Phys 125
Boyda

Reading as noted below. Problems are due on Friday, December 1, at 4 p.m. in my box.

Reading

- For Tuesday 11/28: Townsend §12.1 − 2.
- For Thursday 11/30: Townsend §12.3.

Problems

Recall the coordinate transformations for spherical coordinates:

$$x = r\sin\theta\cos\phi \qquad y = r\sin\theta\sin\phi \qquad z = r\cos\theta$$

$$r = \sqrt{x^2 + y^2 + z^2}$$

1. Compute Δx and Δp_x for the ground state of the Hydrogen atom. What does this computation tell you about the behavior of the electron in the ground state? Hint: Rewrite r in terms of x, y, z to compute the x-derivatives, then translate back to spherical coordinates to do the integrals. WolframAlpha handles these integrals well.
2. Townsend 10.2, 10.5-7, 12.2.

Purely optional alternative-credit assignment (as detailed in email)

In MATLAB or Python, animate the time evolution of a wavepacket inside an infinite square well. The initial wavepacket should be a Gaussian in position space with a non-zero average momentum. Choose parameters so that the packet is small but non-negligible in width relative to the size of the box and the motion initially is dictated by the average momentum. Once done, observe the motion and describe the important features you see.

Up to 80% credit will be given for correct theory, i.e. handling of the quantum mechanical expressions. Full credit requires a working animation that actualizes the underlying equations. Submit your code and a .avi file with your animation.