

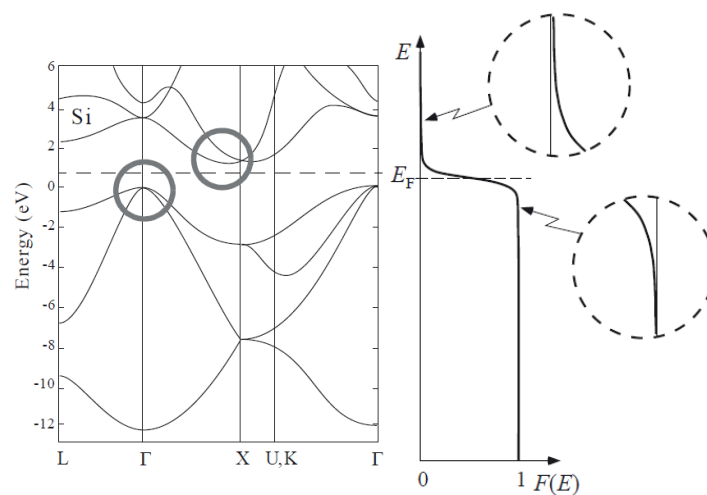
Today:

- Doping
- Carrier transport: scattering
- *Current*

Rep: lecture 1

$T = 0\text{K}$: VB: all states occupied, no holes
CB: no states occupied, no electrons

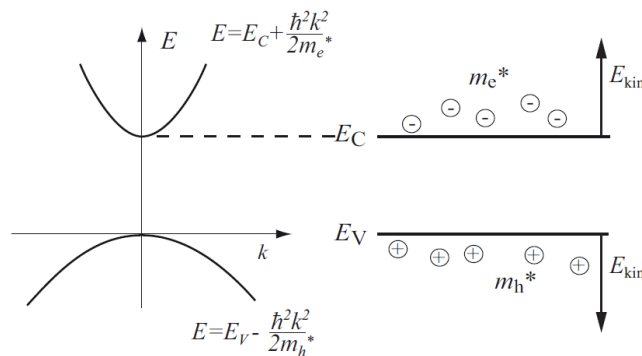
$T > 0\text{K}$: Some carriers are thermally excited.



Effective mass

$$\frac{1}{m_e^*} = \frac{1}{\hbar^2} \frac{\partial^2 E}{\partial k^2}$$

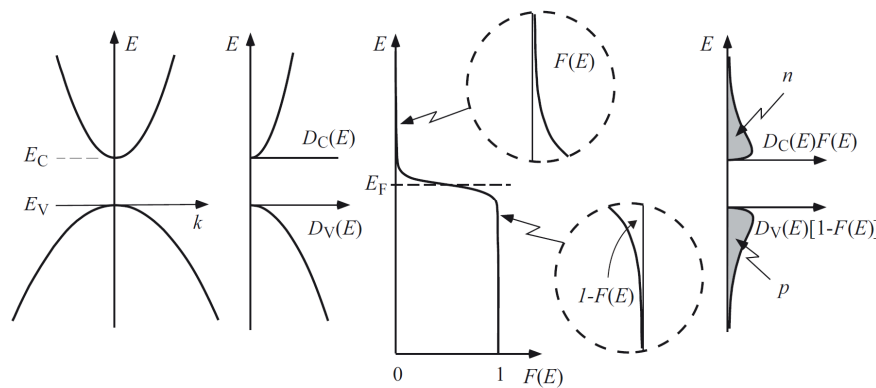
- Related to shape of the bands
- Summarizes crystal – carrier interaction
- Carriers respond to external force as *if* they had a mass $\neq m_0$.



