SPH 326: Applied Atomic & Nuclear Physics

Instructor

Dr Angeyo H. Kalambuka

Course Summary

The atom and its nucleus. Models of material structure. Schrödinger wave theory for atomic structure. Hydrogen and helium. Multi-electron atoms. Quantum theory of radiation. Atomic spectra. Fine-and hyperfine structure. Stimulated emission. Transition rates. Magnetic field effects on atoms: The Raman, Zeeman and Stark effects. Selection rules. Radioactivity. Alpha, beta and gamma emission. Interactions of radiation with matter. Detection of nuclear radiation and reaction products. Nuclear models and forces. Nucleon-nucleon interactions. Energy level spectra. Spectral line shapes. Introduction to high resolution spectroscopy. Experimental methods in nuclear physics. Applications of nuclear physics in medicine and industry (e.g. nuclear medicine, trace element analysis).

Outcome

The course aims to provide students with a unified and concrete foundation of atomic and nuclear structure and spectra and a fundamental knowledge of nuclear physics that not only increases their understanding of the physical principles but also demonstrates how various applications can benefit from knowledge in this field. The course prepares students for analytical work (spectrometry, radiometry, imaging) in a variety of fields using atomic and nuclear, and radiometric instrumentation.

Course Description

The course is devoted to the main experimental and theoretical results in atomic and subatomic physics, which were achieved in the 20-th century. The course gives a basic knowledge about the a) atomic configuration and atomic spectroscopy including fine structure in atomic spectra; b) basic concepts of nuclear physics including properties; c) atoms in magnetic and electric fields; d) many-electron atom; and e) nuclear spectroscopy. The applications of quantum mechanics to the atoms and nuclei are discussed.

Reference Texts

1. *The Atomic Nucleus* by Evans, Robley D., McGraw-Hill, 1982
2. *Introductory Nuclear Physics* by K. Krane, J., Wiley & Sons, 1988
3. *Introductory Nuclear Physics* by Wong, S.M., 2nd Edn., J. Wiley& Sons, 1998.
4. *The Physics of Atoms and Quanta*, by Haken H. and Wolf, H.C., 7th Ed, Springer,
5. *Modern Atomic and Nuclear Physics*, by Yang, F. and Hamilton, J.H., McGraw-Hill, 2000.
6. *Physics of Atoms and Molecules* by Brandsen, B.H. and Joachain, C.J., Pearson, 2003.

Prerequisites

1. Quantum Mechanics
2. Introduction to Modern Physics

Course Structure

Strength	35 hours
CATS	2 (out of 15 marks). In week 7 and week 11
Tutorials	2 (out of 15 marks). In week 4 and week 8
Examination	1 (out of 70 marks): At the end of the semester