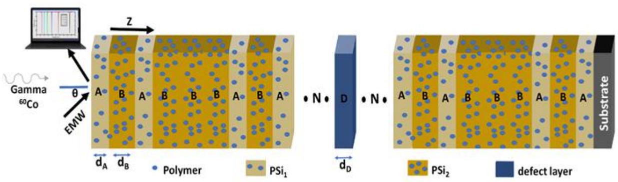
Project: Periodic Superlattices for Radiation Detection

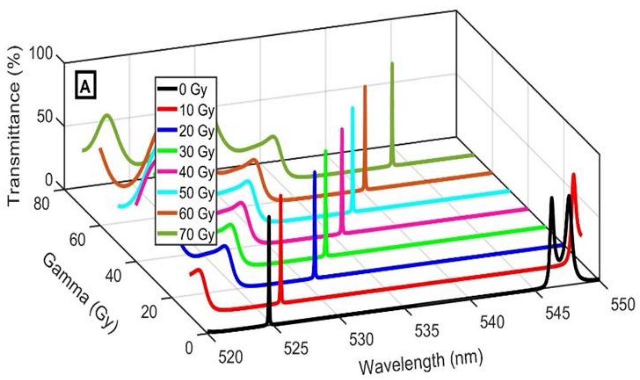
1. Introduction

Gamma rays are high-energy ionizing electromagnetic radiation because they can ionize the materials they pass through. Ionizing electromagnetic radiations alter materials' properties and/or composition through interaction. Ionizing radiations are employed extensively in numerous environmental and medical applications, and they have gained more attention recently [3-5]. The measurement of patients' dosages of radiation caused by medical diagnostics continues to be a challenge. Besides, Neutrons are an excellent tool for demonstrating and investigating the physical properties of layers and massive particles. Neutron optics is one of the physical branches concerned with the nature and applications of neutron wave behavior. Diffraction of neutrons has long been investigated from the standpoint of demonstrating the wave behavior of neutrons and testing the predictions of stationary quantum mechanics. Polarized neutron reflectometry (PNR) is a new and powerful analytical tool that can be used in widespread applications such as analyzing the composition of different structures with incredibly high resolution and quality.

2. Description

This project aims to design different superlattices comprising dielectric, polymers, ferromagnetic, superconductor and/or paramagnetic layers for achieving new developments in neutron filters, radiation detection, enhancing the neutron signal and/or hazardous greenhouse gas sensing field. The suggested devices can filter out a specific neutron wavelength from the reflected broad spectrum. Polarized neutron reflectometry (PNR), Transfer matrix method (TMM) will be used to study the response of proposed periodic structures to different radiation using MATLAB software. These findings will hold potential in the nuclear fields, including neutron waveguides, filters, sensing, and shielding.





Gamma Radiation Detector *(Zaky, A. Z., et al, International Journal of Modern Physics B, 2450409, 2024)*

3. Practice plan

The practice is nominally divided into the following parts. However, final works layout and amount is defined by the students' level.

1. Introduction to periodic and quasiperiodic structures and their effect on incident waves.

2. Designing various detector devices and structures.

3. Building MATLAB codes.

4. Writing the Report.

4. Prerequisites

- Basics of mathematical analysis.
- Basics of physics: Optics – Photonics - Radiation.
- Basics of computer knowledge: MS Windows, MS Office, **MATLAB**.

5. Recommended number of participants

Up to 2 persons.

6. Supervisor

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- Lecturer at Physics Department, Faculty of Science, Beni-Suef University, Egypt.
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7. Recommended literature

[1] Zaky, A. Z., et al., *Gamma Radiation Detector Using Cantor Quasi-Periodic Photonic Crystal Based on Porous Silicon Doped with Polymer*. International Journal of Modern Physics B, xx, 2450409 (2024), https://doi.org/10.1142/S0217979224504095

[2] Zaky, A. Z., et al., *Studying the Impact of Interface Roughness on a Layered Photonic Crystal as a sensor*. Physica Scripta, 98, 105527 (2023), https://doi.org/10.1088/1402-4896/acfa4a

[3] Zaky, A. Z., et al., *Effect of Geometrical and Physical Properties of Cantor Structure for Gas Sensing Applications*. Synthetic Metals 291, 117167 (2022), https://doi.org/10.1016/j.synthmet.2022.117167