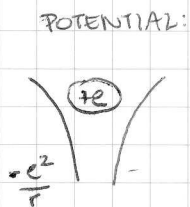


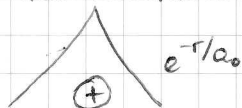
Electronic States of Matter

TYPE OF MATTER:

- Atoms (H as prototype)



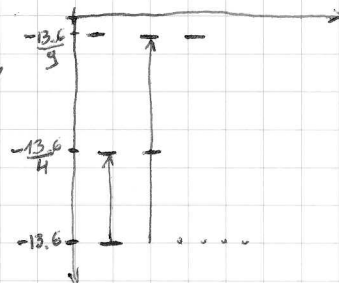
WAVE-FUNCTIONS:



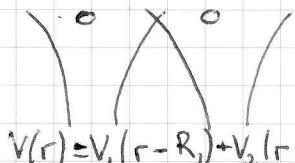
ENERGY SPECTRUM:

$$E_n = -\frac{13.6}{n^2} \text{ eV}$$

EXCITATIONS:



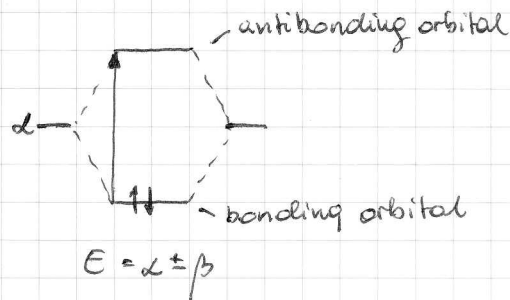
- Molecules (H₂ as prototype)



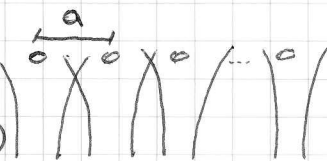
Use the linear combination of atomic orbitals (LCAO)



$$\begin{aligned} \psi_{TOT} &= a_1 \psi_{100}(r-R_1) + a_2 \psi_{100}(r-R_2) \\ &= a_1 |1\rangle + a_2 |2\rangle \end{aligned}$$



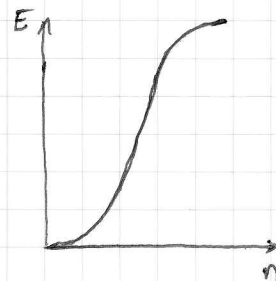
- Solids (1-D chain as prototype)



$$V(r) = \sum_n V(r-R_n)$$

$$\begin{aligned} \psi_{TOT} &= \sum_n a_n \psi_{100}(r-R_n) \\ &= \sum_n a_n |n\rangle = \frac{1}{\sqrt{N}} \sum_n e^{ikna} |n\rangle \end{aligned}$$

$$E(n) = \alpha + 2\beta \cos\left(\frac{2\pi na}{N}\right)$$



spherical harmonics

$$\text{H atom } \psi\text{'s: } \psi_{nlm}(r, \theta, \phi) = \underbrace{R_{nl}(r)}_{e^{-nr/a_0} f_{nl}(r)} \underbrace{Y_{lm}(\theta, \phi)}_{\text{polynomial}}$$