Physics 661 – Quantum Mechanics II – Spring 2009

Mondays and Wednesdays, 12:30-1:45 in Faraday West 227

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Office hours: M,T,W 10:00-11:30 (or whenever you can find me)

Class home page: http://zippy.physics.niu.edu/phys661.html

Textbook: *Modern Quantum Mechanics* by J.J. Sakurai.
Two other recommended books are *Lectures on Quantum Mechanics* by Gordon Baym, and *Principles of Quantum Mechanics* by Ramamurti Shankar. These books are *not* required, but you may find that they complement Sakurai well. A few of the topics that are listed below will follow the treatment of Baym.

Grading:

40% Homework (Late penalty policy: 10% off for each day after the due date, for up to five days; 100% off for > 5 days late.)

25% Midterm Exam: **(tentatively)** 12:30-1:45 Wednesday March 4, 2009,

35% Final Exam: 12:00-2:00 Monday May 4, 2009.

Please feel free to ask questions in or out of class. You are encouraged to consult with each other on the homework. However, you must not turn in anything that you have simply copied, or anything that you do not truly understand. Homework solutions should be your own work and in your own words. Exam questions will be similar to homework questions.

Lecture notes will be scanned and posted on the course web site before each lecture. However, I recommend that you take notes in your own handwriting and in real time, if you can. I believe this facilitates learning.

Topics to be covered (order and content may be subject to change):

- Review of fundamental principles of quantum mechanics
- The Hydrogen atom
  - Wavefunctions and energy levels at lowest order (Sakurai A.5 and A.6, or Baym 169-179)
  - Fine structure (Sakurai 5.3)
  - Hyperfine structure (Baym 572-573)
  - The Lamb shift (Baym 574)
- Applications of time-dependent perturbation theory
  - Transition rates: Fermi's Golden Rule, harmonic perturbations (Sakurai 5.6)
  - Absorption and stimulated emission of EM radiation (Sakurai 5.7)
  - Photoelectric effect (Sakurai 5.7)
  - Decay widths (Sakurai 5.8)
- Symmetry in quantum mechanics
  - Conservation laws from symmetries in quantum mechanics (Sakurai 4.1)

  - Parity (Sakurai 4.2)
  - Periodic potentials and lattice translation symmetry (Sakurai 4.3)
  - Time reversal (Sakurai 4.4)
- Identical particles
  - Multiple particle states and permutations (Sakurai 6.1)
  - Bose-Einstein and Fermi-Dirac statistics (Sakurai 6.2)
  - Two-electron systems (Sakurai 6.3)
  - The Helium atom (Sakurai 6.4)
- Cooper pairs (Baym 180-189)
- Tensor operators and the Wigner-Eckhart Theorem (Sakurai 3.10)
- Scattering Theory
  - Scattering from a potential: the Lippmann-Schwinger equation (Sakurai 7.1, 7.11)
  - The Born approximation (Sakurai 7.2)
  - The Optical Theorem (Sakurai 7.3)
  - The eikonal approximation (Sakurai 7.4)
  - Spherical waves (Sakurai 7.5)
  - Partial wave method (Sakurai 7.6)
  - Low-energy scattering and bound states (Sakurai 7.7)
  - Resonant scattering (Sakurai 7.8)
  - Scattering of identical particles (Sakurai 7.9)
  - Inelastic electron-atom scattering (Sakurai 7.12)
  - Coulomb scattering (Sakurai 7.13)
- Feynman's path integral approach to quantum mechanics (Sakurai 2.5)
- Mixed ensembles and density operators (Sakurai 3.4)
- Bell's inequality (Sakurai 3.9)