Electromagnetic Radiation

Go to overhead →
(see also p. 531)

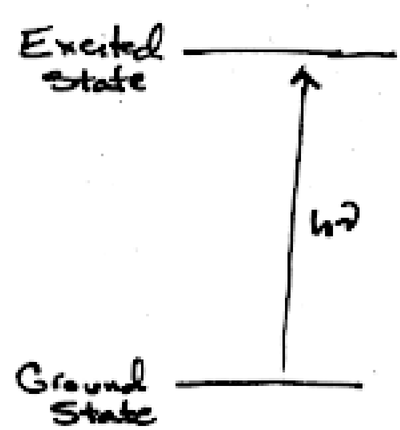
Frequency = $\nu = \frac{c}{\lambda}$ ← wavelength

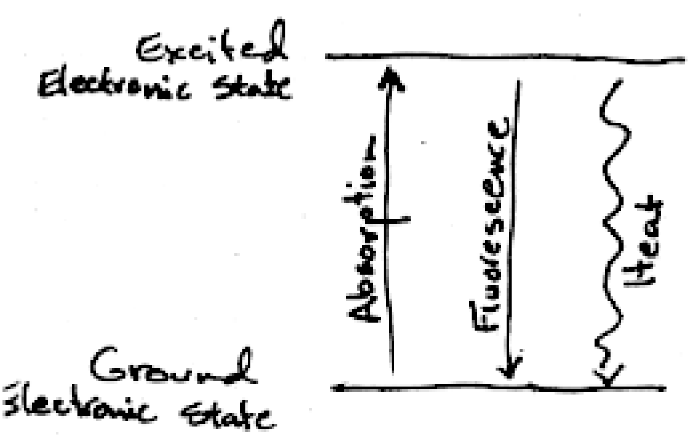
So a plot of λ is a plot of $1/\nu$

γ-Rays	10^{-12} m		Very high E
UV light	10^{-7} m	(100nm)	High E
Red light		(700nm)	Lower E
Microwaves	10^{-2} m		Very Low E

Absorption

Light (<u>any</u> E.M.) can <u>induce</u> transitions between states of different energies





$$I(\nu) = \frac{c}{n}\rho(\nu)$$

Intensity; c: speed of light; n: refractive index; $\rho(\nu)$: Energy/volume (Energy density)

Radiation - Induced $\Rightarrow$ How?

Absorption and Stimulated Emission

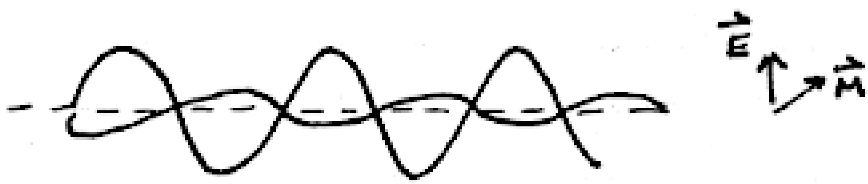
ΔE must match $h\nu$
but that's not enough.

Light/E.M. is an electro/magnetic field

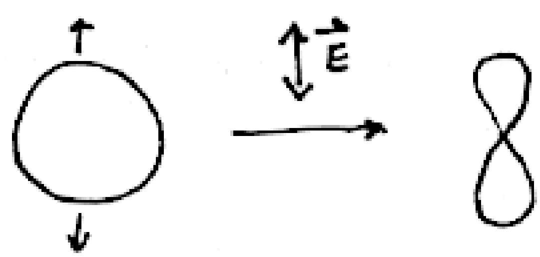
Electric component 

Magnetic component 

Yuck!



Electrons (charged) interact w/ the ~~mag~~ electric field, changing their ~~speci~~ spatial distribution.

So 

Not easy to visualize completely, but...

We say that a radiation field "Connects" the two states

Transition Dipole Moment

Two different wave functions (orbitals)

$$\mu_{0_A} = \int \psi_0 \, \mu \, \psi_A \, dv$$

Electric vector of EM

Tells us the probability that the electric field (E, μ) can induce a transition from ψ_A to ψ_0

How? Qualitatively, at least.

If $\vec{\mu}$ (E) "operates on" (distorts) the electron distribution ψ_A so that it now looks like ψ_0, then

$$\mu_{0_A} = \int \psi_0 (\psi_0) \, dv = 1$$

Actually $D_{0A} = |\mu_{0A}|^2$

$\Rightarrow$ Maximal probability.

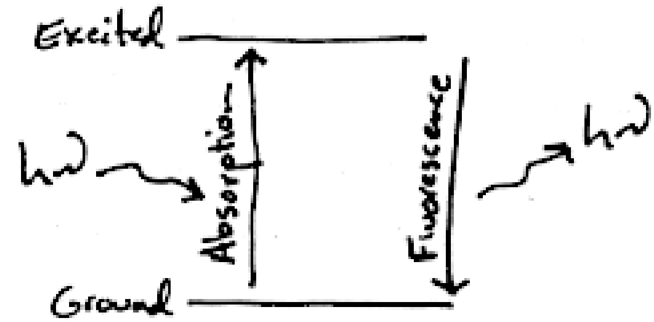
If a bit less perfect, then $\mu_{0A} < 1$ but it can still be non-zero.

Note that E can also act on ψ_0 to make it look like ψ_A

In general, $\int \psi_0 \mu \psi_a \, dv = \int \psi_a \mu \psi_0 \, dv$

$\Rightarrow$ Light stimulates UP <u>and</u> DOWN.

Light stimulates <u>both</u> absorption and emission.



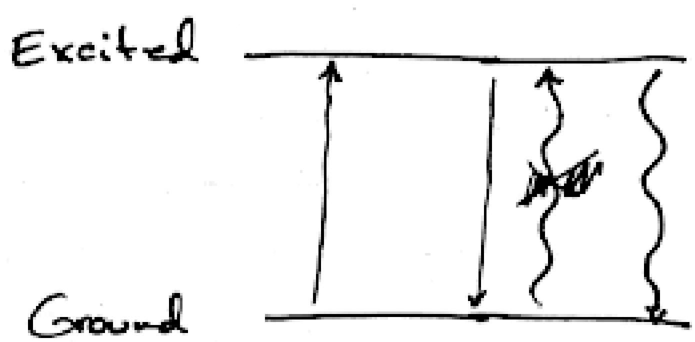
(Can also have spontaneous emission → more complex)

<u>Result</u>: If ground and excited states have equal populations, then

\# transitions up = # transitions down

⟹ No net absorption

Common in NMR, where ΔE is small rel to kT
Not common in electronic spec, ΔE large " " "
Boltzmann important here.



We talk of <u>lifetime</u> of the excited state.
How <u>quick</u>ly does it convert back via $\downarrow$ and $\wr$