



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

Monte Carlo Simulation of Radiation Transport

PHYS373 Presentation

Ibraheem F. Al-Yousef
Department of Physics, KFUPM

Outline

1 Introduction

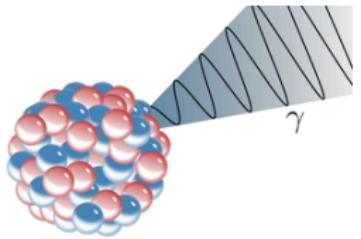
2 My Simulation

3 Results

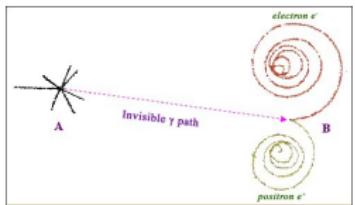
4 Conclusion

Introduction

Radiation Transport of Gamma Rays

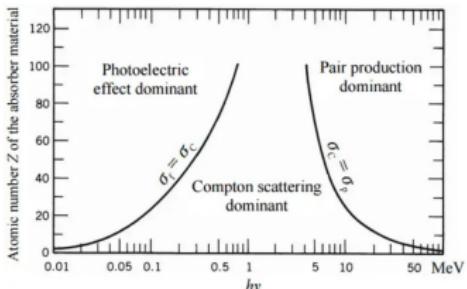


- High-energy photons emitted by radioactive nuclei.
 - γ -ray transport refers to the process by which γ -rays propagate through a medium and interact with the atoms and molecules in the medium.
 - Radiation transport models are used in various fields, such as nuclear physics, astrophysics, and medical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



Gamma Ray Interactions

- γ -rays interact 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 $\theta \& \phi$

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

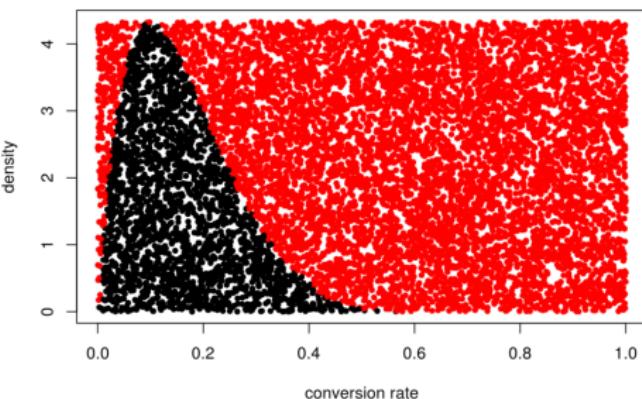
$$\theta \text{ follows : } p(\theta)d\theta = \frac{d\sigma_{KN}}{d\Omega} 2\pi \sin \theta d\theta$$

Acceptance / Rejection Method

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

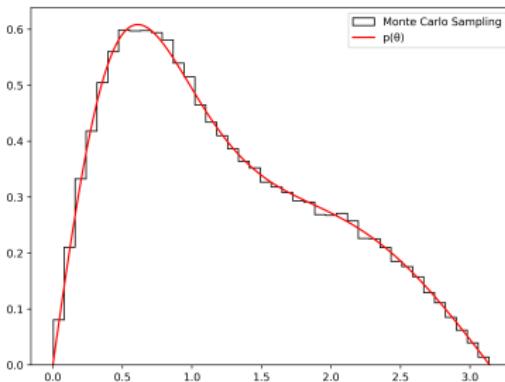
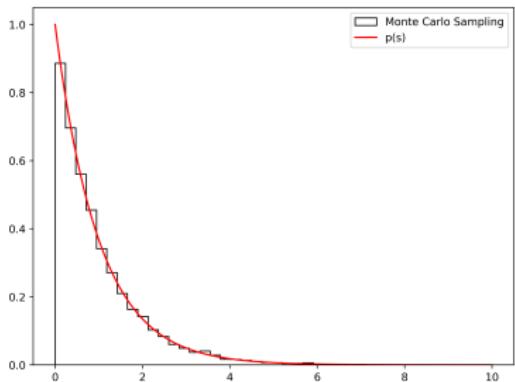
- 1 Sample x_i, y_i according to $U(x)$.
 - 2 Check $y_i \leq p(x_i)$.
 - 3 If $y_i \leq p(x_i) = \text{True}$
 \implies Accept,
otherwise reject and
go to 1.

