



جامعة الملك فهد للبترول والمعادن
King Fahd University of Petroleum & Minerals

Monte Carlo Simulation of Radiation Transport

PHYS373 Presentation

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Outline

1 Introduction

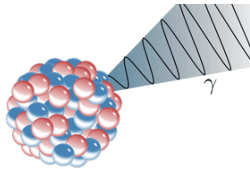
2 My Simulation

3 Results

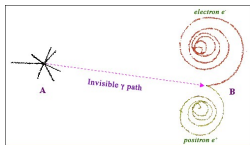
4 Conclusion

Introduction

Radiation Transport of Gamma Rays

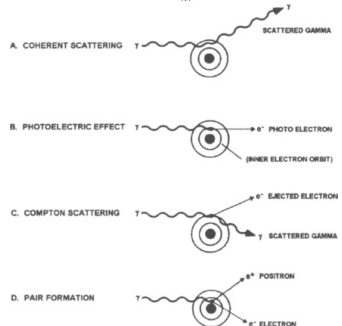
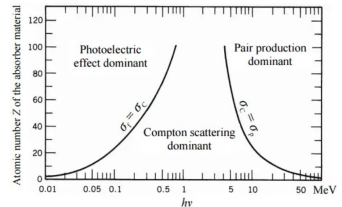


- High-energy photons emitted by radioactive nuclei.
- γ -ray transport refers to the process by which γ -rays propagate through a medium and interact with the atoms and molecules in the medium.
- Radiation transport models are used in various fields, such as nuclear physics, astrophysics, and medical imaging.



Gamma Ray Interactions

- γ -rays interacts with matter via several mechanisms:
 - Photoelectric effect
 - Compton scattering
 - Pair production
- The probability of each type of interaction depends on the energy of the gamma ray and the composition of the material.



Monte Carlo Simulation

Definition

Monte Carlo is a computational technique that involves the usage of random numbers to simulate complex processes.

Main random ingredients:

- Distance to next interaction s
- Scattering angles θ & ϕ

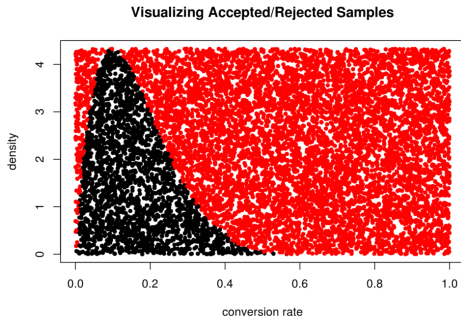
$$s \text{ follows : } p(s)ds = \frac{1}{\lambda} 2e^{-s/\lambda} ds$$

$$\theta \text{ follows : } p(\theta)d\theta = \frac{d\sigma_{KN}}{d\Omega} 2\pi \sin \theta d\theta$$

Acceptance / Rejection Method

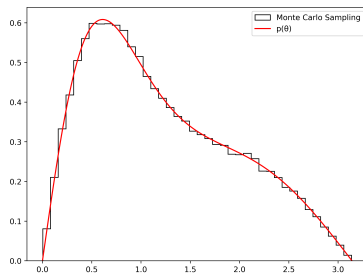
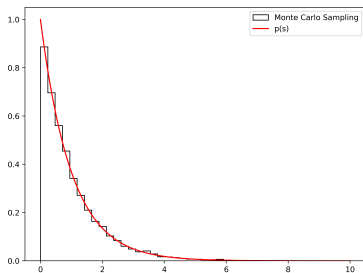
We propose a distribution,
 $U(x)$, to find the
distribution $p(x)$.

- 1 Sample x_i, y_i
according to $U(x)$.
- 2 Check $y_i \leq p(x_i)$.
- 3 If $y_i \leq p(x_i) = \text{True}$
 \implies Accept,
otherwise reject and
go to 1.



