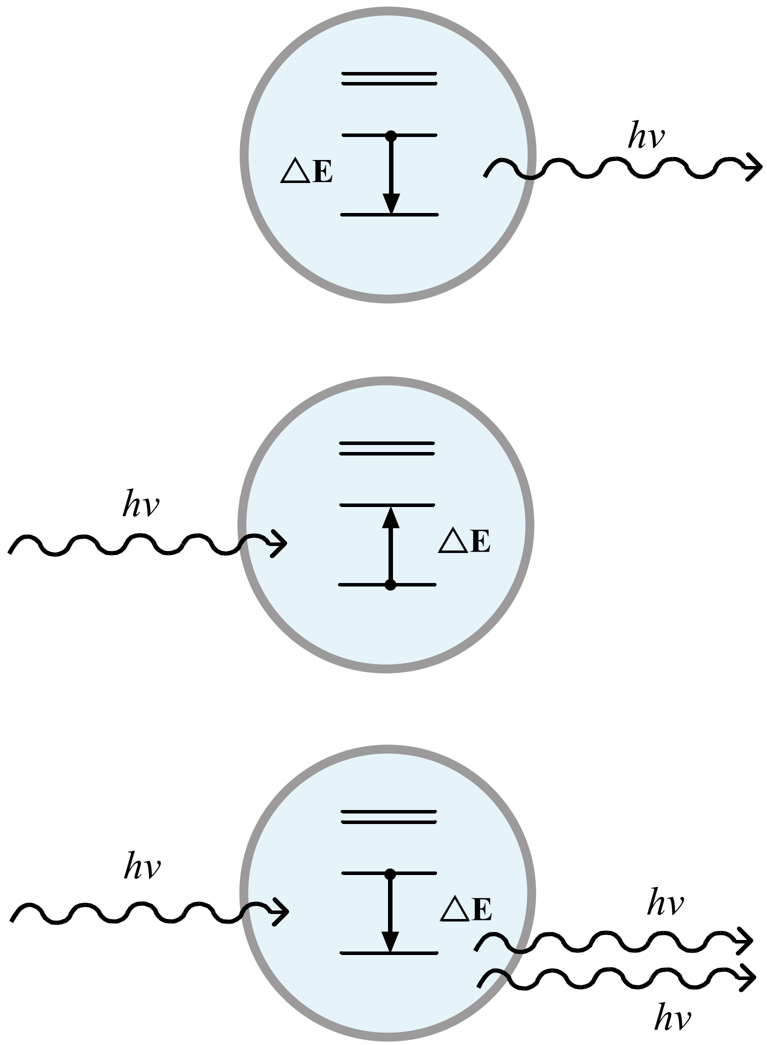

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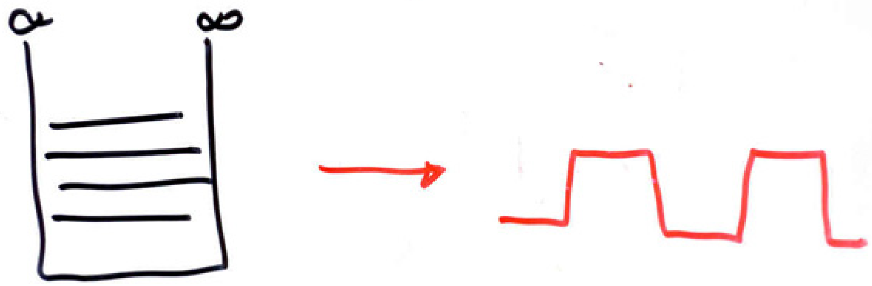
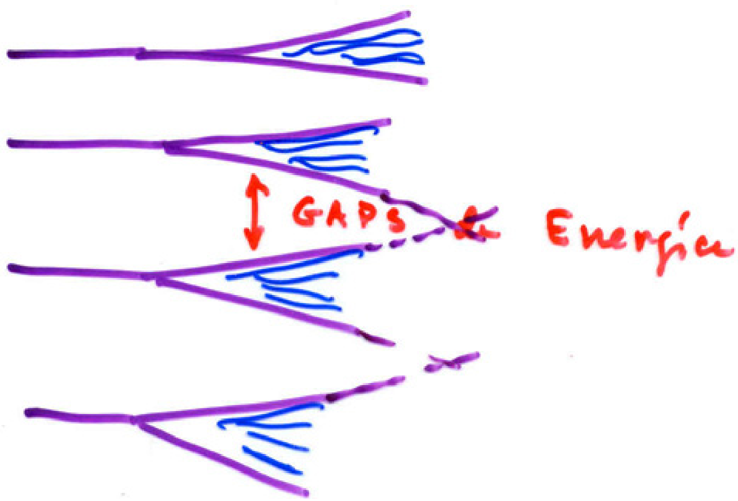
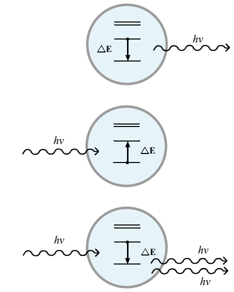
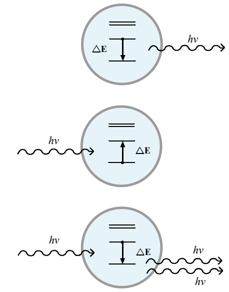

