D. Landau and E. M. Lifshitz, Pergamon Press
- *Quantum Mechanics*, L. I. Schiff, McGraw-Hill
- *Quantum Mechanics*, C. Cohen-Tannoudji, B. Diu, F. Laloe
- *Quantum Physics*, Eisenberg and R. Resnik

Homework (60%): Problem sets due every two weeks

Final Exam (40%): tentatively Mon, Dec 17, 10:30-1pm

## COURSE OUTLINE

1. Introduction
  - (a) Classical mechanics
  - (b) Conflict with experiments
  - (c) Quantum mechanics ideas and coordinate formulation
2. Postulates and mathematical structure of quantum mechanics
  - (a) Hilbert space
  - (b) Hermitian operators
  - (c) Measurement and probabilistic interpretation
  - (d) Density matrix
  - (e) Time evolution: Schrodinger, Heisenberg and Feynman formulations
3. Simple problems in one dimension
  - (a) Free particle
  - (b) Particle in a box
  - (c)  $\delta$ -function potential
  - (d) Harmonic oscillator
4. Symmetries and their consequences
  - (a) Translation in space and time
  - (b) Parity
  - (c) Time-reversal
5. Rotational invariance and angular momentum
  - (a) Proper rotation
  - (b) Angular momentum algebra
  - (c) Spin
  - (d) Addition of angular momenta
6. Applications
  - (a) Harmonic oscillator
  - (b) Hydrogen atom
  - (c) Electron in a magnetic field

- (d) Spectrum and its degeneracy
  - (e) Spin-orbit interaction
7. Approximate methods and applications
    - (a) Perturbation theory
    - (b) Variational theory
    - (c) WKB approximation
    - (d) Applications
  8. Multi-particle systems
    - (a) Spin-statistics theorem
    - (b) Beyond hydrogen atom
    - (c) Fermi gas - metals
    - (d) Bose gases - phonons
  9. Scattering theory
  10. Dirac equation
  11. Path-integrals
  12. Introduction to quantum field theory