Representations of Orbitals

1. **Radial Plot: \( \Psi \) vs. \( r \) or \( \Psi^2 \) vs. \( r \)**
   
   Two-dimensional plot of \( \Psi \) or \( \Psi^2 \) versus the distance, \( r \), from the nucleus, without trying to show the three dimensional aspects of the distribution. Sometimes a particular direction in space is chosen \((x, y, z)\) instead of any direction \(r\).

2. **Radial Distribution Function: \( 4\pi r^2 \Psi^2 \) vs. \( r \)**

   Probability of finding the electron within a vanishingly thin spherical shell with a radius of \( r \) from the nucleus. Going out from the nucleus, this shows the variation in probability on the surface of increasingly larger spherical shells.

3. **Electron Charge Cloud (Electron Density) Diagram**

   Three-dimensional picture of \( \Psi^2 \) in which higher probability is rendered by darker shading or stippling. Most of such diagrams are meant to show approximately 90-99% of the total probability.
Representations of Orbitals

4. *Contour Diagram*
   Two-dimensional cross section (slice) through the probability distribution. Lines on the drawing connect regions of equal probability, much like isobars on a weather map connect regions of equal pressure.

5. *Boundary Surface Diagram*
   Three-dimensional solid model (or a picture of such a model) constructed so as to represent a surface that encloses approximately 90-99% of the total probability. These are sometimes called "balloon models". Sketches of orbitals used in routine work are generally two-dimensional representations of "balloon models".
Probability vs. Distance from Nucleus
1s Wave Function

\[ n = 1, \ l = 0, \ m_l = 0 \]
Three-Dimensional Representation of a 1s Orbital

Electron Cloud Representation

Boundary Surface Model
Ψ and Ψ² vs. Distance from the Nucleus

2s Wave Function

\( n = 2, \ l = 0, \ m_l = 0 \)
Three-Dimensional Representation of a 2s Orbital

Electron Cloud Representation

Boundary Surface Model
The 2s orbital has one spherical node.
\( \Psi \) and \( \Psi^2 \) vs. Distance from the Nucleus

2p\( z \) Wave Function
The plane perpendicular to z (xy plane) passing through the nucleus is a node.
The Three Degenerate $2p$ Orbitals

$n = 2, \ l = 1, \ m_l = +1, \ 0, \ -1$

$2p_x$

$2p_y$

$2p_z$