$m_e > 0$ in the conduction band

$m_h > 0$ in the valence band

Charge carrier concentrations:



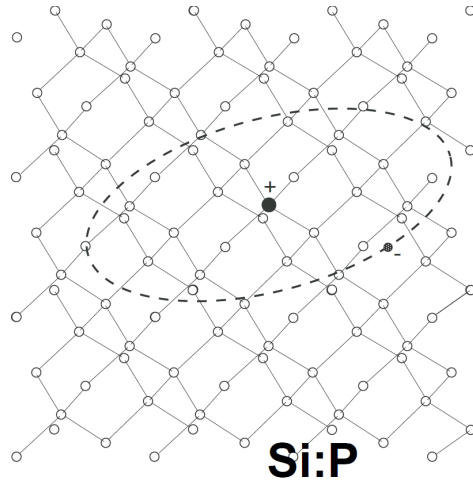
$$E_C - E_F \gg kT \Rightarrow F(E) \ll 1 \text{ f\"or } E > E_C$$

$$E_F - E_V \gg kT \Rightarrow F(E) \ll 1 \text{ f\"or } E < E_V$$

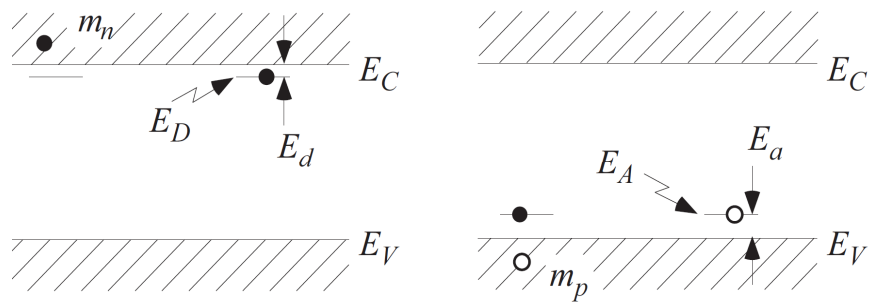
- Thermal equilibrium
- In any band state; small probability for charge carriers

