



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

Monte Carlo Simulation of Radiation Transport

PHYS499 Seminar

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Outline

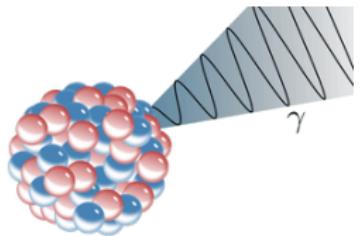
1 Introduction

2 Monte Carlo

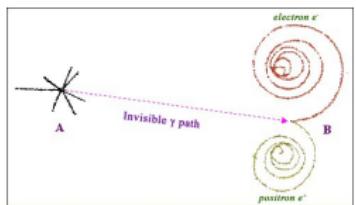
3 My Simulation

4 Conclusion

Radiation Transport of Gamma Rays

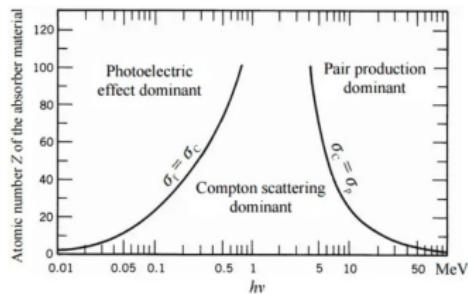


- High-energy photons emitted by radioactive nuclei.
- γ -ray transport refers to the process by which γ -rays propagate through a medium and interact with the atoms and molecules in the medium.
- The interaction of γ -rays with matter can result in absorption, scattering, and emission of secondary radiation.
- 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
- These interactions can lead to the absorption, scattering, or emission of gamma rays.
- 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 using random numbers to simulate complex processes.

Main random ingredients:

- Distance to next interaction s
- Scattering angles $\theta \& \phi$

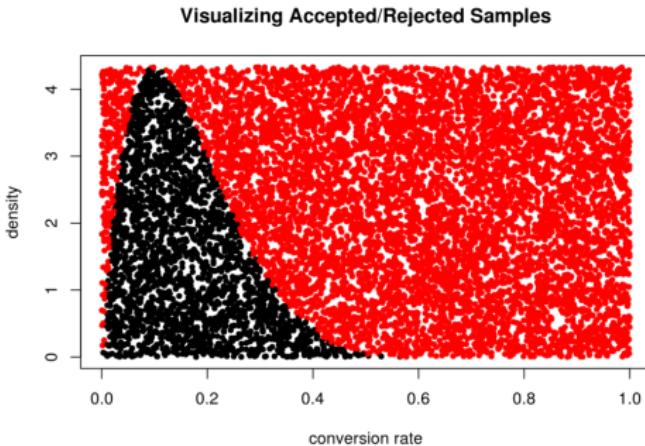
$$s \text{ follows : } p(s)ds = \frac{1}{\lambda} 2e^{-s/\lambda} ds$$

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

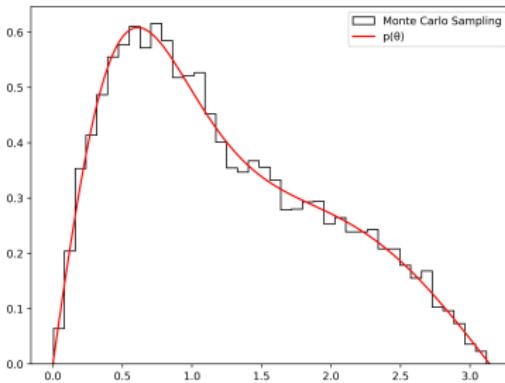
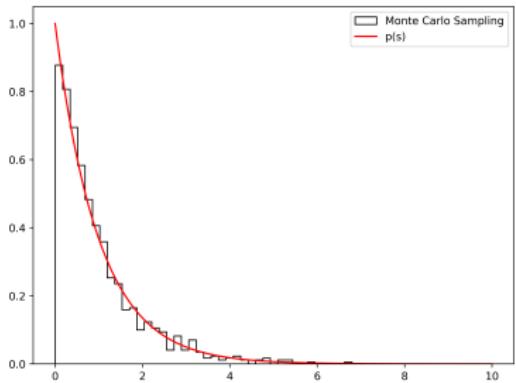
Acceptance / Rejection Method

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.

