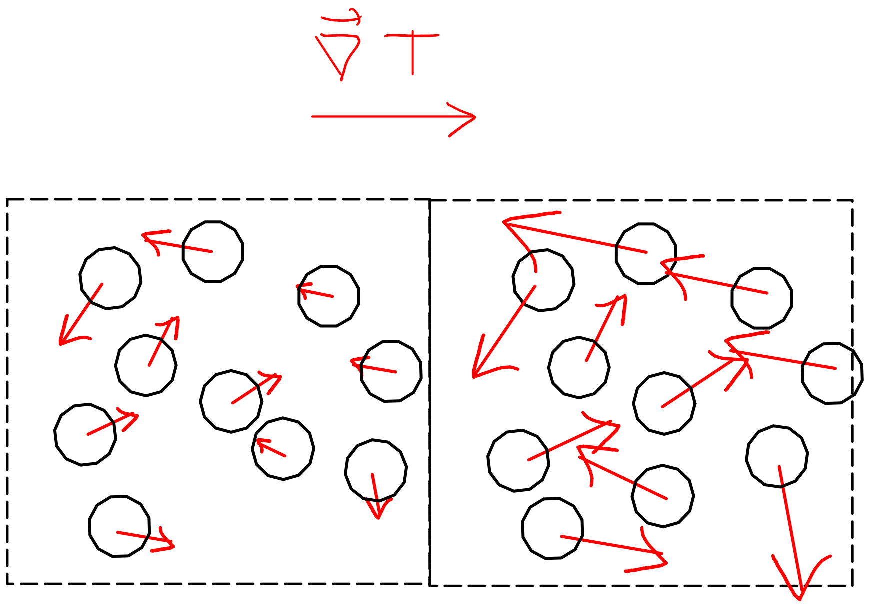
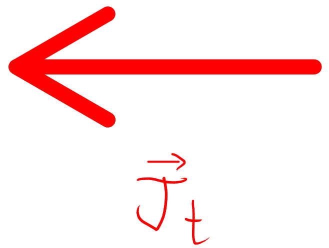
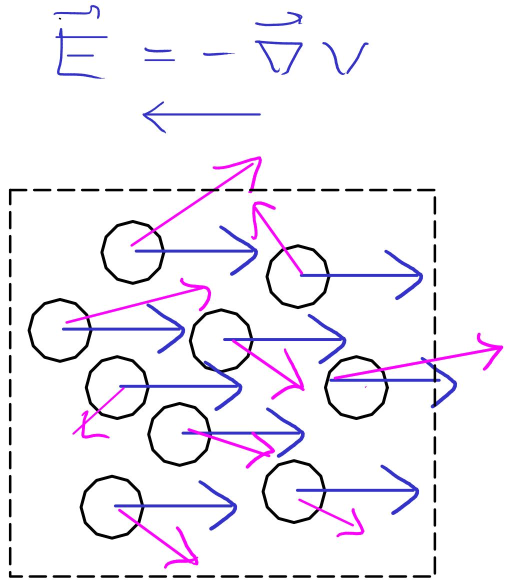
CONDUZIONE ELETTRICA

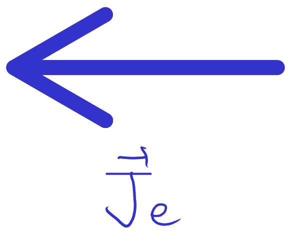


conduzione termica



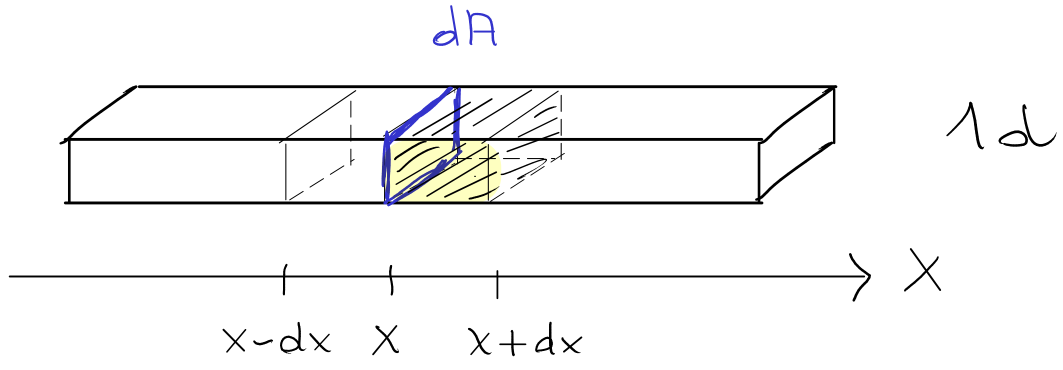


conduzione elettrica

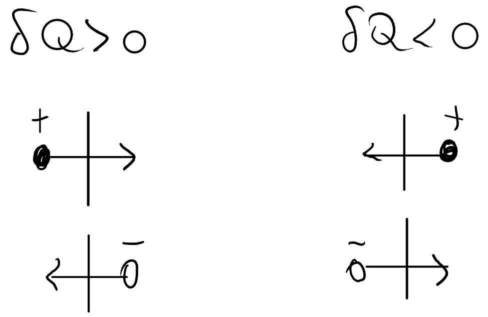


Legge di Ohm

conduttore



$$\vec{E} = E\,\vec{e}_x$$



$\delta q \equiv$ carica elettrica che attraversa la superficie dA del sottosistema in x durante l'intervallo di tempo dt, proveniente dal sottosistema in x - dx

