

ENGR 1213
Fall 2007
Project Overview

This project will focus on creating a piece of software that simulates a random path (random walk) for a particle traveling through a medium in two-dimensions (see Fig. 1). The particle can be described by its energy E and its velocity vector, \vec{v} . In this case the only reason to know the velocity vector is to know the direction. In our case all directions will be specified relative to the x axis (to the right in Fig. 1).

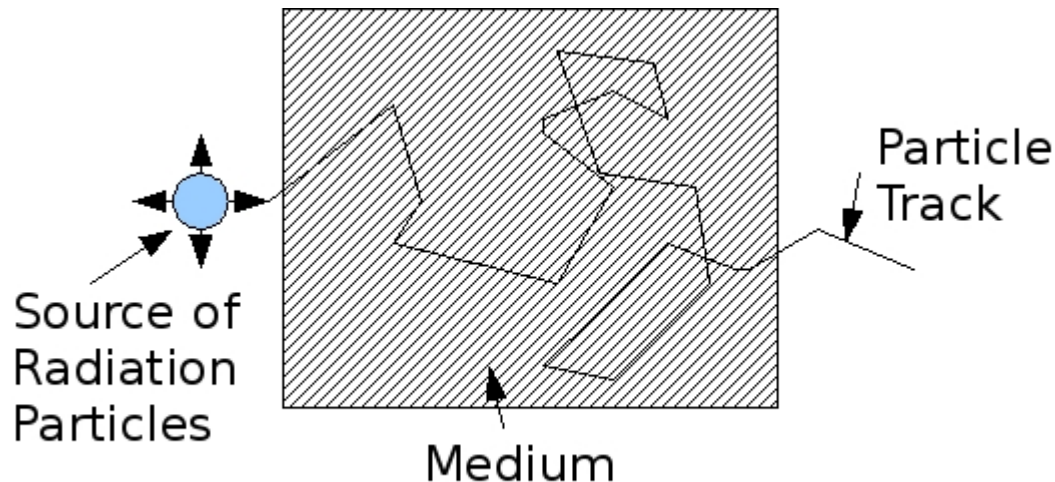


Figure 1

The way the simulation will work is to use random numbers to create possible tracks of particles through the medium.

Based on a random number, ξ , with a value between 0 and 1, the distance a particle travels, d , may be determined by:

$$d = \frac{-1}{\Sigma_t} \ln(\xi)$$

Equation 1

where Σ_t is the total macroscopic cross-section in units of cm^{-1} (this will be given to you). The particle loses some amount of energy per unit length along its path. The fractional energy it loses per unit length of path is:

$$f_E = \frac{dE}{ds}$$

Equation 2

where s is the distance measured along the path. In our case we will treat f_E as a constant, so the amount of energy lost (ΔE) along a length of path (Δs) is

$$\Delta E = f_E \Delta s$$

Equation 3

The source can emit a number of particles per unit time called the intensity I . Each particle has some probability of being emitted in a given direction, $p(\theta)$ as shown in Fig. 2.

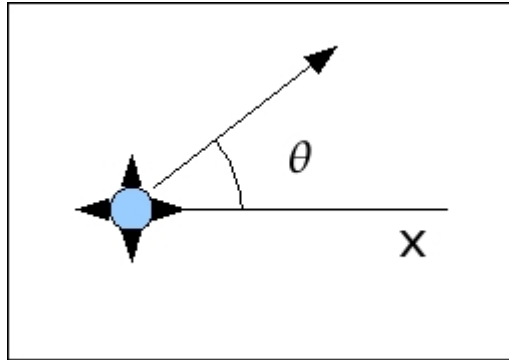


Figure 2:

The source may emit different energy particles so the probability of emitting a particle with energy E is $p(E)$.

