Quantum Physics 1 - Homework 6

Due on Monday (Oct 17) at 11:59 AM

1. A photon with a wavelength of 102.56 nm excites a hydrogen atom from the ground state.

(a) [1pt.] Ignoring spin, what are the possible quantum numbers (n, l, and m) of the excited electron?

(b) [1pt.] How does the degeneracy of this level, i.e. how many values can the quantum numbers take that all share this same energy, compare to the degeneracy of the 3D infinite square well? Provide a brief explanation for your finding.

(c) [2pt.] Consider the states within the energy level of (a) (if you didn't find an answer, take e.g.$n = 4$). If we only look at the radial part of the wavefunction, we see that there is a *most probable* radius for each state. For which allowed value of l is the most probable radius the largest? Give exact expressions for these radii. (You may plot the graphs to support your answer.)

(d) [1pt.] Interpret your answer for exercise (c). How does this result make sense intuitively?

(e) [2pt.] Draw/plot the different density plots that are possible for this excited hydrogen atom from all sides (looking along the x, y, and z axis. You may use Wolfram or other software to help you here. Duplicate drawings can of course be skipped.)

(f) [2pt.] What possible decay paths to the ground state does the electron have? Give the wavelengths of the photons released in the different paths.

(g) [1pt.] Suppose the already excited electron absorbs another photon of the same wavelength. What happens to the electron and the hydrogen atom?

$Grade \in \{1, 4, 7, 10\}$.