8.6 Wave Mechanics
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Key Equations:
$\Psi(r,\phi,\theta)$ (Wave function)
$|\Psi(r,\phi,\theta)|^2$ (electron probability)

Yeah, this section gets really hairy. The concept is not too bad but the equations scare people off.

Refer back to the discussion we had on 8.5. There we talked about the uncertainty principle. The consequence of that principle is that we cannot pinpoint electrons precisely. We can say that electrons have a high probability of existing at a certain area but we cannot predict when or where exactly in this area. As a result, this renders Bohr's orbits obsolete as his model is a really a model based on the macroscopic properties of particles which does not apply in the sub atomic world of electrons. (Bohr assumed that the electron will always be find at the orbit 100% of the time and its exact position and velocity can be predicted by using classical mechanics)

This is when Schrödinger comes into play. Schrödinger, brilliant scientist. He derived a really complex equation straight out from his head. His approach was to replace the precise trajectory of a particle by a wavefunction, denoted by the Greek letter Ψ.

By solving Schrödinger's equation for a particle, we can obtain that particle's unique wavefunction. This wavefunction is simply an equation that will give you a result if you input some numbers into it. Think Schrödinger's equation as a factory. When we are solving Schrödinger's equation, we are basically telling the factory to manufacture a machine that specifically deals with say basketball. We when put basketballs into this unique machine, it will tell us things like the material of the basketball, the gas pressured inside, the size of it etc.. The key thing to know is that wavefunction squared or Ψ^2 give us the probability of finding an electron at that point in space. The wavefunction has the form $\Psi(r,\phi,\theta)$. Think the r, ϕ,θ as x, y, z. (It is simply a different coordinate system but the idea is the same). By specifying the values of r, ϕ,θ, we can determine the probability of finding an electron at these values by squaring the result from the wavefunction.

Whenever Ψ, and hence Ψ^2, is 0, there is zero probability of locating the particle. This place is called a node. So we can say that there is a zero probability of locating an electron whenever this wavefunction has nodes.

Note that the wavefunction itself does not have any direct physical significance: we have to take the square of Ψ before we can interpret it in terms of the probability of finding an electron somewhere. Make sense so far?

The wavefunctions actually have a name. They are called orbitals. We will examine orbitals in detail at section 8.7 and 8.8.

Beware that the wavefunction itself is made up of 2 other functions. One is called the radial wave function, R(r), and the other is called the angular wave function Y(θ,ϕ). The exact relationship is as follows:

$$\Psi(r,\phi,\theta) = \underbrace{R(r)}_{\text{Radial}}\underbrace{Y(\theta,\phi)}_{\text{Angular}}$$

Keep this is mind because it will become useful when we talk about multielectron atoms.