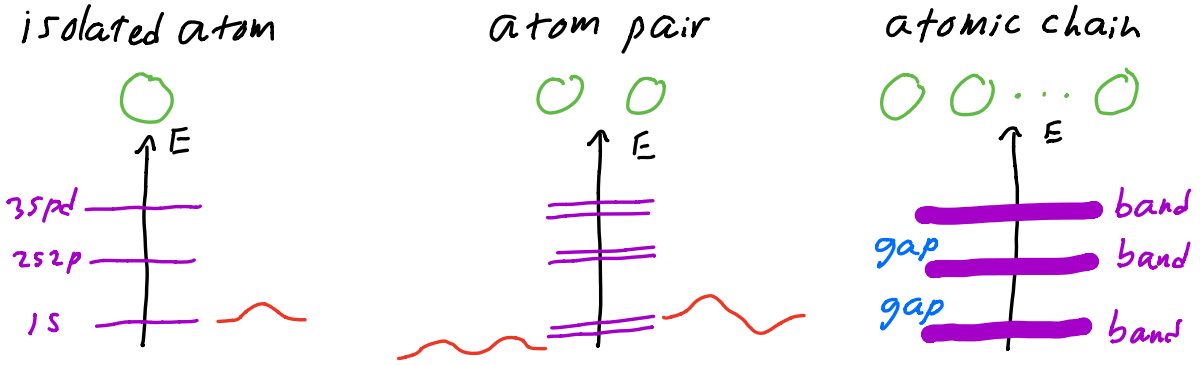
Energy Bands

Tight binding limit



Nearly free electrons

potential $V(x)$ periodicity $V(x+a) = V(x)$

Bloch Theorem: $\psi_k(x) = e^{ikx} u_k(x)$ $u_k(x+a) = u_k(x)$ a = period

empty lattice approximation:

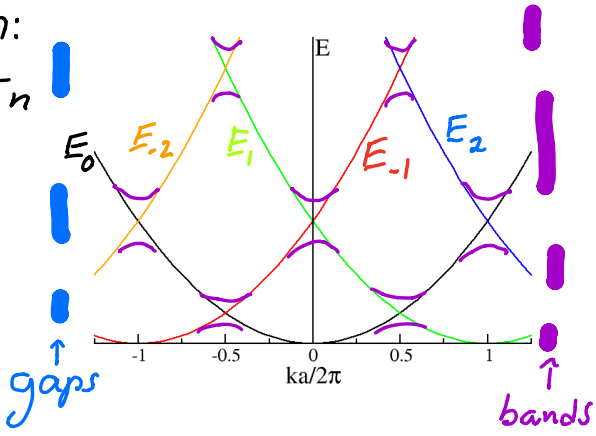
$V(x) = 0$ $u_k(x) = e^{iGx}$ $G = \frac{2\pi}{a} n$

$\Rightarrow E_n(k) = \frac{\hbar^2}{2m}\left(k - \frac{2\pi}{a} n\right)^2$

$\Rightarrow$ band crossings

Weak potential $V(x) \neq 0$:

$\Rightarrow$ non-crossing rule



Fermi energy in band $\Rightarrow$ metal

Electrons at E_F accelerated by applied field

Fermi energy in gap $\Rightarrow$ Semiconductor or insulator

Electrons must cross gap to respond to field