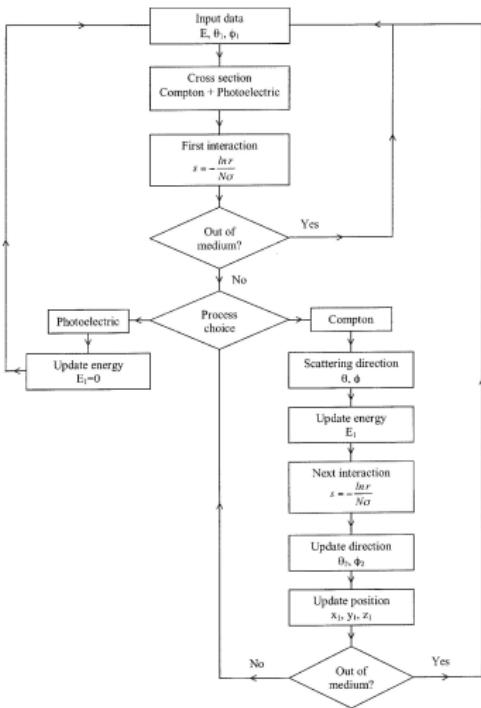


My Simulation

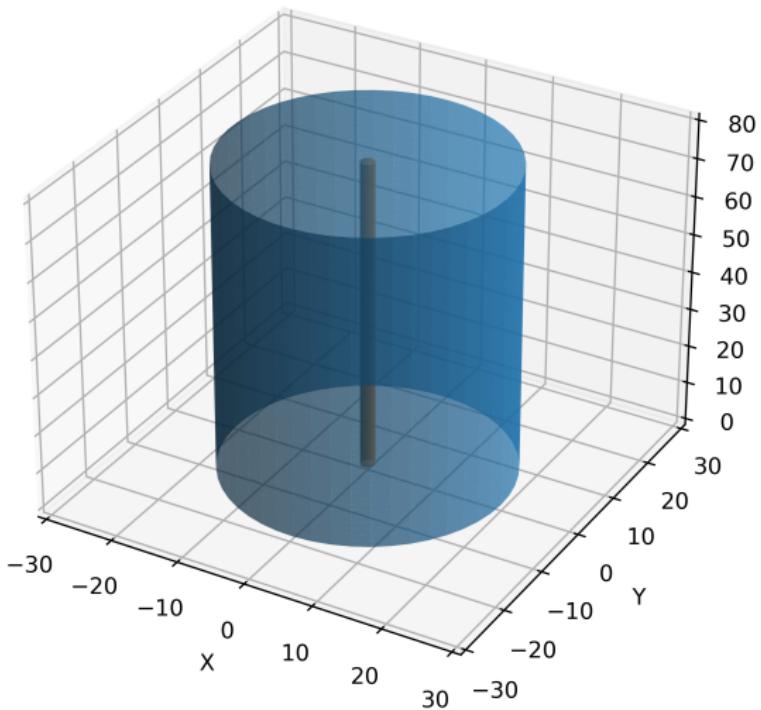


My Monte Carlo Accept / Reject method results

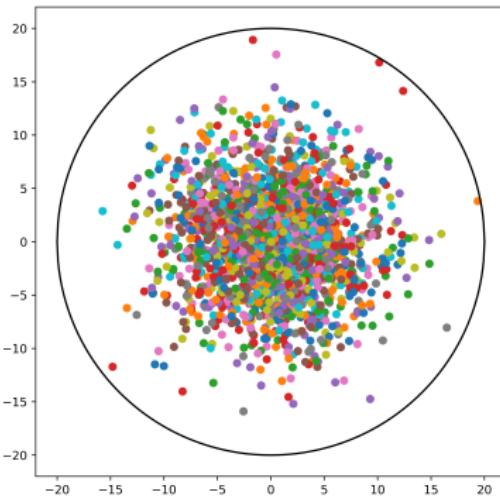
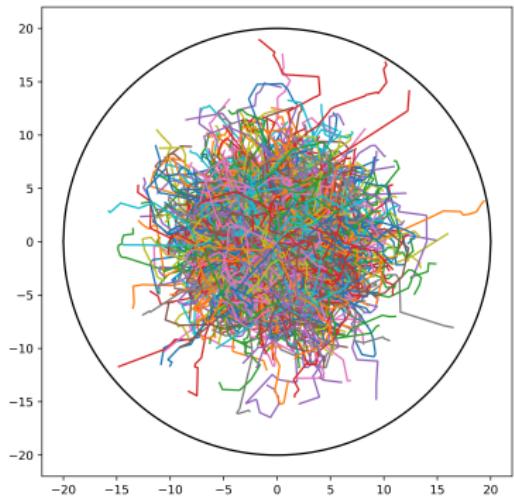
Flowchart