$$\delta q \sim dA\, dt\, E \sim -\, dA\, dt\, \frac{dV}{dx}$$

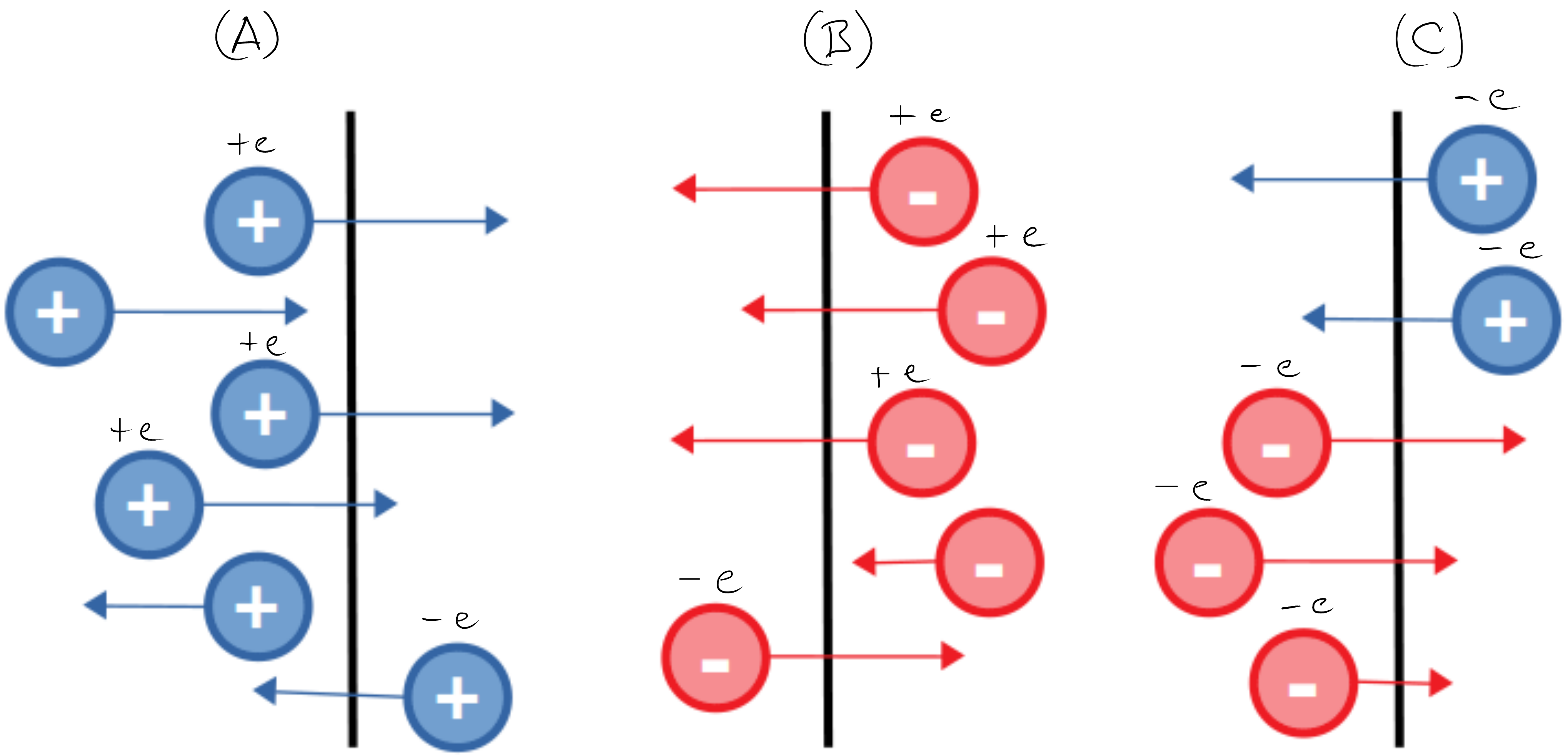
$$I_e \equiv \frac{\delta q}{dt}$$ corrente elettrica SI: A (Ampère) $= \frac{C}{s}$

$$J_e \equiv \frac{\delta q}{dt\, dA}$$ densità di corrente elettrica SI: $\frac{A}{m^2}$ $\Rightarrow \vec{J}_e$