Visualizing Accepted/Rejected Samples



My Simulation

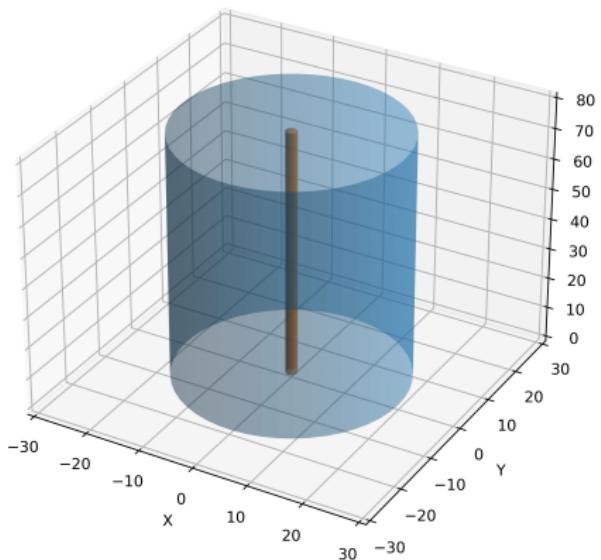
$p(s)$ & $p(\theta)$



My Monte Carlo Accept / Reject method results

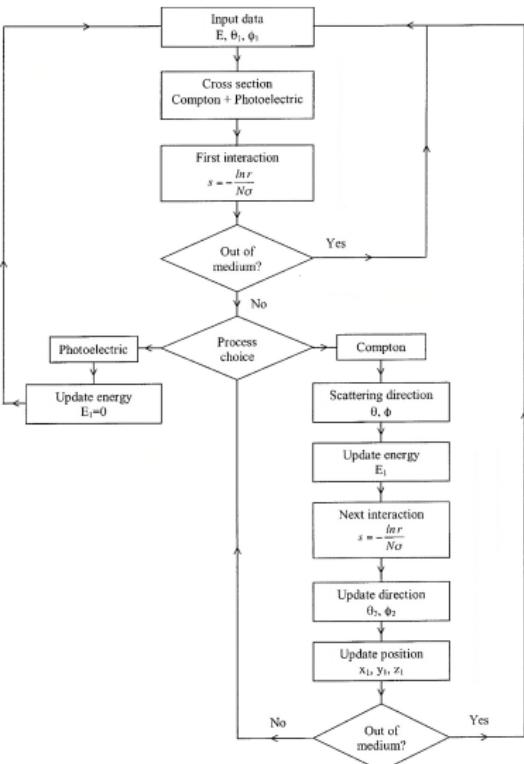
The Setup

3D plot of setup



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

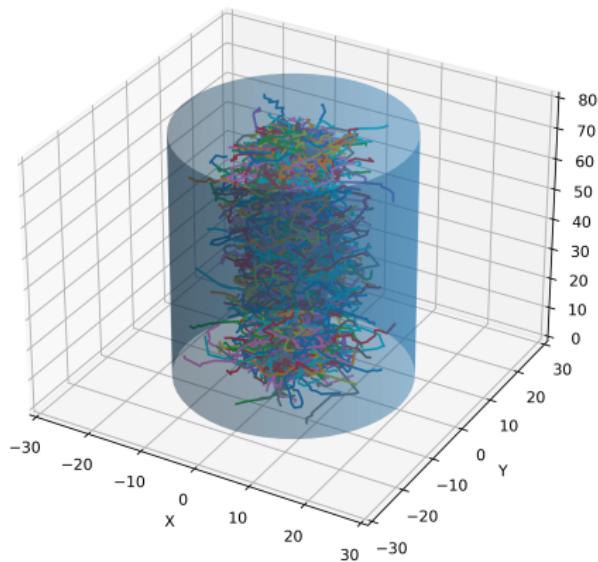
Flowchart



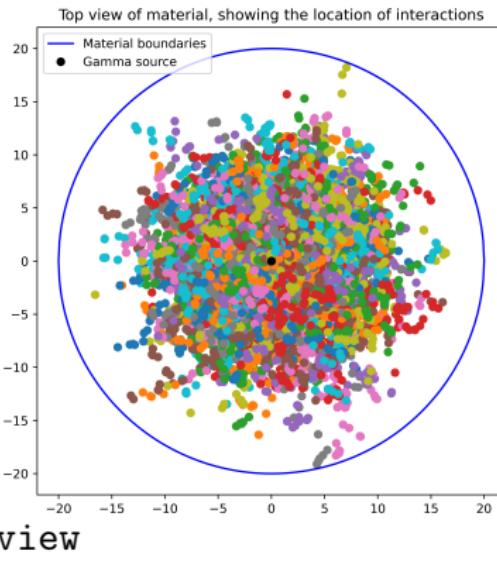
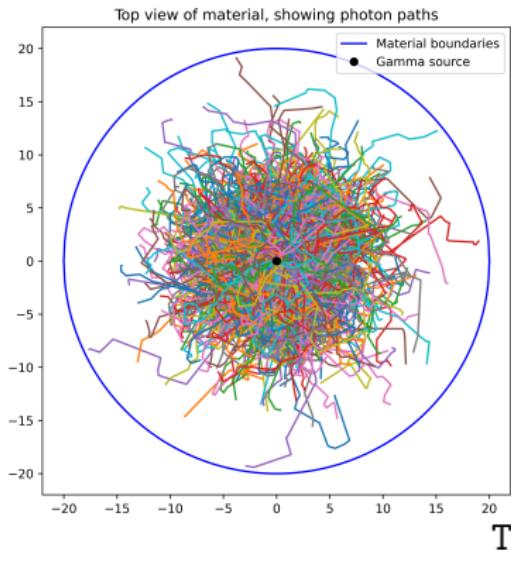
Results