The Setup

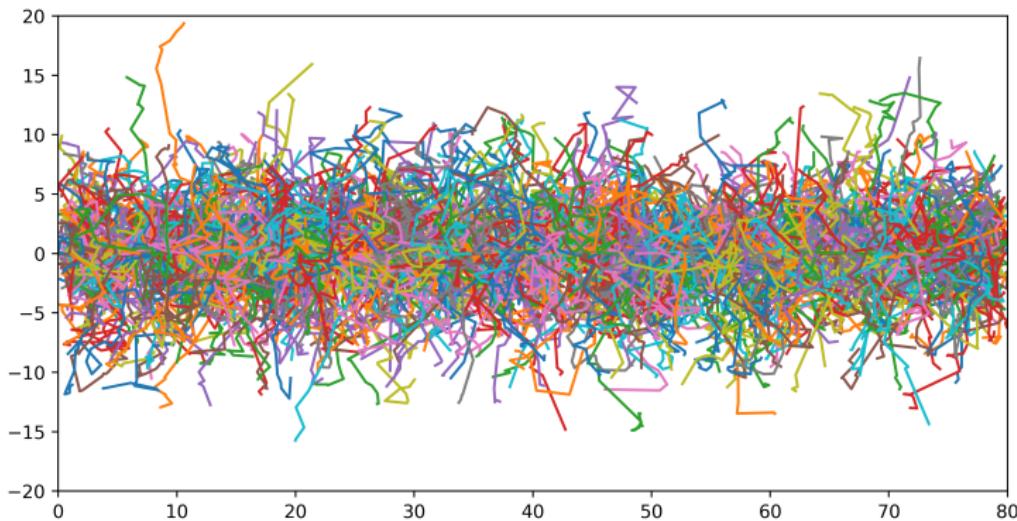


Results



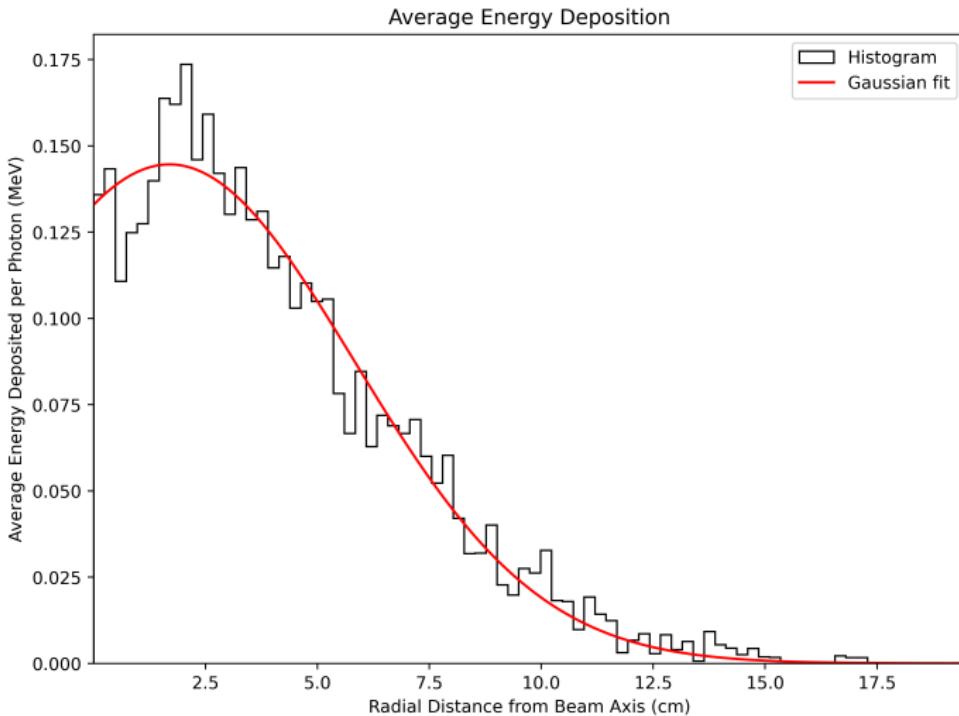
Top view

Results



Side view

Results



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?**