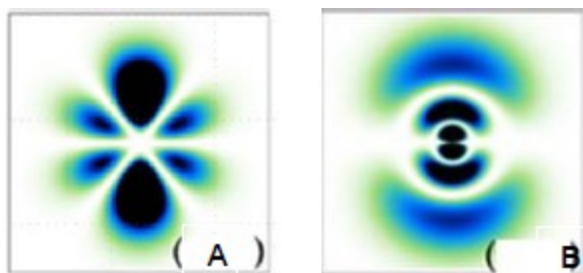


CH 107 Tutorial 3

Please solve these problems BEFORE the tutorial session

1. Sketch the polar plot of d_z^2 orbital as a function of θ and ϕ . Pictorially, depict the angular nodes present for $3d_z^2$ orbital of hydrogen atom $[3d_{z^2} = N_1(r/a_0)^2(3\cos^2\theta - 1)e^{-r/3a_0}]$. How many nodal planes/surfaces are present and at what values of (r, θ, ϕ) ?
2. From the projections of the hydrogenic orbitals shown below, guess the quantum numbers n and l . Assign a sign to regions and show radial/angular nodes for each orbital. (Vertical direction: z-axis)



3. In a single graph with proper axes labels, draw the Radial functions and Radial Distribution Functions for 1s, 2s, 2p (same graph) and 3s, 3p and 3d (same graph) orbitals for a Hydrogen atom indicating nodes and relative position of the maxima. Qualitatively explain what happens in case of other hydrogenic atoms such as Li^{+2} ?
4. Where is the probability of finding an electron in 1s and $2p_z$ orbital greatest?
5. Write general Hamiltonians for a many electron atom and expand it for Li and C atoms.
6. Why can we not exactly solve the Schrödinger equation for He atom? What is orbital approximation?
7. What is a spin-orbital? Why are $\alpha(1)\beta(2)$ or $\beta(1)\alpha(2)$ not acceptable two electron spin-functions?
8. Write the total wavefunctions (space and spin) of the He atom in the ground and first excited states. Now write the total wavefunctions in the form of Slater determinants.
9. Show that for Li, it is impossible to have the third electron occupy the 1s orbital (when the other two electrons already reside in 1s).