01.07.2019

Bar-Ilan University

Atomic Physics

86-755-01

Lecturer: Prof. Lev Khaykovich

Course type: Lecture + Practice

Date: 2019-2020 **semester:** A **weekly hours:** 3L + 1P

Aim of the course:

In this course we apply the quantum mechanical methods to describe the internal structure of atoms and their interactions with external static and dynamic fields. We consider classical experiments which triggered the remarkable developments of theory to describe the full complexity of the internal degrees of freedom of atoms. Thanks to these ideas, atomic physics ultimately emerged as a frontier disciple for precision measurements of the fundamental constants of nature and different standards such as frequency, time, voltage etc…

Details of subjects to be covered:

1. One-electron atom (hydrogen and hydrogen-like systems). Eigenstates and eigenvalues of the Schrödinger equation with Coulomb potential.
2. Relativistic corrections and the fine structure of hydrogen atom.
3. Effect of nucleus: hyperfine structure of one-electron atom.
4. More on nucleus: finite volume effect and higher-order corrections.
5. Interaction of an atom with external electric and magnetic fields (Zeeman and Starck effects).
6. Two-electron atoms (Helium and helium-like systems): the role of exchange interaction.
7. Basic principles of many-electron atom. Hartree-Fock method and Thomas-Fermi model.
8. L-S and J-J schemes.
9. Interaction of the two-level atom with the black-body radiation. Selection rules.
10. Interaction of the two-level atom with the monochromatic electromagnetic field. Optical Bloch equations. Atomic clock and the precision measurement of time.

Prerequisites:

Requirements: elementary course on quantum mechanics.

Grading:

Homework (40%); Final exam (60%).

Bibliography:

1. "Physics of atoms and molecules", B. H. Brandsen and C. H. Joachain, second edition (Prentice Hall) 2003.
2. "Atomic physics", C. J. Foot (Oxford University Press) 2005.