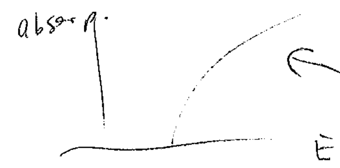
Chapter 15 (some of, anyway)

Optical Absorption



← "joint density of states"
combined CB + VB

GaAs actual

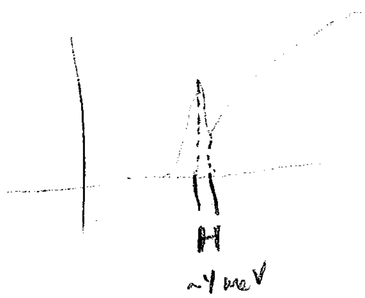


Fig 15.7 pg 438

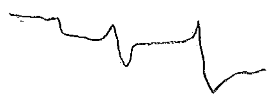
exciton!

(e^-) (h^+)
bound state

like hydrogen atom again

Plan of attack for rest of optics discussion

see Fig 16.8 pg 464



1. Learn More about Maxwell's Eqns, how does "polarizability" relate to optics
   today + next lecture (Mon)
2. Understand the UV section "$\alpha_{electronic}$" Wed.

   Model : (+)~~~(−)

3. Understand the IR section "α_{ionic}" Friday

   (+)~(−)~(+)~(−)
   etc.

4. Skip $\alpha_{dipolar}$ – applicable to molecular solids
5. Talk about conductors (not in this figure) Monday

Ch 14 + 15

Maxwell's Eqns

1) Gauss's Law $\oint \vec{E} \cdot d\vec{a} = \frac{q_{enc}}{\epsilon_0} \xrightarrow{\text{div. thm.}} \boxed{\nabla \cdot \vec{E} = \rho / \epsilon_0}$

2) No magn. monopoles
aka Gauss's Law for B $\oint \vec{B} \cdot d\vec{a} = 0 \xleftrightarrow{\text{div Thm}} \boxed{\nabla \cdot \vec{B} = 0}$

3) Faraday's Law $\mathcal{E} = -\frac{\partial \Phi_B}{\partial t}$

$\rightarrow \oint \vec{E} \cdot d\vec{\ell} = -\frac{\partial \Phi_B}{\partial t} \xrightarrow{\text{Stokes Thm}} \boxed{\nabla \times \vec{E} = -\frac{\partial \vec{B}}{\partial t}}$

4) Ampere's Law $\oint \vec{B} \cdot d\vec{\ell} = \mu_0 I_{enc} \longrightarrow \nabla \times \vec{B} = \mu_0 \vec{J}$

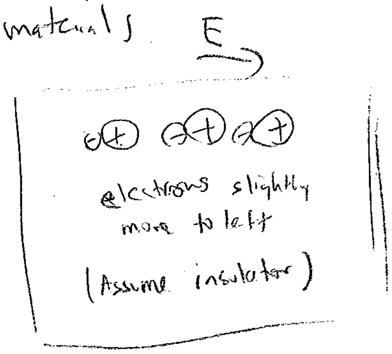
w/ Maxwell correction

$\oint \vec{B} \cdot d\vec{\ell} = \mu_0 I_{enc} + \underbrace{\mu_0 \epsilon_0 \frac{\partial \Phi_E}{\partial t}}_{\text{displacement current}} \rightarrow \boxed{\nabla \times \vec{B} = \mu_0 \vec{J} + \mu_0 \epsilon_0 \frac{\partial \vec{E}}{\partial t}}$

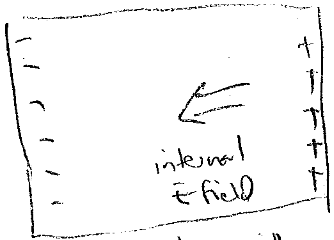
Those are equations in <u>vacuum</u>.

Also ~~true~~ in materials, but not the most useful form.

Inside materials



overall end result



which partially cancels external field

For Maxwell's Eqns, need total $\vec{E} = \vec{E}_{ext} + \vec{E}_{int}$

instead, use Polarizability $\vec{P} = \epsilon_0 \chi_e \vec{E}$

↳ electric susceptibility. Describes dipole moments that get formed ($\equiv$ ave $\frac{\text{dipole moment}}{\text{volume}}$)

"D-field" or "displacement field" $\vec{D} = \epsilon_0 \vec{E} + \vec{P}$

then

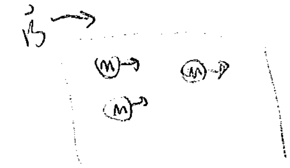
(1) $\boxed{\vec{\nabla} \cdot \vec{D} = \rho_{extra}}$ ← "ρ_{free}"

(2) $\boxed{\vec{\nabla} \cdot \vec{B} = 0}$ still

(3) $\boxed{\nabla \times \vec{E} = -\frac{\partial \vec{B}}{\partial t}}$ still (why?)

day 39 pg (1)

Same sort of deal for B field



$\vec{M} = \chi_m \vec{H}$

$\vec{H} = \frac{\vec{B}}{\mu_0} - \vec{M}$ } historically done this way instead of $\vec{M} = \chi_m \vec{B}$ and $\vec{H} = \mu_0 \vec{B} + \vec{M}$

Magnetic moment / volume

Then $\boxed{\nabla \times \vec{H} = \vec{J}_{extra} + \frac{\partial \vec{D}}{\partial t}}$