Quiz 3
PHY 4605

Friday, January 27

Each problem is worth 10 points

1. A hydrogen atom is in a state given by the real-space wave function,

\[ \psi(r, \theta, \phi) = \frac{1}{\sqrt{3}} \varphi_{100} - \frac{1}{\sqrt{3}} \varphi_{210} - i \frac{1}{\sqrt{3}} \varphi_{300} \]

where

\[ \hat{H} \varphi_{nlm} = E_n \varphi_{nlm} \]

and \( E_n \) the energy eigenvalues of a hydrogenic atom with \( Z = 1 \) (i.e. hydrogen).

Determine the following.

a. What is the energy expectation value \( \langle E \rangle \) in eV?

b. What is the expectation value \( \langle L^2 \rangle \)?

2. At \( t=0 \) the angular momentum is measured to be \( L^2 = 2\hbar^2 \).

a. After this measurement, determine the time-dependent wavefunction \( \psi(r, \theta, \phi, t) \).
You do not need to write out all of the \( r, \theta, \) and \( \phi \) dependence, but clearly show the time-dependence.

b. What is the energy expectation value in this new state in eV?