Selection rules for electric dipole transitions

when is $\vec{\epsilon}\langle f|\vec{r}|i\rangle \neq 0$? $= \vec{\epsilon}\int d^3r \, (R_{n_f l_f} \, Y_{l_f m_f}(\theta,\phi))^* \, \vec{r} \, (R_{n_i l_i} \, Y_{l_i m_i}(\theta,\phi))$

$\int d\Omega$

$\int_0^{2\pi} d\phi \cdot \int_0^{\pi} \sin\theta \, d\theta \; Y_{l_f m_f}^* \, Y_{1m} \, Y_{l_i m_i}$ can be zero

suppose $l_i = 0$, $Y_{00} = $ const.

$\int d\Omega \, Y_{l_f m_f}^* \, Y_{1,m} = \delta_{l_f,1} \, \delta_{m_f,m}$

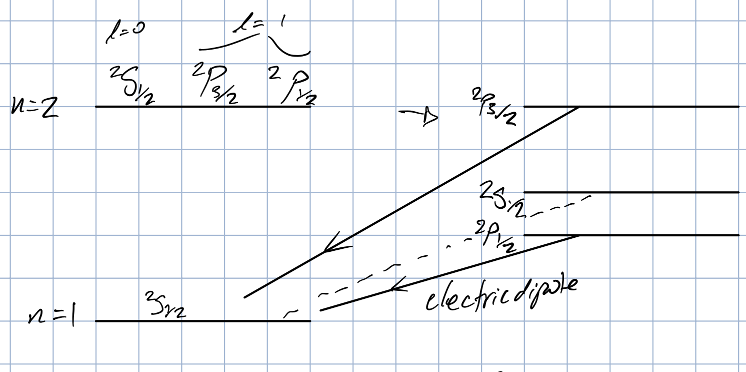
Parity $\vec{r} \to -\vec{r}$ $\quad Y_{1m} \to (-1)^1 Y_{1,m}$

$l_f + l_i + 1 = 0 \;\to\; \Delta l \neq 0$

perturbation is indpt. of spin, $\Delta S = 0$

$\Delta m = \pm 1$
$\Delta l = \pm 1$
$\Delta S = 0$
} electric dipole selection

${}^{2S+1}L_j$ $\qquad L = S, P, D \ldots$ for $l = 0, 1, 2, \ldots$



$2p \to 1s \qquad \tau \sim 10^{-9}$ sec

${}^2S_{1/2} \; (n=2) \to {}^2S_{1/2} \; (n=1) \qquad \tau \sim 1/7$ sec

${}^2S_{1/2} \to {}^2P_{1/2} \qquad \tau \sim 10^7$ sec

What was left out

- Scattering theory in 3D
- WKB approximation
- Periodic Potentials & band structures in solids
- Multiple electrons in $\vec{B}$ field
- Details & applications of radiation theory & Fermi's golden rule
- Path integral formulation (used in QFT)
- QM of many → ∞ particle systems
- String Theory

QFT → condensed matter physics (non-relativistic)
QFT → Particle physics (relativistic)

Impt math: Complex analysis, Lie groups

"QM is so cool!"

Hofstader Butterfly