Chapter 1: Quantum Mechanics

ψ: The wave function or orbital

- The mathematical description of an electron as a three-dimensional standing wave
- Defined or labeled by three quantum numbers: n, l, and m_l (see below)
- Undergoes constructive interference, destructive interference, and diffraction like any other wave
- The electron's amplitude; cannot be observed directly

ψ^2: The probability density or charge density.

- The electron's intensity; can be observed directly (*e.g.* by the technique of scanning tunneling microscopy)
- ψ^2 * volume = the probability of finding an electron in that volume
- ψ^2 * volume can never equal one (that is, 100% probability) at any one point in space. That is, we can never completely localize the electron. (Bohr was wrong!)
- ψ^2 (and ψ) does equal zero at a node. We can say where the electron can't be.

The 4 Quantum Numbers (QN's) and Their Rules

QN	Name	Allowed Values	What It Determines
n	principal	1, 2, 3,…	Total number of nodes = $n - 1$ $\Rightarrow E = -2.179 \times 10^{-18}\ \text{J}\,\frac{Z^2}{n^2}$ for a 1-electron atom or ion
l	angular momentum $[L^2 = l(l+1)\,h^2/4\pi^2]$	0, 1, 2, …, n - 1	Number of angular nodes = l $\Rightarrow$ shape of ψ $\Rightarrow$ Number of radial nodes = $n - l - 1$
Note: $l = 0 \Rightarrow s$ $l = 1 \Rightarrow p$ $l = 2 \Rightarrow d$ $l = 3 \Rightarrow f$ $l = 4 \Rightarrow g$ $l = 5 \Rightarrow h$			
m_l	magnetic	$-l, -l+1, \ldots, 0, \ldots, l$	Orientation of ψ [with respect to a magnetic field] $\Rightarrow 2l + 1$ possible orientations

Orbital: A wave function with a given value of n, l, and m_l
Subshell or Sublevel: A set of orbitals with the same values of n and l (m_l can be anything)
Shell: A set of orbitals with the same value of n (l and m_l can be anything)

m_s	spin	+½, -½	Orientation of an electron's intrinsic angular momentum (with respect to a magnetic field)