Phys 4910 Spectroscopic Techniques and Applications

Introduction and course description

> Spectroscopic instrumentation and techniques; detectors; atomic structure and spectroscopy; spectroscopy of diatomic molecules. Satisfies upper-division writing proficiency requirement. Prerequisites: Completion of the Writing Proficiency Screening Test with a passing score, PHYS 3520 or CHEM 4020. (Lecture, 2 hours; laboratory, 3 hours)

As well as being an elective in the physics major, this course also satisfies the Writing Proficiency (WP) requirement for graduation. In order to satisfy this requirement you must have received a passing score on the WPST ***before*** taking this class.

Learning Goals

- To learn some of the techniques which are used to separate light into its component colours (wavelengths).
- To understand how the resolution of the spectrum depends on both the properties of the source and on the properties of the instrument.
- To develop models of atoms and molecules which help explain the spectra which are obtained.

Course Requirements

- Prerequisites
  - *either* PHYS 3520 Modern Physics and Quantum Mechanics
  - *or* CHEM 4020 Physical Chemistry II
- Basic understanding of
  - Angular Momentum, at the level of Phys 2250 General Physics I
  - Electrostatic and Magnetic interactions, at the level of Phys 2260 General Physics II
  - elementary quantum mechanics
  - particles as waves
  - Bohr model.
- An understanding of the concept of perturbation theory is helpful but not necessary.
- Basic optics (most required optics covered in class)

Units

The standard unit of energy, the Joule, is really too large for the energies then we shall be dealing with in this class. It is more usual to work in one of the following

- The electron-volt (eV). Conversion is 1 J = 1.6 x 10^{-19} J. Typical energies for atomic physics are in the region of a few eV.
- The wavenumber (cm^{-1}), defined as the inverse of the wavelength when measured in cm. A green photon of wavelength 500 nm = 5 x 10^{-5} cm has an energy of 20,000 cm^{-1}. Another useful conversion factor is 1 eV = 8065.4 cm^{-1}.

For wavelength two units are in common usage

- Nanometers (nm) = 10^{-9} m = 10^{-7} cm
- Angstroms (Å) = 10^{-10} m = 10^{-8} cm

The range of wavelengths for visible light is approximately 400 nm to 700 nm, or equivalently 4000 Å to 7000 Å.

Class Information

Meeting time and room:	MF at 12:00 noon in N 130
Instructor:	Dr Ian M. Littlewood
Office:	N 172
Phone:	667-3466 or 667-3467. Fax number 667-3099
Email	ian@physics.csustan.edu
Office Hours	MW 1:00 to 1:50 (except February 3, 10, 17, 24) W 5 to 5:50
Web Site:	http://physics.csustan.edu
Text:	there is no formal text, but see below.

Grading Scheme

Category	Percentage
Problem sets	30%
Project Presentations	25%
Drafts of Project Reports	10%
Project Reports	35%
Total	100%

Letter grades will be determined from a curve using the final scores. I will not be using a +/- grading scheme.

Since this is a WP course, you must pass the writing assignments in order to pass the course, with at least 70% of the possible points for those assignments, and 70% on the final

report. Preliminary drafts of the out of class assignments are encouraged, preliminary drafts of the final report are mandatory.

Due dates for all assignments will be enforced. Unless you are otherwise notified, assignments submitted up to one week late will receive a 50 % penalty. Assignments cannot be accepted more than one week late.

Texts

I have placed a number of texts in the lab room (N 136). You are encouraged to read the relevant sections of these books. Since there is only one copy of each, please leave the books in the room. You may sign out one book at a time for a maximum of 2 hours if you wish to make photocopies. Please, no overnight sign outs.

- Texts on Modern Physics
  - *Physics of the Atom*, 3rd ed., by Wehr, Adair, and Richards
  - *Modern Physics for Scientists and Engineers*, by Thornton and Rex.
  - *Modern Physics*, by Bernstein, Fishbane, and Gasiorowicz
  - *Modern Physics*, by Serway, Moses, and Moyer
- Texts on Instrumentation
  - *Geometrical and Physical Optics*, by R S Longhurst
  - *Principles of Physical Optics*, by C A Bennett
- Texts on Atomic and Molecular Physics
  - *Introduction to Modern Physics*, by Richtmeyer, Kennard, and Cooper
  - *Fundamentals of Modern Physics*, by Eisberg
  - *Spectra of Diatomic Molecules*, by G Herzeberg
  - *Atomic Physics*, by Max Born
  - *Atomic Spectra*, by W R Hindmarsh
  - *Elementary Atomic Structure*, by K Woodgate
- General Reference
  - *Handbook of Chemistry and Physics* (see pages E-219 through E-340)
  - *MIT Wavelength Tables*
  - *Constants of Diatomic Molecules*, by Huber and Herzeberg

There are also a number of internet resources available. Please see web site[1].

1 http://physics.csustan.edu/ian/spectroscopy/