October 27, 1999

PHY 339– Problem Set # 4

Complete reading of Chapter 2 of **Griffiths**.

1. Consider a neutral hydrogen atom having a proton with charge density $e_0\delta^3(\mathbf{r})$ and an electron in its ground state having a density

$$\frac{e_0}{\pi a_0^3} e^{-2r/a_0},$$

where a_0 is the bohr radius (0.529177249 Å). (Here we have denoted the elementary charge as e_0 in order distinguish it from the natural number $e = 2.7182818...$) Show that the electrostatic potential associated with this atom is given by

$$V(r) = \frac{e_0}{4\pi\epsilon_0 r}\left(1 + \frac{r}{a_0}\right) e^{-2r/a_0},$$

using the following two methods:

(a)

$$V(r) = \frac{e_0}{4\pi\epsilon_0}\int \frac{\rho(\mathbf{r}')}{|\mathbf{r} - \mathbf{r}'|} d^3r'$$

(b) $\nabla^2 V(\mathbf{r}) = -\rho(\mathbf{r})/\epsilon_\mathbf{0}$.