3D Visualization

3D plot of photon paths

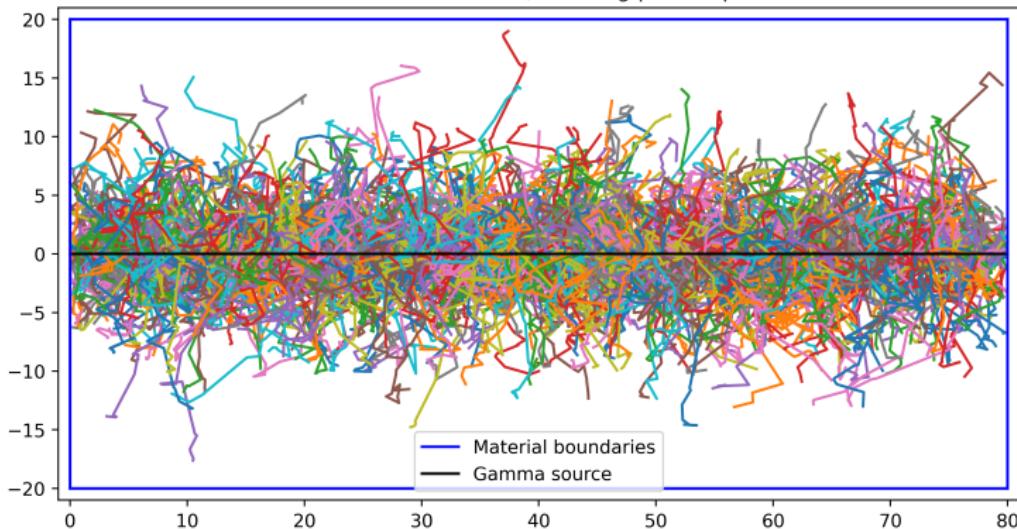


Results



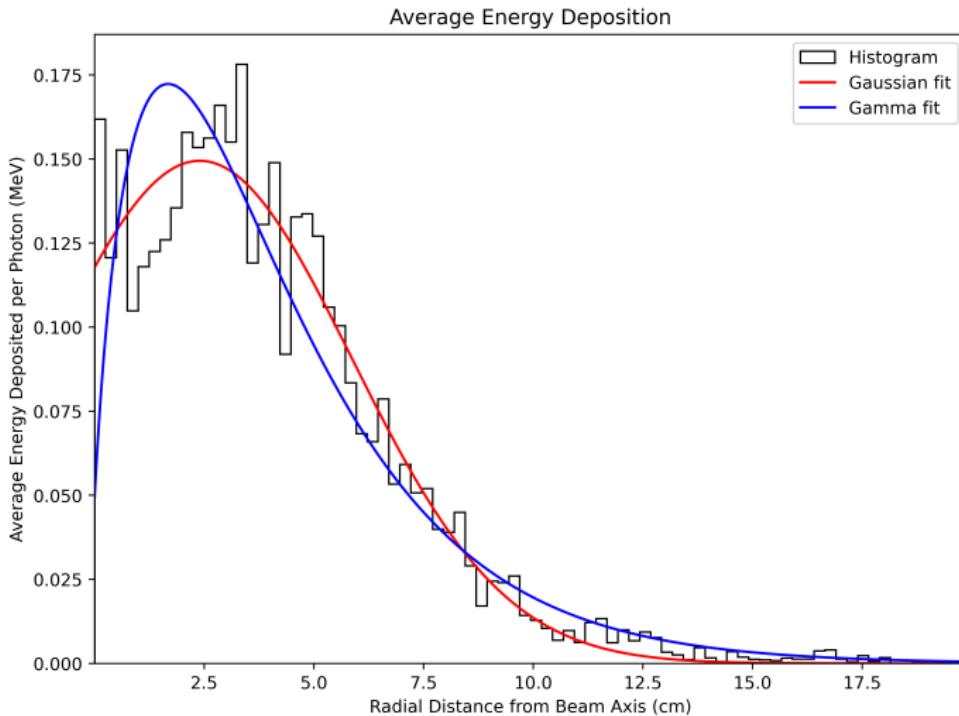
Results

Side view of material, showing photon paths

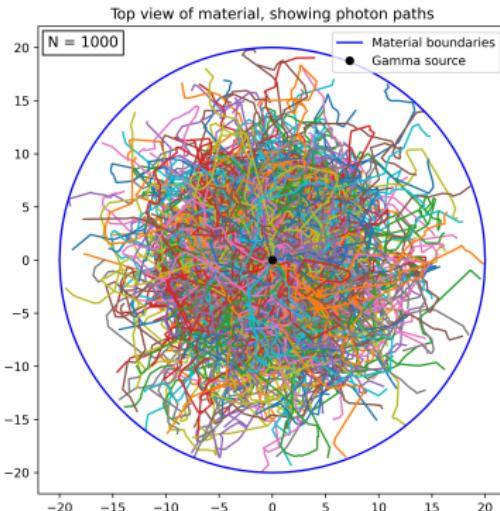
