# Physics 492: Recitation #3
# February 5, 2016

1. What is the corresponding Bohr radius for positronium compared to the Bohr radius for hydrogen?

2. Verify the uncertainty relation for orbital angular momentum eigenstates $|\ell, m\rangle$:

$$\Delta L_x \Delta L_y \geq \frac{\hbar}{2}|\langle L_z \rangle|$$

3. For a general potential $V(\vec{r})$ (not assumed to be spherically symmetric), prove Ehrenfest's theorem,

$$\frac{d}{dt}\langle \vec{L} \rangle = \langle \vec{N} \rangle$$

where the torque

$$\vec{N} = \vec{r} \times (-\vec{\nabla} V)$$

In the special case of a spherically symmetric potential, prove that angular momentum is conserved.

4. The ammonia molecule can be considered a rigid rotor $NH_3$ that is a top, that is two identical moments of inertia. Take the z-axis to be the symmetry axis of the molecule. What is the Hamiltonian? Show that $[\hat{H}, \hat{L}_z] = 0$. What are the eigenstates and eigenvalues of the Hamiltonian?