Ministry of Higher Education and Scientific Research

Salahaddin University-Erbil
College of Education
Department of Physics
(Course book) 4th stage
Subject: Nuclear Physics
Academic year: 2022-2023

Instructor Information:

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Lectures:

Tuesday, from 08:30 - 10:30 Am. in Hall 10

General:

Nuclear Physics is under graduate course on nuclear Physics

Course description:

The main topics of this course are nuclear properties, nuclear radiation, nuclear radioactivity, nuclear reaction, and nuclear fission and fusion.

Course Coordinator:

The coordinator of this course is the nuclear physics

Course Objectives and expected outcomes:

The objective of this course study the nuclear physics and nuclear radiation detection. It is not to be a complete survey of either field, but will instead cover selected topics and methods. The format will be lecture-based, with some homework and practice in reading, evaluating and writing scientific papers, and emphasis on design of precision measurements and null tests.

The Syllabus of Nuclear Physics

First semester

Chapter One: Basic Nuclear Concepts

1-1 Introduction
1-2 Discovery of electron (J. J. Thomson' s Atomic Model; The Plum –Pudding Model)
1-3 Discovery of Nucleus
1-4 Discovery of Neutron
1-5 Nuclear Composition
1-6 Basic properties of nuclei
1-7 Charge and Matter Distribution in Nuclei

1-8 Nomenclature

1-9 Parity

Chapter Two: Nuclear Structure

2-1 Units of energy and mass in atomic scale

2-2 Nuclear Binding Energy

2-3 Separation Energy

2-4 Average Binding Energy $B.E_{av}(A,Z)$

2-5 Nuclear Stability

2-6 Nuclear Force

Chapter Three: Nuclear Models

3-1) The Liquid Drop Model, Semi empirical Mass Formula (Binding Energy Formula)

3- 2) Shell Model.

Chapter Four: Radioactivity and Radioactivity Laws

4-1) Introduction (Radiation and Radioactive decay)

4-2) Radioactivity Decay Law

4-3-a) Units of Activity

4-3-b) Half-life ($t_{½}$)

4-3-c) Mean life –time (τ);

4-4) Production of a radio-isotope

4-5) Radioactivity Equilibrium

4-6) Radioactive decay Series

Second semester

Chapter Five: Alpha, Beta and Gamma Decay

5.1. Gamma Decay

5.1.1 Energetic of Gamma Ray

5.1.2 Interaction of Gamma Rays with Matter

5.1.3 Decay constant of Gamma Decay

5.1.4 Selection Rules for Gamma Decay

5.2 Alpha Decay

5-2.1 Energetics of Alpha Decay

5.2.2 Theory of Alpha Decay

5.2.3 Range of Alpha Particle

5-2.4 Interaction of Charged Particle with Matter

5.3 Beta Decay

5.2.1 Violation of Conservation Laws in Beta Decays

5.3.2 Neutrino Hypothesis;

5.3.3 Energetics of Beta- Decay

5-3.4 Electron Capture Decay

5.3.4 How Beta Decay Occurs

Chapter Six: Nuclear Reactions

6.1. Introduction

6.2. Theory of Nuclear Reaction

6.3. The Q-value of the nuclear reaction

6.4 Threshold Energy of Nuclear Reaction

6.5. Cross Section of Nuclear Reaction (σ)

Chapter Seven: Nuclear Fission and Fusion

7.1. Nuclear Fission

7.2 Products of Fission reaction

7.3. Theory of Fission

7.4 Distributions of Fission Fragment Masses

7.5 Energy Release in Fission

7.6 The Energy distribution After fission of $^{235}_{92}U$

7.7 Breeding Reactions

7.8 Fission Chain Reaction

7.9 Nuclear weapon design:

7.10 Nuclear Fusion

7.11 Cosmic Rays

Chapter Eight: Nuclear Reactor

8.1 Introduction:

8.2 Components of nuclear reactors

8.3 A Simple Reactor Design:

8.4 Control of Power Level

References:

- Elements of Nuclear Physics Walter E. Meyerhof.
- Concepts of Modern Physics Arthur Beiser.
- Modern Physics (Third Edition) Raymond A. Serway
- Schum's Outline of Modern Physics