Physics 410

Assignment #7: Due Monday November 25, 2013

1) Calculate the integral

$$I = \int_0^\pi \frac{1}{x^2 + \cos^2 x} dx$$

using brute force Monte Carlo with $p(x) = 1/\pi$ and acceptance rejection method. Compute the standard deviation for both methods. Which method is best? Why?

2) The deuteron is a particle formed of a proton and neutron. One model for the interaction between the proton and neutron is the Yukawa potential

$$V(r) = V_0 \frac{\exp(-r/a)}{r/a}$$

where $V_0$ is the strength and $a = 1.5F$ is the range of the potential.

a) Using the variational method, calculate the binding energy of the ground state of the deuteron. (Recall that the Schroedinger equation is

$$-\frac{\hbar^2}{2\mu}\nabla^2\Psi + V(r)\Psi = E\Psi$$

where $\vec{r}$ is the separation between the proton and neutron, $\mu$ is the reduced mass, $r = |\vec{r}|$.) Assume the ground state is spherically symmetric and use the variational wavefunction $\Psi(\vec{r}) = R(r)$ where $R(r) = N\exp(-\alpha r)$.

b) If the observed value of the deuteron binding energy is $2.23MeV$, what is $V_0$? (Use $m_n c^2 = m_p c^2 = 938MeV$).