My Simulation

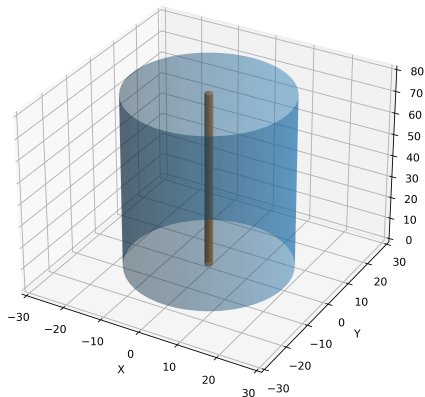
$$p(s) \ \& \ p(\theta)$$



My Monte Carlo Accept / Reject method results

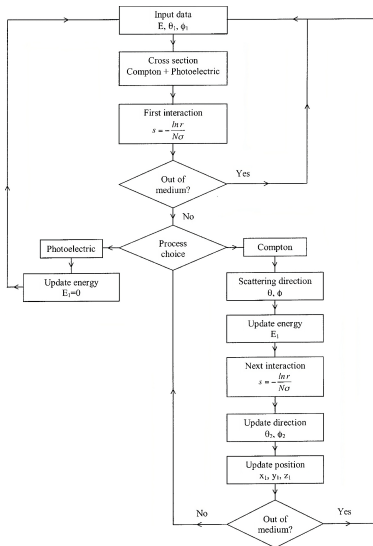
The Setup

3D plot of setup



$$E = 1.00 \text{ MeV}; \quad N = 2000$$

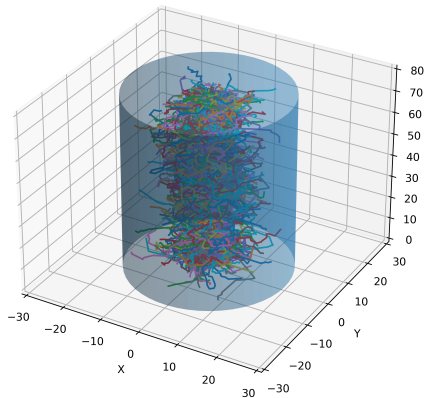
Flowchart



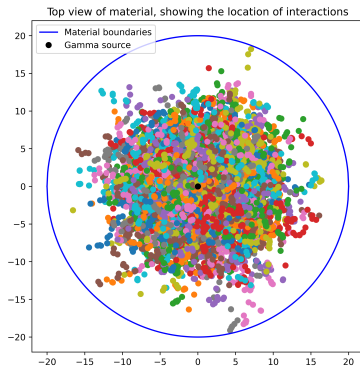
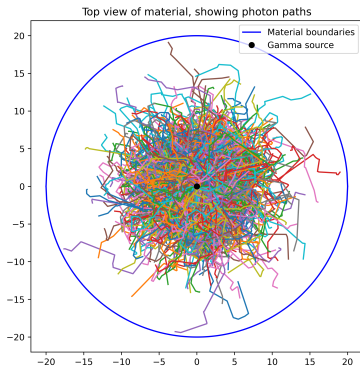
Results

3D Visualization

3D plot of photon paths

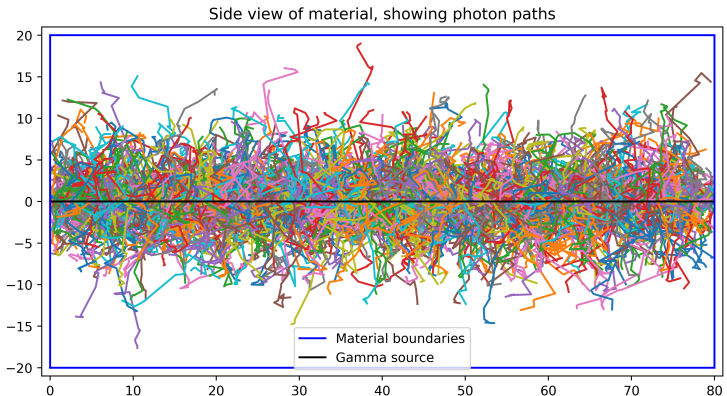


Results



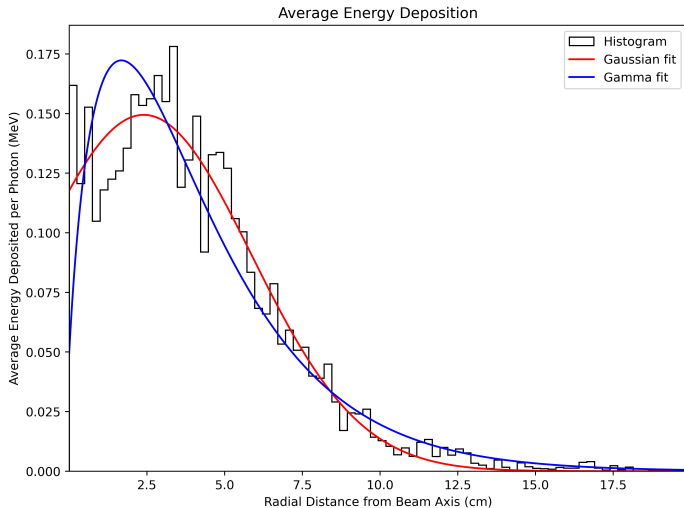
Top view

Results

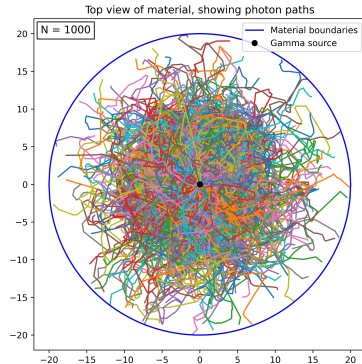
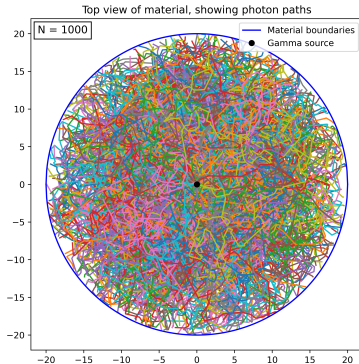


Side view

Results

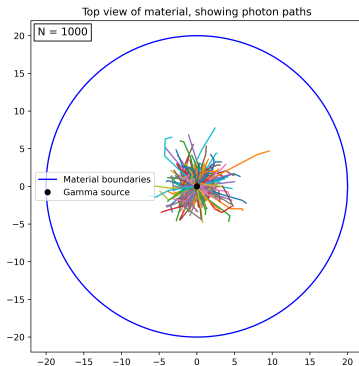


Qualitative Analysis

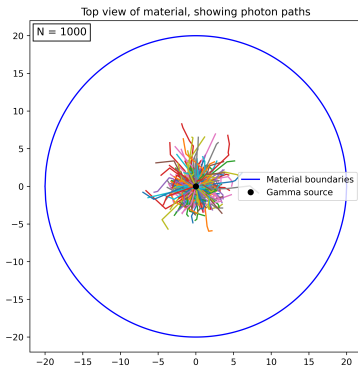


Hydrogen and Lithium

Qualitative Analysis



Lead and Osmium



Conclusion

- Monte Carlo methods are a powerful and flexible tool for simulating gamma radiation transport.
- They allow for accurate modeling of complex geometries, materials, and sources.
- Monte Carlo simulations can be used to optimize radiation shielding designs and evaluate the performance of radiation detectors.

Thank you!
Questions?