a
∞

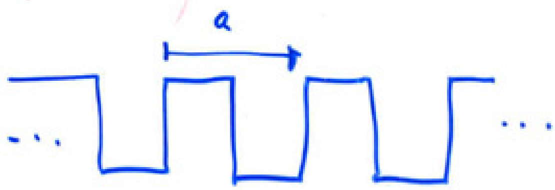

GAPS
Energía


ΔE
hν

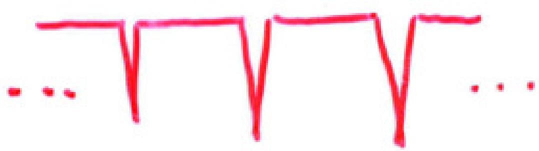


Estructura de Bandas en Sólidos

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



Modelo + simple

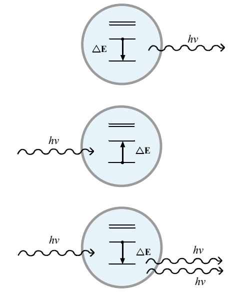


Teorema de Bloch.

$$-\frac{\hbar^2}{2m}\frac{d^2}{dx^2}\psi + V(x)\psi = E\psi$$

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

$$\Longrightarrow$$



$$\psi(x+a) = e^{ika}\,\psi(x)$$

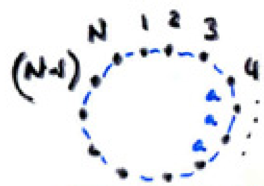
Teorema de Bloch

$$\boxed{k = ?}$$

(red ∞) $(N \simeq \infty)$ 10^{24}

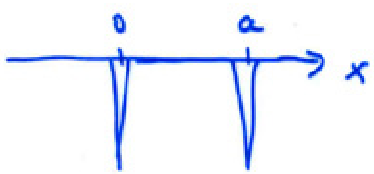
$$\psi(x+Na) = \psi(x)$$

$$e^{ikNa}\,\psi(x) = \psi(x)$$



$$\boxed{k = \pm \frac{2\pi n}{aN}} \Leftarrow$$

Modelo red periódica Na



$0 < x < a$

$$-\frac{\hbar^2}{2m}\psi'' = E\psi$$

$$k \equiv \sqrt{\frac{2mE}{\hbar^2}}, \qquad \psi = A \sin kx + B \cos kx$$

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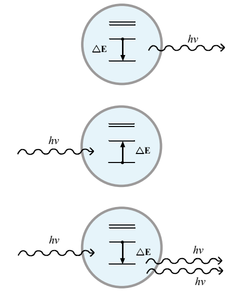
Clase 21B



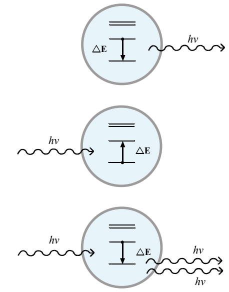
$$\psi(x) = e^{-ika}\left[A \sin k(x+a) + B \cos k(x+a)\right]$$

$(-a < x < 0)$

Cond. de Borde

$\psi(0)$: continua

$\psi'(0^-) \neq \psi'(0^+)$ (la función $\delta(x)$!!)



