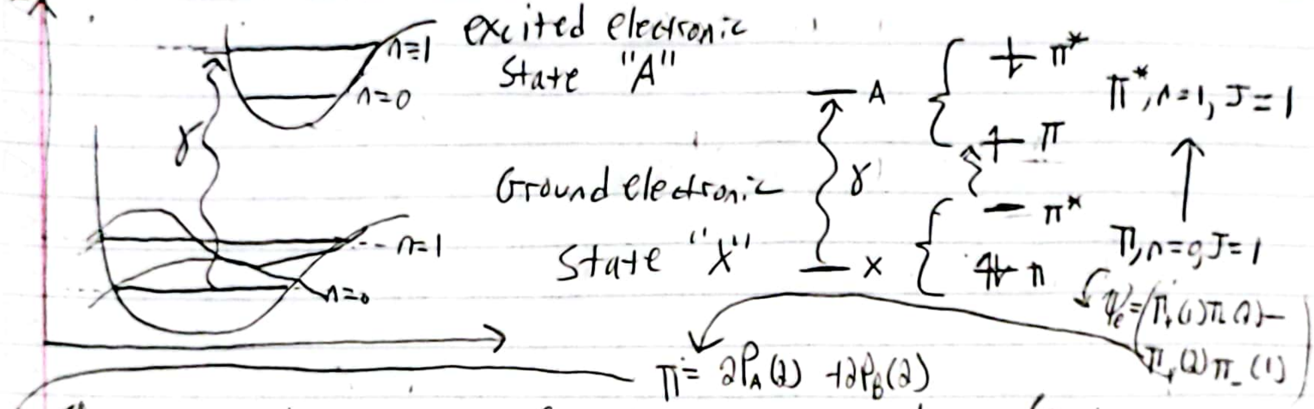
lecture 15

Last time: Spectroscopy



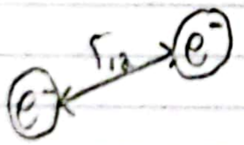
Charge needs to move for electromagnetic radiation (e.g. light, microwave, etc.) to be absorbed. Absorbed intensity $\sim \vec{V_e} \cdot \vec{A} \sim \vec{\mu} \cdot \vec{\mathcal{E}}$

V_e = Velocity of e^-, $\vec{A}$ = "vector potential"; $\vec{\mu}$ = dipole moment; $\vec{\mathcal{E}}$ = electric field

$\psi(r, ...) = r \cdot e^{-r/2a_0} \cdot \sin\theta \cdot \cos\varphi$

Today: More spectroscopy, tunneling, fourier principle

Note: The exact solutions of the molecule Schrödinger equation are somewhat distorted from simple sums or differences of atomic orbitals due to e^- repulsion.



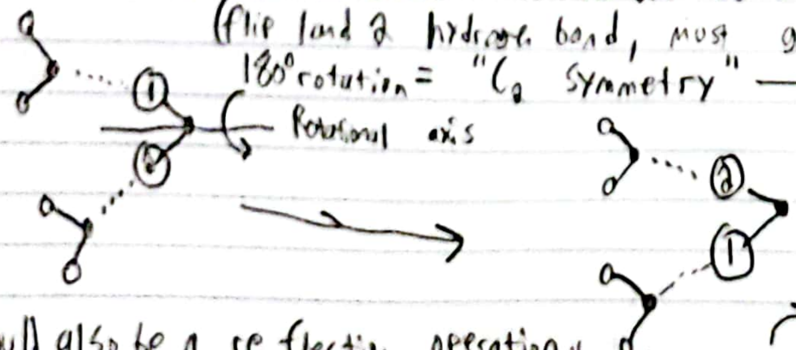
$$V = + \frac{e^2}{4\pi\varepsilon_0 r_{12}}$$

Thought Experiment: μ-waves → H_2O

What kind of rotation allows a hydrogen bond to be broken?

(flip 1 and 2 hydrogen bond, must go over energy barrier)

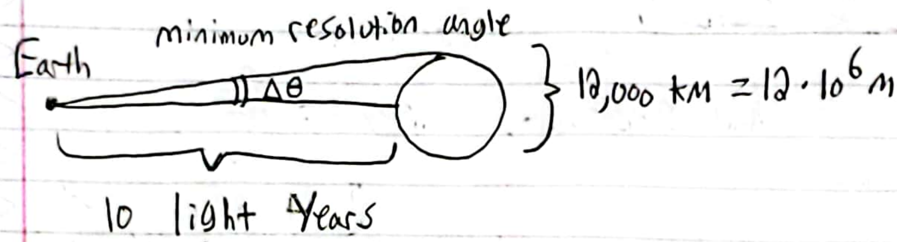
180° rotation = "C_2 Symmetry" → from group theory



H1 and H2 exchange from the flip

Could also be a reflection operation, "σ Symmetry" (mirror plane) → also from group theory

HW* 5.2 What would it take to resolve a continent on an exoplanet?



$10\ ly = 3\cdot10^8\ m/s \cdot (60\cdot60\cdot24\cdot365)\cdot10 = 9\cdot10^{16}\ m$

$\therefore \Delta\theta = \tan^{-1}\left(\frac{6\cdot10^6 m}{9\cdot10^{16} m}\right) = \underline{4\cdot10^{-9}\ \text{degrees}}$!! Very small resolution angle

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A fourier Principle

$\Delta\theta\cdot\Delta d = \frac{\lambda}{4\pi}$ Δd: diameter of the lens (or imaging)

eye: $\Delta d \approx 5mm \Rightarrow \Delta\theta \approx 0.02^\circ = 10^{-2}$ degrees