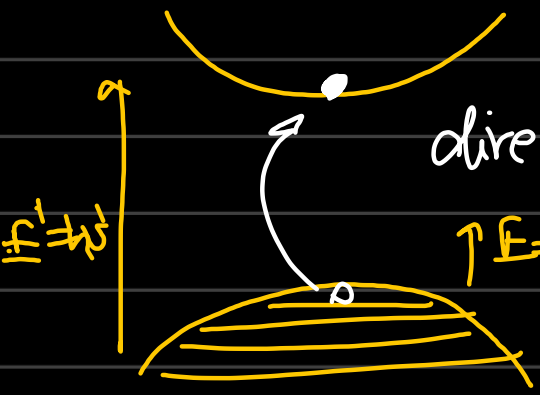
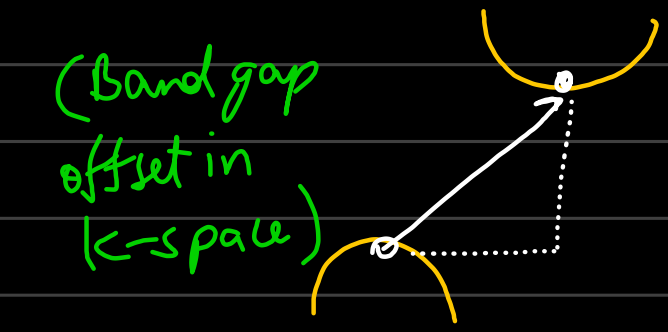
Lecture 26

Direct & Indirect Semiconductors:-



direct transition: → only with help of photons.



have momentum no energy

indirect transition:

↳ need help of phonons for k translation followed by photon transition.

↳ have energy, no momentum.

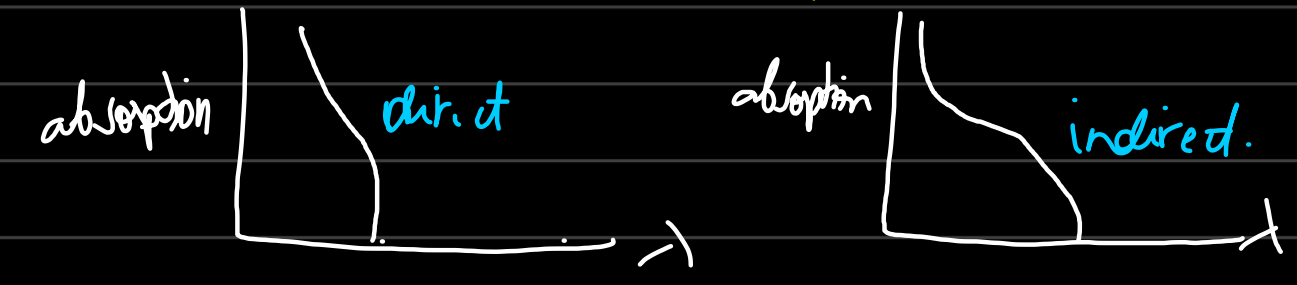
broad absorption peaks

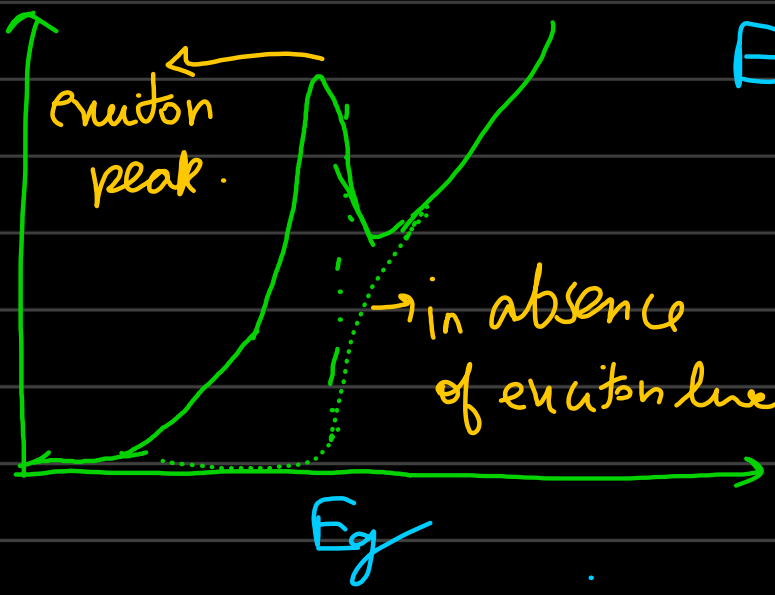
⇒ Si, Ge → indirect semiconductors.

