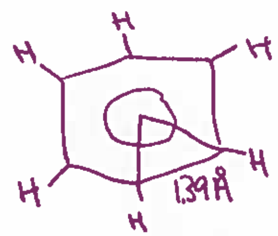
Dealing w/ multiple electrons

Electrons are fermions, wavefunctions are not antiasymmetric under (postulate 6) particle exchange

(Pauli exclusion principle)

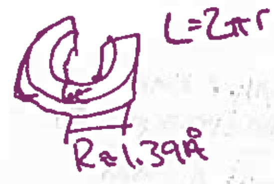
Today: Quantum model for benzene

↳ why is it transparant



3/4 of carbone-localized bonds in plane, but 6p e^- out of plane

model →



particle of a ring

$\hat{H} = \frac{\hbar^2 M^2}{2 m_e R^2}$ → exact solution for 1 e^-, not for benzene

What do these energy levels for benzene look like

E ↑

$\overline{M=2}$ $\overline{M=-2}$ ← empty (could shine light to excite e^- to here) (one energy exists for each different excitation) (longest wavelength, lowest energy is ΔE drawn)

ΔE

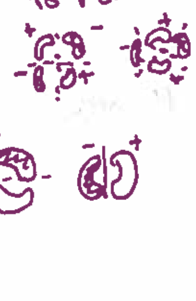
$\frac{\uparrow\downarrow}{M=-1}$ $\frac{\uparrow\downarrow}{M=1}$

$\frac{\uparrow\downarrow}{M=0}$

$\psi_{\pm 2} = \frac{1}{\sqrt{2\pi}} e^{\pm 2i\varphi}$

$\psi_{\pm 1} = \frac{1}{\sqrt{2\pi}} e^{\pm i\varphi}$

$\psi_0 = \frac{1}{\sqrt{2\pi}}$



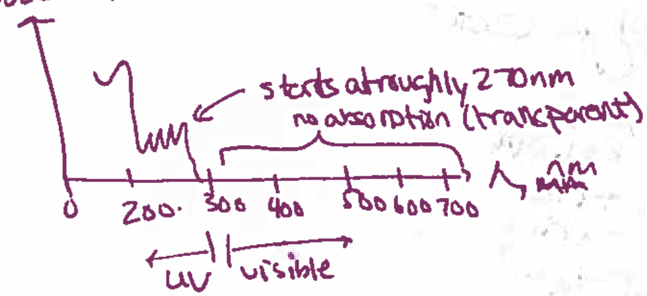
Wavefunction and energy levels

$\psi_P = \hat{A}_6 \psi_0\alpha(1)\psi_0\beta(2)\psi_{-1}\alpha(3)\psi_{-1}\beta(4)\psi_{+1}\alpha(5)\psi_{+1}\beta(6)$

Absorption of light

$E_{photon} = \hbar\omega = \hbar\nu = h\frac{c}{\lambda}$ ← c: speed of light, λ: wavelength

$E_{photon} = \Delta E = E_2 - E_1$



$\Delta E = e_2 - e_1 = \frac{\hbar^2}{2m_eR^2}(2^2 - 1^2)$

$\approx \frac{(1.05\times10^{-34} J)^2}{2\cdot 9.11\times10^{-31} kg\,(1.39\times10^{-10} m)^2}$

$\approx 1.25\times10^{-18} J$

$\Rightarrow \lambda = \frac{hc}{\Delta E} = \frac{6.62\times10^{-34} \cdot 3.00\times10^{8}}{1.25\times10^{-18} J}$

$= 210 nm$

Actual experiment absorbs at 270 nm