$$n = N_C e^{-(E_C - E_F)/kT}$$

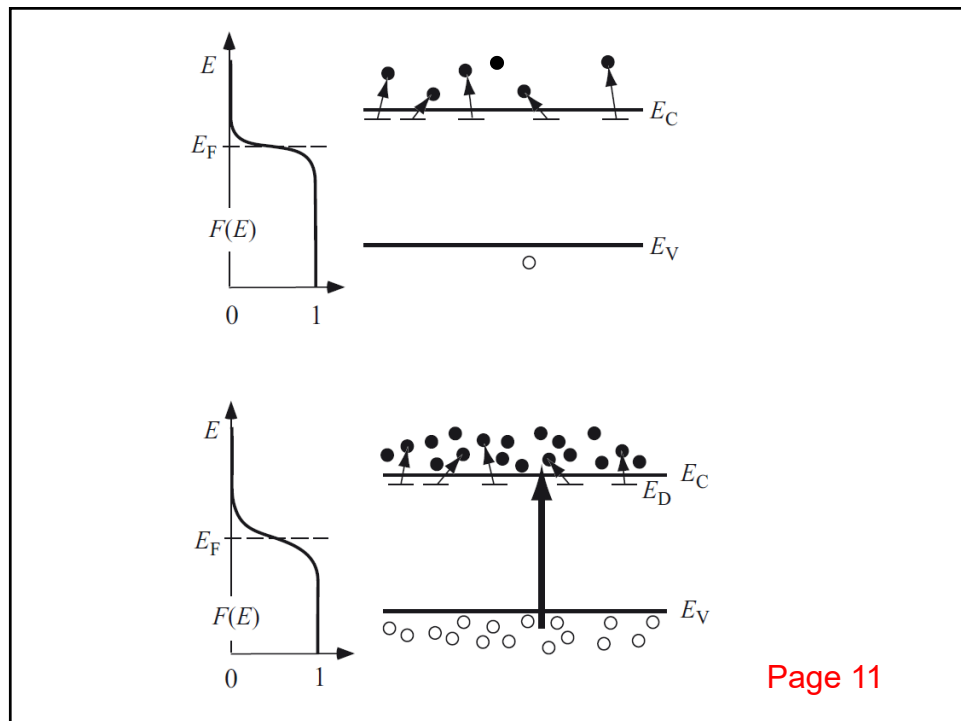
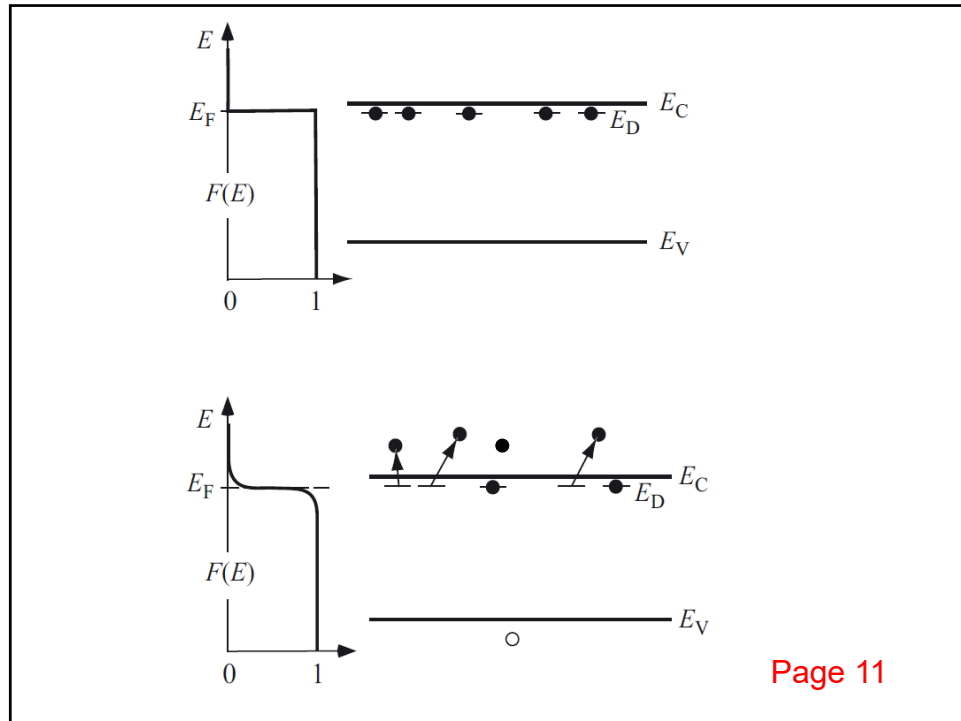
$$p = N_V e^{-(E_F - E_V)/kT}$$

