PHYSICS 617:

FALL - 2005

MODERN ATOMIC AND NUCLEAR PHYSICS

• Instructor: Dr. Igor Ostrovskii

SYLLABUS

> COURSE OBJECTIVES AND GOALS:

- 1. Introduce the physics graduate students to 20-th century atomic and nuclear physics.
- 2. To give main results in the atomic and molecular spectroscopy, and contemporary nuclear physics.
- 3. Expand an understanding of the applications of quantum physics to the atoms and nuclei.
- 4. Develop an understanding of the current basis of broad knowledge in atomic and nuclear physics.
- 5. To discuss the connections between quantum mechanics and some contemporary tasks in physics.
- 6. Enhance the critical thinking, analytical reasoning and problem solving skills of graduate level.
- 7. Discuss the problems confronting physics in the 21-st century.
 - **♦ Lecture:** TTh 9:30 10:45, Room 126 Lewis Hall
 - ♦ Office: Room 207 Lewis Hall; Email: iostrov@phy.olemiss.edu
 - ♦ Office Hours: TWF 2:30 3:30 p.m. (207 Lewis Hall)
 - <u>**TEXT**</u>: Modern Atomic and Nuclear Physics, by Fujia Yang and Joseph H. Hamilton, 2000 or 1996 year edition, McGraw-Hill Companies.

We will cover Chapters 2, 3, 4, 5, 6, 9, 10, 11, 12, 13.

PLEASE, READ THE BOOK

- Additional reading: 1) Physics of Atoms and Molecules by B.H. Brandsen and C.J. Joachain, 2nd edition, 2003, Pearson Education Ltd., England. 2) Principles of Modern Physics, by Robert B. Leighton, McGraw-Hill Book Company.
- <u>GRADING SCALE</u>: A's ------ 90 100 B's ----- 80 - 89 C's ----- 70 - 79, Etc.
- **EVALUATION**: Grades will be based on the home works, tests, and final examination:

Homework ------ 15 % Three tests ------ 45 % (#1=15%, #2=15%, #3=15%) Final exam ------ <u>40 %</u> 100 %

• TESTS AND FINAL EXAMINATION SCHEDULE:

Test 1 (Class # 10), Chapters 2, 3, 4, 5. ----- Thursday, September 22. Test 2 (Class # 19), Chapters 6, 9, 10. ----- Tuesday, October 27. Test 3 (Class # 26), Chapters 11, 12. ----- Thursday, November 17.

FINAL EXAMINATION ------ Wednesday, December 7, 8:00 a.m.

• **<u>REQUIREMENTS OF THE COURSE AND HOMEWORK RULES:</u>**

1. The basic knowledge of calculus based General Physics, Differential Equations and Math-Methods are required. Undergraduate Quantum Mechanics is a good support for understanding of Phys-617.

- 2. Homework is assigned after some sections are covered.
- 3. Homework paper should be 8.5×11 inches with no torn or tattered edges.
- 4. Show all your work; the answer alone is not worth anything. Homework problems must include <u>enough English</u> to be understandable.
- 5. Homework answers should have units and a reasonable number of significant digits.

6. Circle the finale answers that you want to be graded.

COURSE DESCRIPTION AND CONTENT:

The course of Modern Atomic and Nuclear Physics is devoted to the main experimental and theoretical results in atomic, molecular and subatomic physics, which were achieved in the 20-th century. The PHYS-617 gives a basic knowledge in the a) atomic configuration and atomic spectroscopy including fine structure in atomic spectra; b) X-Rays spectroscopy; c) basic concepts of nuclear physics including radioactive decay, nuclear forces, nuclear interactions and reactions. The applications of quantum mechanics to the atoms, molecules and spectroscopy are discussed.

<u>PART 1:</u>

- 1. (Ch. 2) The Configuration of the Atom: Background, The Rutherford Model, The Rutherford Scattering formula.
- 2. (Ch. 3) Quantum States of Atoms: The Bohr Model, Experimental evidences, Frank-Hertz experiment, Bohr-Sommerfeld model.
- 3. (Ch. 4) Fine Structure in Atomic Spectra: Magnetic orbital moment, Stern-Gerlah experiment, Spin of electron, Zeeman Effect.
- 4. (Ch. 5) Atoms Containing Many Electrons: Helium, Coupling of two electrons, The Pauli Exclusion Principle, The Periodic Table of Elements.

> Test 1 (Class # 10), Chapters 2, 3, 4, 5. ----- Thursday, September 22.

<u>PART 2:</u>

- 5. (Ch. 6) X-Rays: Discovery of X-Rays, Mechanisms for producing X-Rays, Compton Scattering, Absorption of X-Rays.
- 6. (Ch. 9) Basic Concepts of Nuclear Physics: Nucleus of atom, Properties at ground state, Ground state spins and moments.
- 7. (Ch. 10) Radioactive Decay: Decay Laws, Alpha and Proton fission decays, Beta decay, Gamma decay.

> Test 2 (Class # 19), Chapters 6, 9, 10. ----- Tuesday, October 27.

<u>PART 3:</u>

- 8. (Ch. 11) Nuclear Forces and Nuclear Models: Nuclear forces, Models, Toward a Unified Model to describe the properties of the nuclei.
- 9. (Ch. 12) Nuclear Interactions and Reactions: Reaction Kinematics, Reactions, Fission and Fusion, Applications of Nuclear Physics.

> Test 3 (Class # 26), Chapters 11, 12. ----- Thursday, November 17.

- 10. (Ch. 13) Hyperfine Interactions: Hyperfine Interactions due to Magnetic and Electric dipoles, Isotope Shift.
- 11. REVIEW (Last class # 28 on Thursday, December 1, 2005).

> FINAL EXAMINATION ------ Wednesday, December 7, 8:00 a.m.

* - The dates of chapter tests are tentative and may be changed, but NOT THE FINAL EXAMINATION DATE/TIME.