GaP, GaAs, InP → direct semiconductor

↓

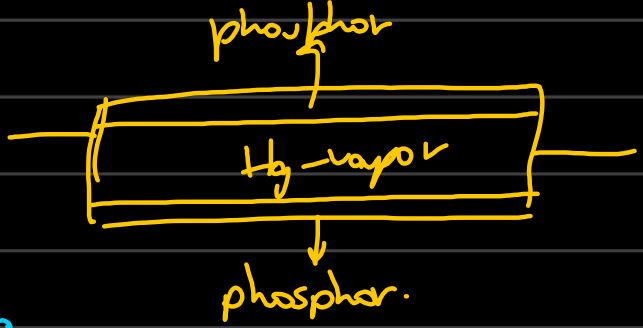
sharp absorption peaks.





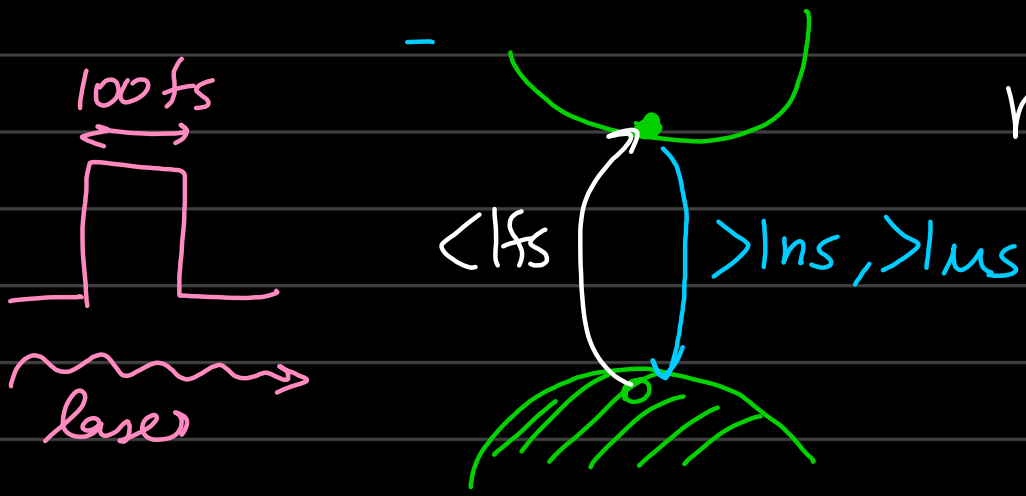
Exciton: e-hole pair bound state
↳ level below E_G
↳ e^- need not get excited to conduction band.

Emission:-



Recombination of e-hole pair:

↳ much harder process than absorption.



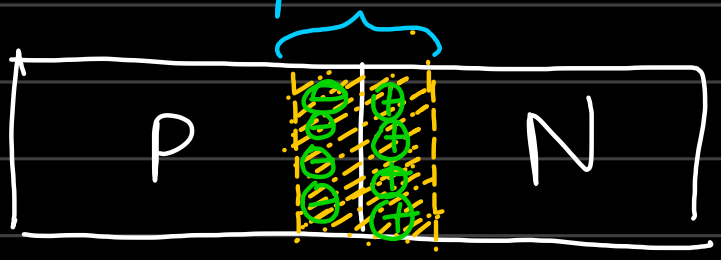
recombination is 10^6 order slower than absorption.

