

## 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.

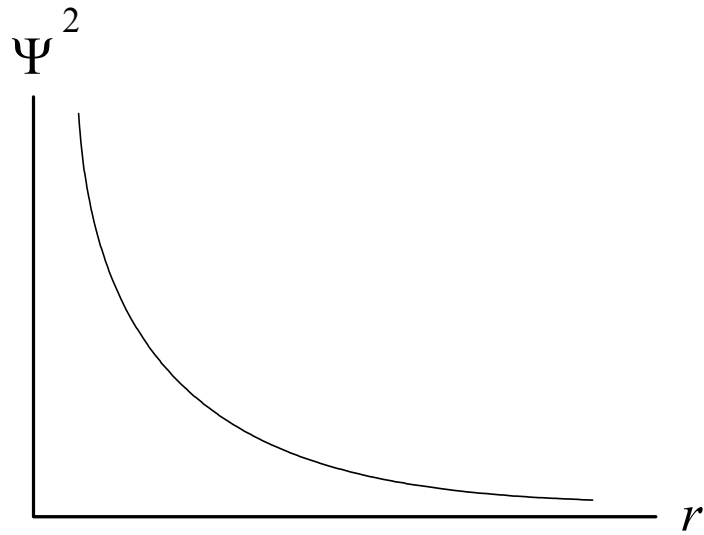
### 5. *Boundary Surface Diagram*

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".

