SPH 620: Advanced Nuclear Physics

(Instructor: Dr Angeyo H. Kalambuka)

Course Description

The nucleus is the center of the atom and contains all the positive charge and almost all the atomic mass. This course deals with the properties and structure of the nucleus, sub-atomic particles and their interactions, nuclear reactions and elementary particle physics. The course lays out the foundation that allows students to interpret the observations obtained in experiments at the forefront of nuclear structure research. Students will be introduced to fundamental and advanced models of nuclear structure that are used to describe various modes of nuclear excitation. The course will also give an overview over the most important types of nuclear reactions, introduce reaction models, and discuss how reactions can be used to study specific nuclear structure phenomena.

Course Objectives

At the end of the course students should be able to:

- Describe the structure of the nucleus and the nature of nuclear forces.
- Explain the interactions of nucleons and other subatomic particles with nuclear matter.
- Use nuclear models to explain nuclear properties, stabilities and nuclear reactions.
- Discuss nuclear models in relation to stability of atoms.
- Determine conservation of physical quantities.
- Give the properties and classify elementary particles.
- Use elementary particle physics in nuclear analysis.

Course Content

Review of fundamentals of nuclear physics-the nuclear atom (Rutherford's model and the Bohr's modifications). Nuclear structure & models; nuclear stability; nuclear moment, parity and statistics. Nuclear reactions (scattering, collisions) - conservation of physical quantities, Q-value determination, cross-sections, the Breit–Wigner formula. Excited states of nuclei-nuclear decays (alpha, beta and gamma) and spontaneous fission. Elementary particle physics.

Course Assessment

The course consists of one final examination graded out of 70 % and two tutorial assessments (the first in week 4 and the second in week 8) and two tests (the first in week 7 and the second in week 12) all which carry equal weight i.e. 30 % to be averaged out among the four assessments.

Recommended Text Books

1 Introductory Nuclear Physics by K.S. Krane
2 Nuclear Physics: Principles and Applications by John Lilley
3 Nuclear and Particles by E. Segre
4 Nuclear Reactions and Nuclear Structure by P. E. Hodgson

Prerequisites: Undergraduate (i) Atomic Physics (ii) Nuclear Physics (3) Quantum Mechanics