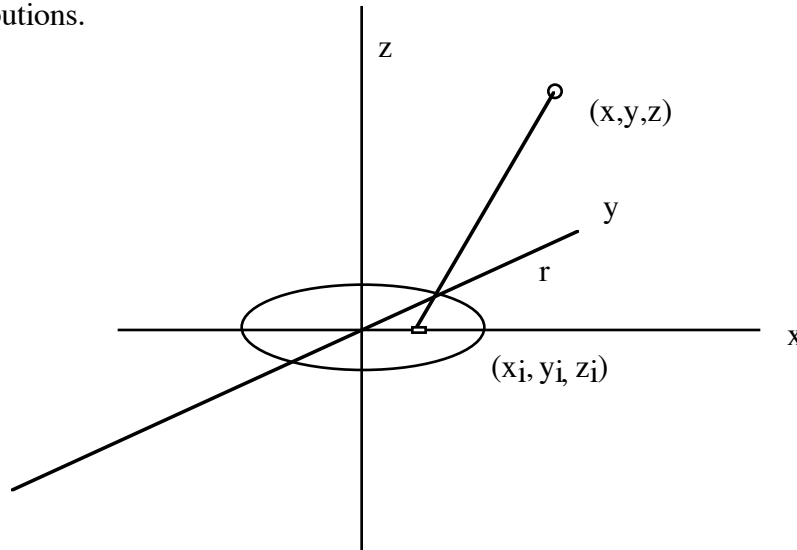


## Assignment 5: Simple Integration

A circular pool of a liquid contaminated with radioactive  $^{60}\text{Co}$  is on the ground. The disk has side radius of  $= 0.5$  m. The total quantity of activity present is  $2 \text{ Ci}$ , ( $1 \text{ Ci} = 3.7 \times 10^{10} \text{ dis/sec}$ ). Each disintegration gives off two (2) photons ( $1.33 \text{ MeV}$ ,  $1.17 \text{ MeV}$ ).

We are interested in writing a computer program that will compute the flux of photons at any arbitrary point  $(x, y, z)$ . We will approximate the pool as a 2-D grid of point sources and sum over all of the contributions.



### How to do it:

1. Divide the disk into  $N$  pieces in the  $x$  and  $y$  directions.

$$\Delta x = \frac{L}{N}$$

$$\Delta y = \frac{L}{N}$$

where  $L$  is the diameter. The total number of grid points will be no more than  $N^2$ . Each grid point will represent a length  $\Delta a = \Delta x \cdot \Delta y$

2. Each grid point will be a point source of strength  $2 \text{ Ci}/N$ . Each point will emit

$$\rho_i = (2 \text{ Ci}/N) * 2 * 3.7 \times 10^{10} \text{ photons/sec}$$

3. Assume that the center of the disk is at  $(0,0,0)$  and that it lies along the  $x$  axis. Grid points will extend over the disk. Carefully describe the  $x_i$  position of area element each point in a simple algorithm. The algorithm should be

$$x_i = -\frac{l}{2} + (i - \frac{1}{2}) \cdot \Delta x$$

$$y_j = -\frac{l}{2} + (j - \frac{1}{2}) \cdot \Delta y$$

4. The flux of photons from the  $i$ th grid point is

$$\phi_i = \rho_i / 4 \pi r_i^2$$

where

$$r_i^2 = (x - x_i)^2 + (y - y_i)^2 + (z - z_i)^2$$

The photons spread out evenly over the surface of a sphere, so the intensity goes as  $1/\text{Area}$  of a sphere.

5. Compute the total flux by summing over all the point sources...

$$\phi = \sum_{i=1}^N \phi_i$$

6. The sum is a pair of nested do loops. Rather than trying to program how the  $y$  varies with  $x$ , write a small function that returns 1 if

$$x_i^2 + y_j^2 \leq \left(\frac{L}{2}\right)^2$$

The FORTRAN would look something like

```

do i=1, N
  xi=
  do j=1,N
    yj=
    r=sqrt((x-xi)**2+(y-yj)**2+z**2)
    flux=flux+f(xi,yi,rl)*rho/(4.0*pi*r**2)
  end do
end do
end do

```

### **Programming Suggestions:**

Read in the total activity, the diameter  $l$ , the observation point  $(x,y,z)$ , and the number of segments  $N$  from the terminal or a file. This makes the code more general than hard-wiring in the numbers.

**Check:**

Design and carry out tests to show the program is correct. Consider what happens to the flux when you are very far from the source. What symmetries are present that you can check.

How many grid points are necessary for the solution to converge? How is this related to the distance from the disk?