When a particle comes to an interaction site (determined from Eq. 1) the particle must either be terminated and no longer tracked if the particle's energy has dropped below the threshold, or continued with a new energy and new direction. The new energy and new direction have to be determined from the scattering angle probability, $p_{\text{scatt}}(\theta)$ and the scattering energy loss decrement, κ

$$\kappa = -\ln\left(\frac{E_0}{E}\right)$$

Equation 4:

The right side of the geometry may be broken up into a number of bins as shown in Fig. 3. **3. The output of the program will be the fraction of total particles sampled that arrive in each bin, the energy distribution of the particles arriving in each bin, and the fraction of particles absorbed by the medium.**

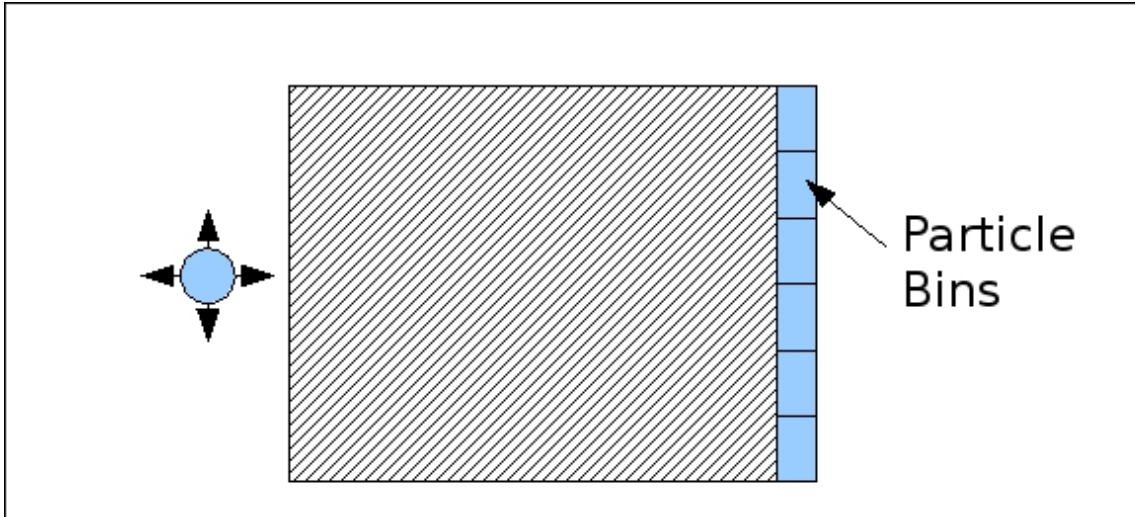


Figure 3:

In this project you will function individually and as a team. Individuals will submit individual programming projects to Dr. Lemley. The group as a whole, lead by the group leader, will pull all of the individual modules together to form one piece of software. The end result will be a working and fully documented piece of software. Group project presentations will take place on Monday December 3 and Wednesday December 5. To document the software and it's testing there will be a report submitted by the last day of class on December 7, 2007. To receive a grade each group must submit a functional program. The degree to which the program meets requirements will determine part of the grade for the project. There will be an individual project score (25% of class grade) for each student in the class and an overall project grade (20% of class grade).

The overall program can be broken into the following parts (**These are the Individual Projects for each Team**):

1. Input (must be from a file)
 - Geometry (slab thickness and height), medium properties (macroscopic absorption cross-section, scattering probabilities, and the scattering energy loss decrement), source energy distribution, source angular distribution, energy loss per unit length, desired grid size, energy threshold (energy below which particle is terminated), number of particles to sample.
2. Distribution Sampling
 - How to use random numbers to properly sample from given probability distributions.
3. Particle Tracking
 - Proper use of distribution sampling to move particles through medium.
4. Output (must be to a file)
 - Taking results of particle tracking to generate a report that details the deposition of energy in the medium, the statistics of the particles arriving in bins and their energies.

Each of these parts will have to be individually tested and documented. The individual project grades will be based on this performance. **An independent report along with**

source code and test data will have to be provided to Dr. Lemley no later than Monday Nov. 19.

ENGR 1213 Teams Fall 2007	
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