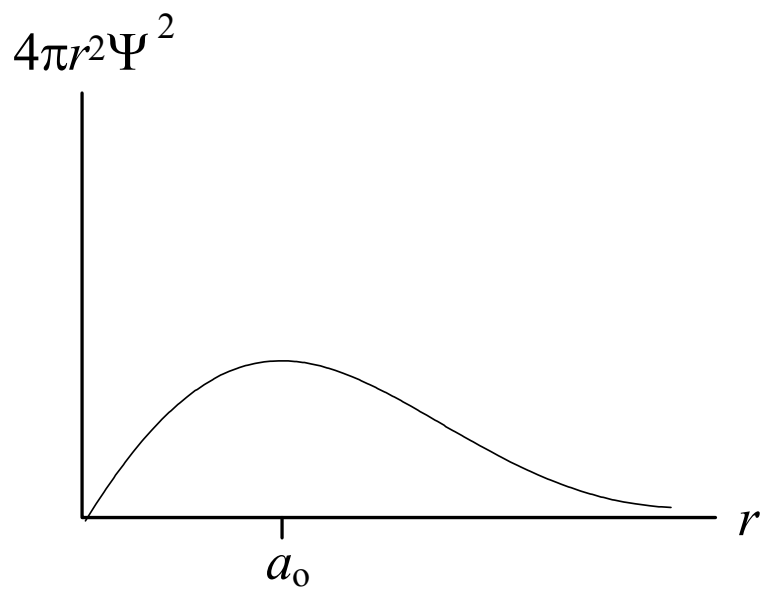
# Probability vs. Distance from Nucleus

## 1s Wave Function

$$n = 1, l = 0, m_l = 0$$

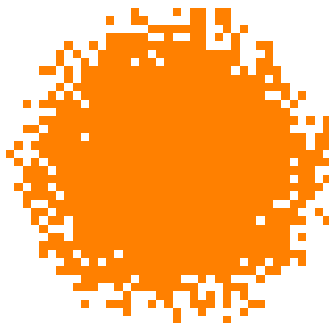


Radial plot

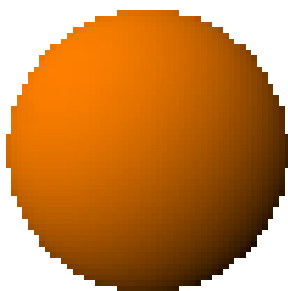


Radial distribution plot

# Three-Dimensional Representation of a 1s Orbital

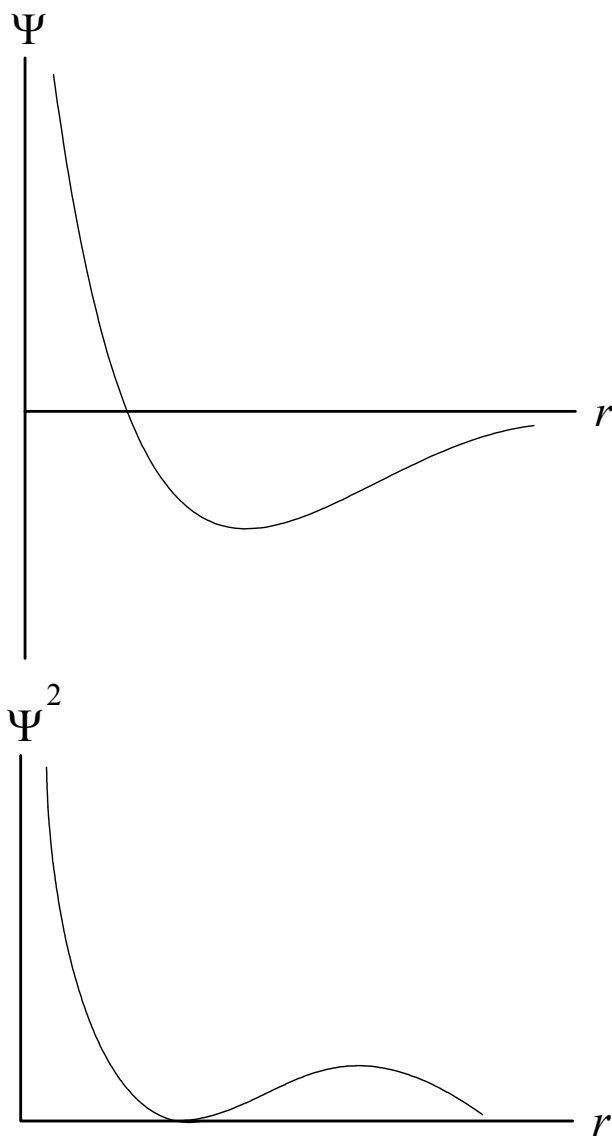


Electron Cloud Representation

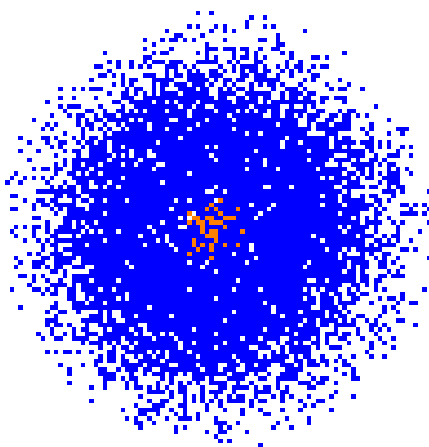


Boundary Surface Model

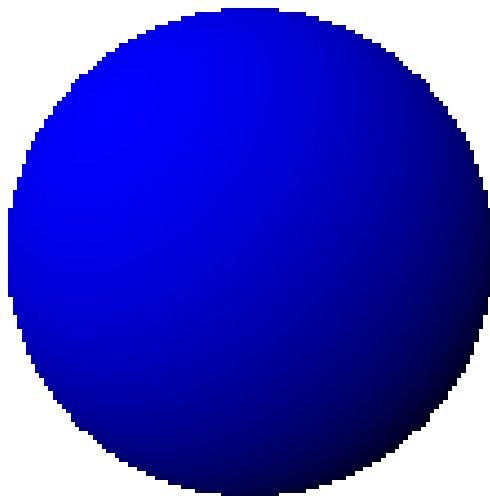
**$\Psi$  and  $\Psi^2$  vs. Distance from the Nucleus**  
 **$2s$  Wave Function**  
 $n = 2, l = 0, m_l = 0$