Técnica para resolver la $\delta(x)$

$$\psi'' + (-)\frac{2m\alpha}{\hbar^2}\delta(x)\,\psi(x) = E\,\psi(x)$$

$$V(x) = -\alpha\,\delta(x)$$

$$\int_{-\varepsilon}^{+\varepsilon}\psi''\,dx - \frac{2m\alpha}{\hbar^2}\int_{-\varepsilon}^{+\varepsilon}\delta(x)\,\psi(x)\,dx = E\int_{-\varepsilon}^{+\varepsilon}\psi(x)\,dx.$$

$$\psi'(+\varepsilon) - \psi'(-\varepsilon) - \frac{2m\alpha}{\hbar^2}\psi(0) = E\,\psi(0)(2\varepsilon)$$

si $\varepsilon \to 0$

$$\boxed{\psi'(0^+) = \psi'(0^-) + \frac{2m\alpha}{\hbar^2}\psi(0)}$$

Discontinuidad de las Primeras derivadas.

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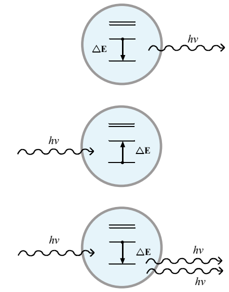
Clase 21B



Continuidad de ψ en $x=0$: $\psi(0) = e^{-ika}\,\psi(a)$

(*) $$B = e^{-ika}\left[A \operatorname{sen} ka + B \cos ka\right]$$

$\boxed{\psi'(0)}$:

(**) $$kA = e^{ika}\cdot k \cdot\left[A \cos ka - B \operatorname{sen} ka\right] - \frac{2m\alpha}{\hbar^2} B$$

$$\begin{bmatrix} \cdot & \cdot \\ \cdot & \cdot \end{bmatrix}\begin{bmatrix} A \\ B \end{bmatrix} = 0 \Rightarrow \det\begin{bmatrix} \cdot & \cdot \\ \cdot & \cdot \end{bmatrix} = 0$$

$$\boxed{\cos Ka = \cos(ka) - \frac{m\alpha}{\hbar^2 k}\operatorname{sen}(ka)}$$

$K = \frac{2\pi n a}{N}$

$k^2 = \frac{2mE}{\hbar^2}$

cuantización de la energía!

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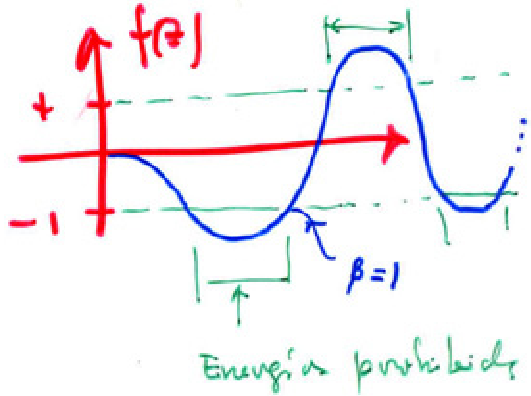
Clase 21B

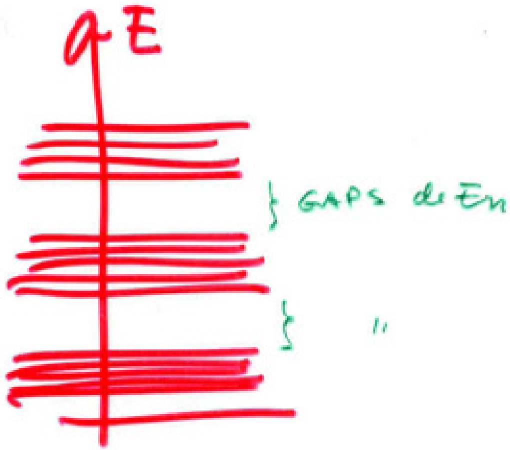
$$\beta \equiv \frac{m a \alpha}{\hbar^2}$$

$$f(z) = \cos z - \beta \frac{\sin z}{z} \longrightarrow \square$$

$$= \cos\left(\frac{2\pi}{N} n\right) \longrightarrow \Delta$$

$$|\Delta| < 1$$





Distingue: conductores
Aisladores
semi-conductores