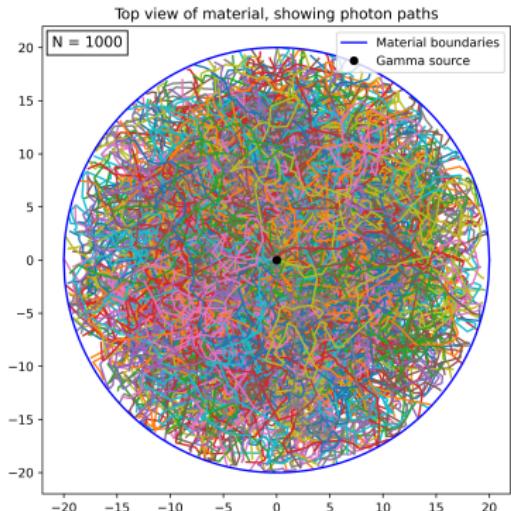


Side view

Results

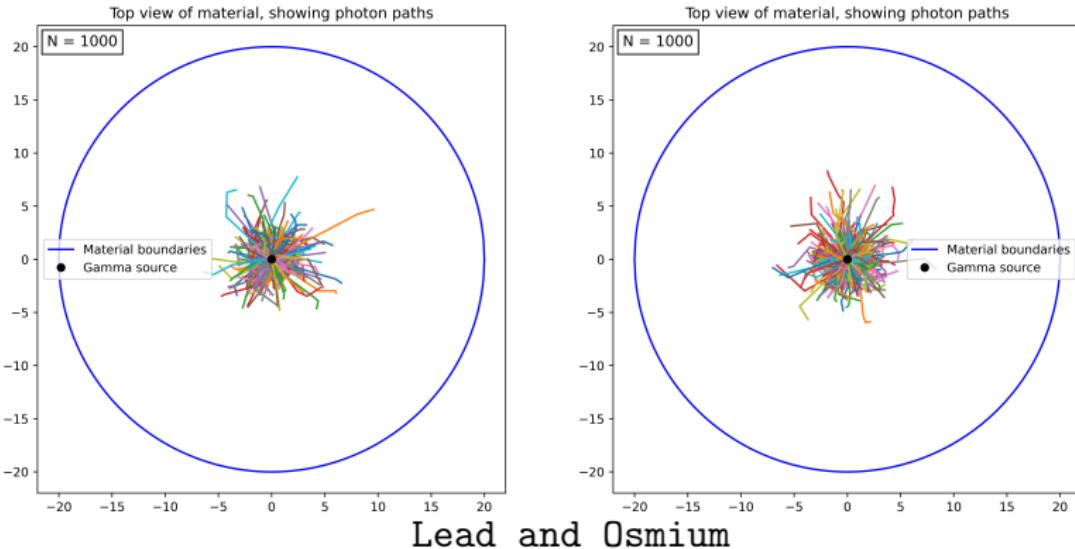


Qualitative Analysis



Hydrogen and Lithium

Qualitative Analysis



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?**