# Three-Dimensional Representation of a 2s Orbital

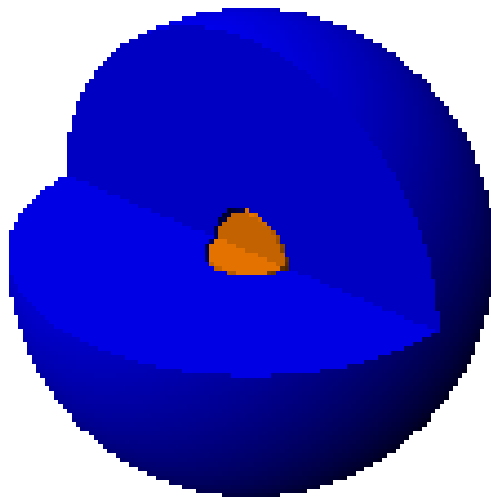


Electron Cloud Representation



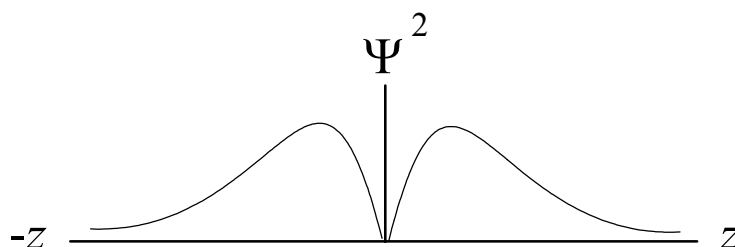
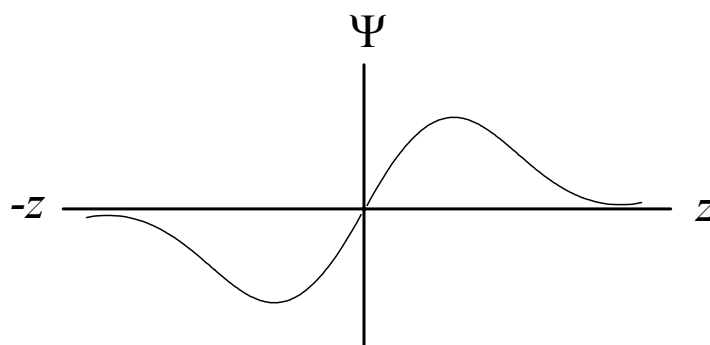
Boundary Surface Model

## Cutaway Model of 2s Orbital



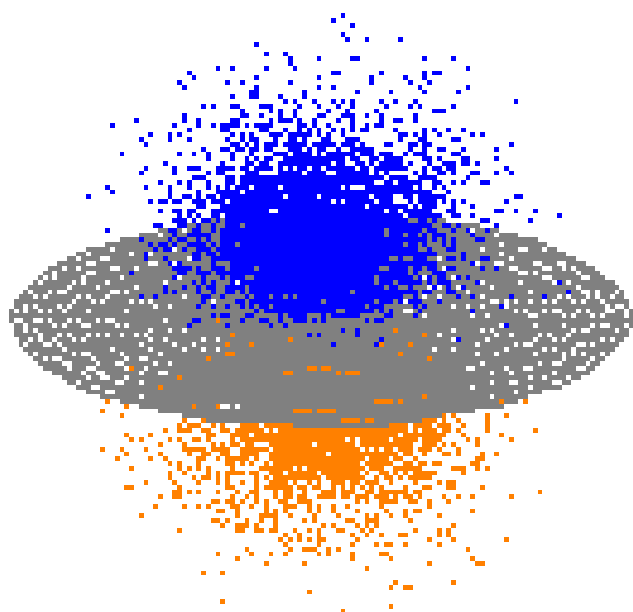
The 2s orbital has one spherical node.

**$\Psi$  and  $\Psi^2$  vs. Distance from the Nucleus**  
 **$2p_z$  Wave Function**





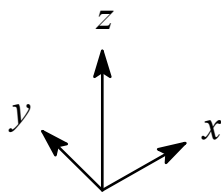
## Electron Cloud Representation of a $2p_z$ Orbital



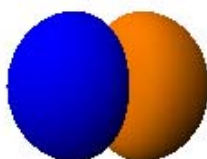
The plane perpendicular to  $z$  ( $xy$  plane) passing through the nucleus is a node.

# The Three Degenerate $2p$ Orbitals

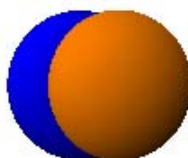
$$n = 2, l = 1, m_l = +1, 0, -1$$



$2p_x$



$2p_y$



$2p_z$

