Boğaziçi University
Department of Physics

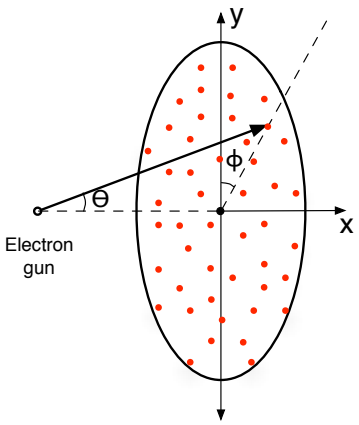
Phys 496/68N — Fall 2011

Problem Set 8

Due on December 23rd, 2011

Problem 1

You want to bombard a circular metal sheet with radius of 1 m with an electron gun 1 cm away from the center of the sheet as shown below:



Direction of the gun can be defined using θ and ϕ. We want to hit the sheet with a uniform distribution, i.e. electron marks (red dots) on the sheet are uniformly distributed.

a) Write down $P_\theta(\theta)P_\phi(\phi)d\theta\, d\phi$ which yields such a distribution.

b) Find $\theta = f(x_1)$, and $\phi = g(x_2)$ functions which yields the desired $P_\theta(\theta)d\theta$ and $P_\phi(\phi)d\phi$ distributions for $x_{1,2}$ uniform random numbers between $[0, 1]$.

c) Write a code to create 5000 (θ, ϕ) direction pairs, and mark them on a plot on the x–y plane.

Problem 2

Consider the following probability distribution:

$$w(x, y) = Ce^{-(x^2+y^2)}$$

where C is the normalization constant, x and y are defined such that $r \equiv \sqrt{x^2 + y^2} \leq 3$.

a) Write a code to generate 100,000 numbers with this probability distribution using Metropolis *et. al.* algorithm. Note that in the metropolis algorithm, you have to choose (x, y) points uniform on the region of interest, which is going to be your test point. You can do so, by choosing (r, θ) *carefully*, then convert it to the cartesian coordinate system.

b) Make a histogram with 100 bins of these numbers.

c) Make a plot of $w(r)$ for $0 < r \leq 3$, and superimpose the histogram with this curve to check the validity of your distribution. [Use a proper normalization for comparison.]