Radial Distribution Functions for the Hydrogen Atom

The Radial Distribution Function (RDF) gives the probability density for finding the electron at a radius $r$ from the nucleus. The RDF is defined as

$$\text{RDF} = r^2 R_{nl}(r)^2.$$ 

Plots of the Radial Distribution Functions for the 1s, 2s, and 3s orbitals of the hydrogen atom are shown in Figure 1.

![Figure 1. RDF plots for 1s, 2s, and 3s orbitals of the H atom.](image)

Note that as the principal quantum number increases, the maximum in the probability density occurs at larger distances for orbitals of the same angular momentum type. For example, the maximum probability for the 1s orbital occurs at 1 bohr (0.529 Å), for the 2s orbital the primary maximum occurs at 5.3 bohr, and for the 3s orbital the primary maximum occurs at about 13 bohr.

Similar trends are observed as the principal quantum number increases for the higher angular momentum orbitals (e.g., p-type, d-type, or f-type orbitals). For example, plots of the Radial Distribution Functions for the 2p and 3p orbitals are shown in Figure 2.
In contrast, if the principal quantum number is held fixed and the angular momentum type of the orbital is varied, we see from the example in Figure 3 that the position of the primary maximum in the probability distribution decreases as the angular momentum increases.