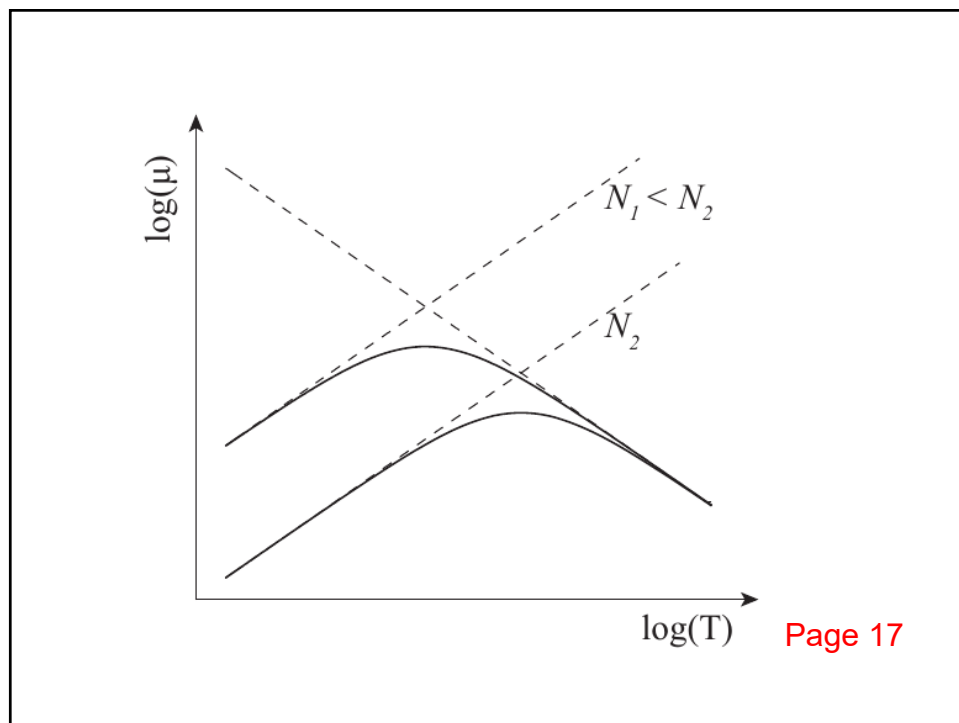
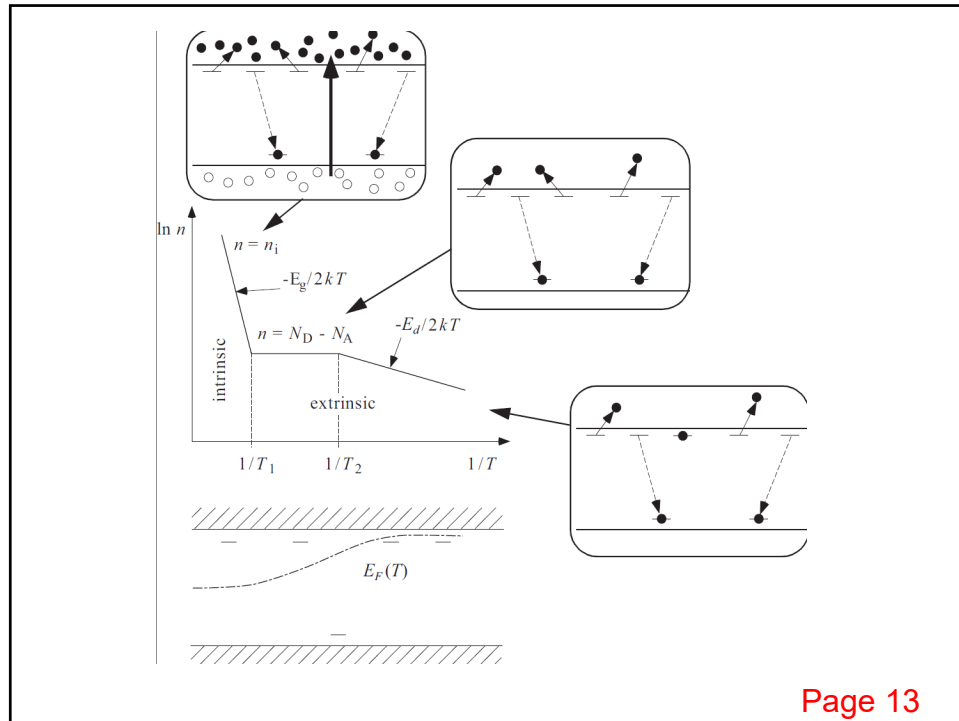


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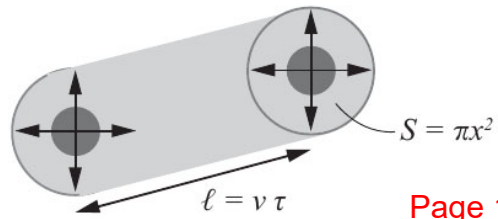


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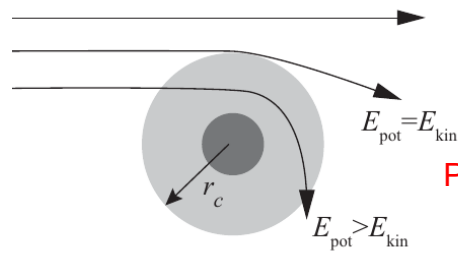


Scattering by
lattice vibrations



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Scattering by
charged
impurities



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