Current Flow in Semiconductors

$$I = J \times A$$

$$\mu = \frac{e\tau}{m^*}$$

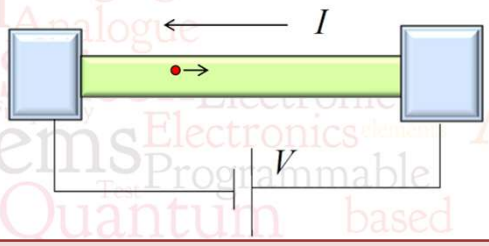
Mobility

$$\mathrm{J} = n \times e \times \mu \times \mathbb{E}$$

Electric Field

Carrier Concentration

Electronic Charge



Chemical composition, crystal structure, temperature, doping, etc. – **SOLID STATE PHYSICS**

$$n = \int n(E)\,\mathrm{d}E$$

$$= \int \rho(E) f(E)\,\mathrm{d}E$$

Carrier Density

Density of States

Fermi Function

Density of States, Fermi function – **QUANTUM MECHANICS & STATISTICAL MECHANICS**

Mobility, Diffusion – **ELECTRODYNAMICS**

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Band Theory of Solids

- Electrons interact with each other and in a real solid atoms are vibrating causing time dependent variations in the potential energy.

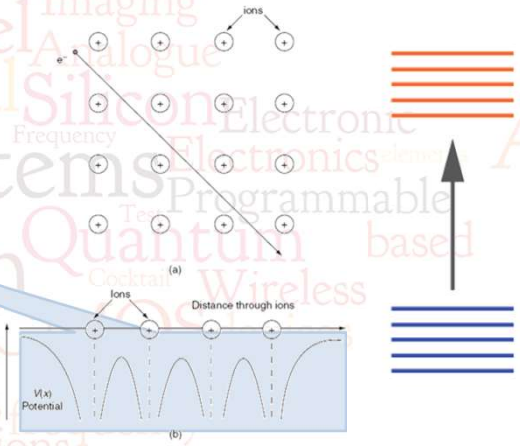
$$\left(-\frac{h^2}{2m}\nabla^2 + V\right)\psi(\vec{r}) = E\psi(\vec{r})$$

- The wavefunctions for the electron must satisfy Bloch's theorem

$$\psi(\vec{r}) = \psi_{n,k}(\vec{r}) = e^{i\vec{k}.\vec{r}}u_{n,k}(\vec{r})$$

$$\psi_{n,k}(\vec{r}+\vec{R}) = e^{i\vec{k}.\vec{R}}\psi_{n,k}(\vec{r})$$

$$u_{n,k}(\vec{r}+\vec{R}) = u_{n,k}(\vec{r})$$



- There are two main categories of realistic band structure calculation for semiconductors:
  - Methods which describe the entire valence and conduction bands.
  - Methods which describe near band-edge band structures.

Tight Binding Methods, pseudopotential methods

K.P methods

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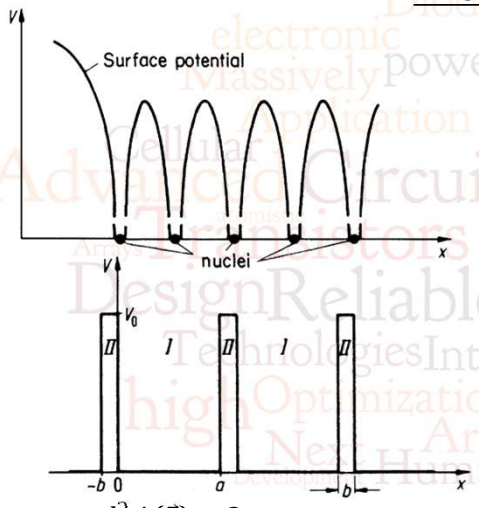
Krönig-Penney Model



$$\frac{d^2\psi(\vec{r})}{dx^2} + \frac{2m}{\hbar^2}E\psi(\vec{r}) = 0$$

$$\frac{d^2\psi(\vec{r})}{dx^2} + \frac{2m}{\hbar^2}(E - V_0)\psi(\vec{r}) = 0$$

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