Ministry of Higher Education and Scientific Research

Salahaddin University-Erbil

College of Education

Department of Physics

(Course book) Master of Science

Subject: Practical Gamma-ray Spectrometry

Academic year: 2023-2024

Instructor Information:

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Lectures:

Monday: 12:30 – 3:30 Pm in Hall 10

General:

Practical Gamma-ray Spectrometry is a course for a graduate (M.Sc.) in Nuclear Physics.

Course Description:

The main topics of this course are nuclear radioactivity, nuclear decay, nuclear radiation detections and gamma-ray spectrometry.

Course Coordinator:

The coordinator of this course is the nuclear radiation physics

Course Objectives and expected outcomes:

The objective of this course study nuclear radioactivity 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 the design of precision measurements and null tests.

The Syllabus of Nuclear radiation detection

Chapter One: Radioactivity and Radioactivity decays

1.1 Introduction (Radiation and Radioactive decay)
- 1.1.1 Radioactivity Decay Law
- 1.1.2 Production of a radio-isotope
- 1.1.3 Radioactivity Equilibrium
- 1.1.4 Radioactive decay Series

1.2 Alpha Decay
- 1.2.1 Energetics of Alpha Decay
- 1.2.2 Range of Alpha Particle
- 1.2.3 Interaction of Charged Particle with Matter

1.3 Beta Decay
- 1.3.1 Energetics of Beta - Decay
- 1.3.2 Electron Capture Decay

1.4 Gamma Decay
- 1.4.1 Energetic of Gamma Ray
- 1.4.2 Interaction of Gamma Rays with Matter.

Chapter Two: **Nuclear Radiation Detector**

2.1 Gas-filled detectors
- 1.2.1 Ionization chambers
- 1.2.2 Proportional counters
- 1.2.3 Geiger-Müller counters

2.2 Scintillation detectors NaI(Tl) crystals

2.3 Semiconductor detectors
- 2.3.1 High-purity germanium (HPGe)
- 2.3.2 Lithium-drifted silicon (Si(Li))
- 2.3.3 Lithium-drifted germanium (Ge(Li))
- 2.3.4 Radon detectors RAD7 radon detector

Chapter Three: Electronic components for Gamma-Ray Spectrometry

3.1 Introduction

3.2 Pulse shapes in gamma spectrometry systems.

3.3 Detector power supply.

3.4 Preamplifiers.

3.5 Amplifiers and pulse processors.

3.6 Multichannel analyzers and their analogue-to-digital converters.

3.7 Detector Cool Down.

Chapter Four: **Counting Systems and Spectrum Analysis**

4.1 Counting

4.2 Spectrum Analysis.
- 4.2.1 Peak location (Energy Range).
- 4.2.2 Peak Measurement
- 4.2.3 Photo peaks.
- 4.2.4 Compton edge peak.
- 4.2.5 Annihilation peak.
- 4.2.6 Sum peak
- 4.2.7 Escape peak
- 4.2.8 Backscatter peak
- 4.2.9 Sum peak

References:

❖ Elements of Nuclear Physics Walter E. Meyerhof.
❖ Concepts of Modern Physics Arthur Beiser.
❖ Practical Gamma-ray Spectrometry G. Gilmore and John D. Hemingway
❖ Nuclear Radiation, Detectors and Experiments K. Mahesh and S. M. Mustafa