→ Trapping centers aid recombination, as otherwise electron is quite stable in conduction band.

→ Trapping centre → some energy level below conduction band where electron comes and sits while hole gets recombined.

{Trap assisted recombination}

Light-Emitting Diode:-



$np = n_i^2$ ..

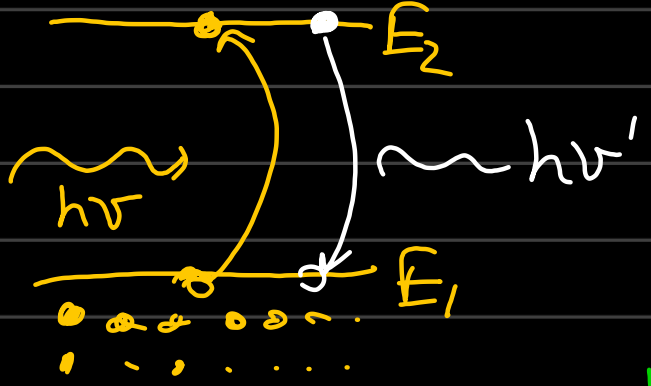
$p \uparrow n \downarrow$ → no recombination

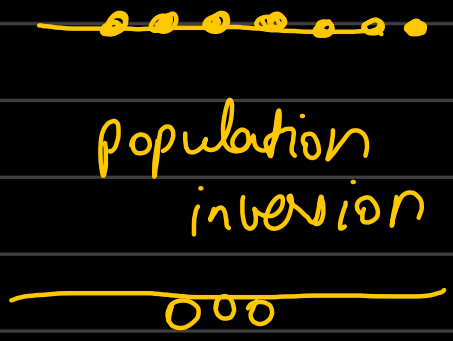
$np = n_i^2$

$n \uparrow p \downarrow$ → no recombination.

* In depletion width: large density of minority charge carriers
  - this aids recombination hence.
  - PN junction are good light emmitters.

LASER: Light Amplification by Stimulated Emission:

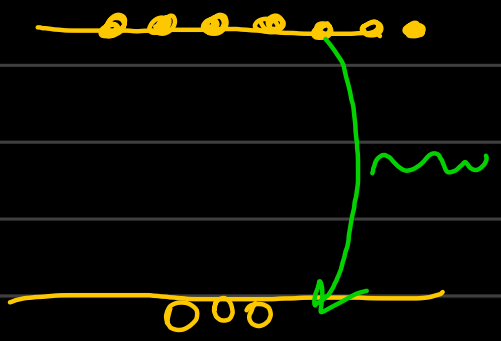


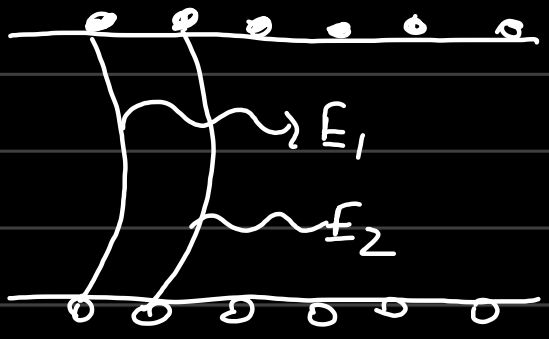


$n_{e_{valency}} < n_{e_{conduction}}$

1) Population inversion

2)





Light gain (Amplification)

photon propagation:

* $E_1 = E_2$
* $ph(E_1) = ph(E_2)$

* photon emitted by one recombination puts electrons in conduction in resonating vibration.
  - An electron under resonating vibration emits photons.