PHYS*4120 Atomic and Molecular Physics
Fall 2017 Course Outline

Department of Physics
University of Guelph

Instructor Information

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Lectures

Tuesday and Thursday 10:00 am - 11:20 am
MacN 318 (except the 1st lecture which is still in MINS, Room 017)

Calendar Description

The application of quantum theory to atomic and melcular structure, and the interaction between electromagnetic radiation and atoms and simple molecules.

Prerequisites

PHYS*4040 (Quantum Mechanics II)

Evaluation

Scheme 1

Assessment	% of Grade
Assignments	20%
Quizzes	10%
Midterm Exam	30%
Final Exam	40%

Scheme 2

Assessment	% of Grade
Assignments	20%
Quizzes	10%
Midterm Exam	20%
Final Exam	50%

Assignment deadlines will be enforced with a late penalty of 10% per day.

Midterm Examination
Tuesday, October 17tth, 7:00 pm to 9:00 pm. Room TBA

Final Examination
Saturday, December 9th, 8:30 am to 10:30 am. Room TBA

Text

“The Fundamentals of Atomic and Molecular Physics” by R.L. Brooks, Springer 2013.

References

Familiarity with a quantum text of your choice is essential. Griffiths' "Quantum Mechanics" covers some of the material in this course. Gerhard Herberg's "Atomic spectra and atomic structure" and "Molecular spectra and molecular structure, Vol 1" are gold mines of experimental information with wonderful qualitative discussions.

Outline

Part 1: Atoms (~70%)

i. Overview of atomic structure: Interaction and energy scales, qualitative effect of spin, Pauli principle. Some spectroscopic notation.
ii. Central forces and Angular momentum: Conmmutator relations, ladder operators, review of hydrogen atom solutions, spherical harmonics, spin angular momentum, addition of angular momentum.
iii. Dealing with many electrons: Pauli principle, anti-symmetrization. Variational principle with application to He, H-. Approximate treatment of more than two electrons – independent particle picture + perturbation treatment of e-e repulsion.
iv. Fine structure (spin-orbit coupling), hyperfine structure (nuclear spin and shape effects).
v. External perturbations: Zeeman and Stark effects.
vi. Transition probabilities: Selection rules, Fermi's golden rule.

Part 2: Molecules (~30%)

i. Born-Oppenheimer separation: Variational treatment of H2+. Molecular orbitals and qualitative treatment of H2 and first-row two diatomic molecules. Van der Waals forces.
ii. Vibration and rotation of diatomic molecules. Separation of variables, harmonic vibration and simple rotation. Anharmonic effects. Morse potential. Interpretation of molecular spectra, deduction of molecular constants. Selection rules, (nuclear) spin statistics. Thermal effects.

Consideration for Illness, etc.

If you request academic consideration due to illness of a physical, psychological or emotional nature, or due to compassionate reasons, you may be required to provide suitable documentation (e.g., a medical certificate from a physician) at the discretion of the lecturer. See the Undergraduate Calendar for details.

Getting Help:

No fixed office hours set at this time, however, should it become necessary, I will inform you of these hours in class or via the course D2L site. You're encouraged to drop by my office anytime during the day to look for help or make an appointment to see me.

Collaboration versus Copying

Students are encouraged to discuss with each other during working on the problem assignments. However, the work that you submit as your assignment must not be a copy of someone else's work. Identical scripts will be given a mark of zero and plagiarism will be dealt with severely. Proper citations should be provided when books and other articles are used in your works.

Course Assessment

The Department of Physics requires student assessment of all courses taught by the Department. These assessments provide essential feedback to faculty on their teaching by identifying both strength and possible areas of improvement. In addition, annual student assessment of teaching provides part of the information used by the Department Tenure and Promotion Committee in evaluating the faculty member’s contribution in the area of teaching. The Department’s teaching evaluation questionnaire invites student response both through numerically quantifiable data, and written student comments. In conformity with University of Guelph Faculty Policy, the Department Tenure and Promotion Committee only considers comments signed by students (choosing “I agree” in question 14). Your instructor will see all signed and unsigned comments after final grades are submitted. Written student comments may also be used in support of a nomination for internal and external teaching awards.