Es: intervallo di tempo $dt = 10^{-14}\,s$, cariche elementari $\pm e = \pm 1.6 \times 10^{-19}\,C$

Calcola la corrente elettrica I_e attraverso la superficie in ciascun caso.

$$I_e = \frac{\delta q}{dt}$$



$$I_e = \frac{+2e}{10^{-14}\,s} = 3{,}2 \times 10^{-5}\,A$$

$$I_e = 3{,}2 \times 10^{-5}\,A$$

$$I_e = \frac{-5e}{10^{-14}\,s} = -8 \times 10^{-5}\,A$$

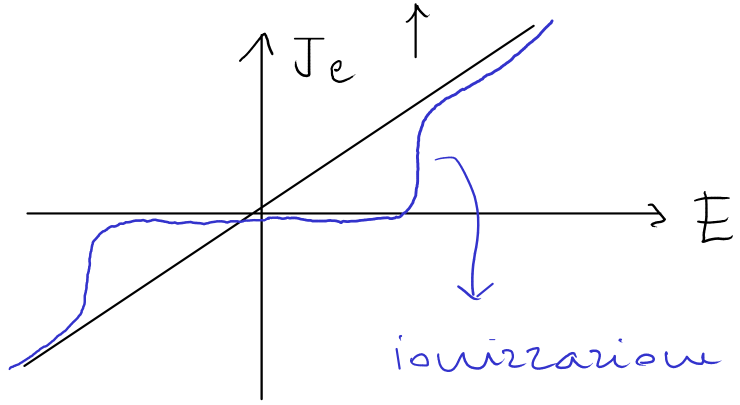
$J_e \sim E \longrightarrow J_e = \sigma E = -\sigma \frac{dV}{dx}$ legge di ohm $\vec{J}_e = \sigma \vec{E}$

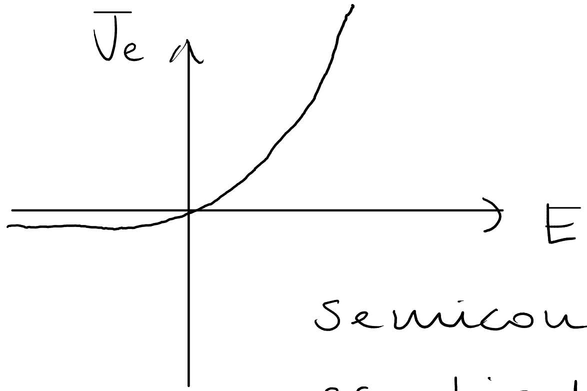
$= -\sigma \vec{\nabla} V$

σ ↑ conducibilità elettrica

SI : ...

conduttori ohmici





semiconduttori :

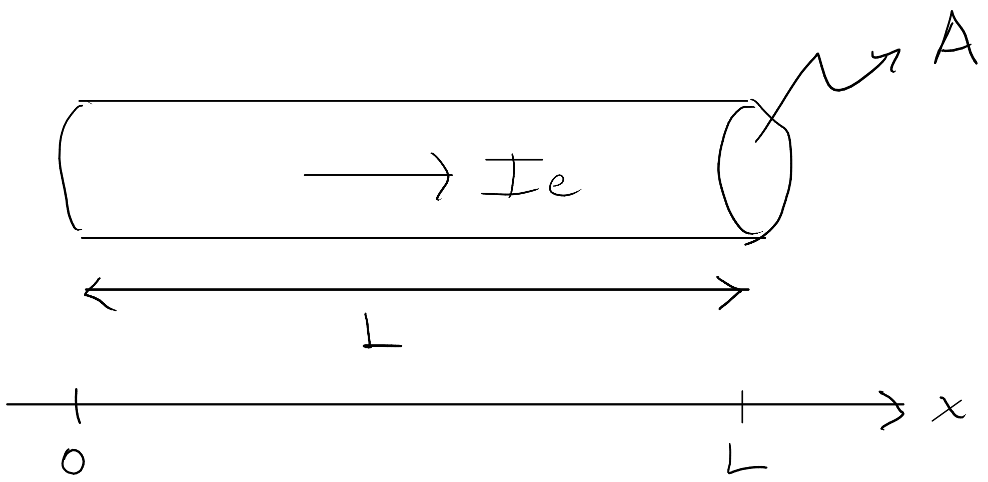
es. diodi

Analogia con la conduzione elettrica

$\vec{J}_t = -\lambda \vec{\nabla} T$ Fourier $R_t \equiv \frac{L}{\lambda A}$

$\vec{J}_e = -\sigma \vec{\nabla} V$ Ohm $R_e \equiv \frac{L}{\sigma A}$

Regime stazionario : $J_e = \text{cost}$ Conduttore uniforme : $\sigma = \text{cost}$



$$I_e = J_e A = -\sigma A \frac{dV}{dx}$$

$$\int_0^L I_e \, dx = -\sigma A \int_0^L \frac{dV}{dx} \, dx$$

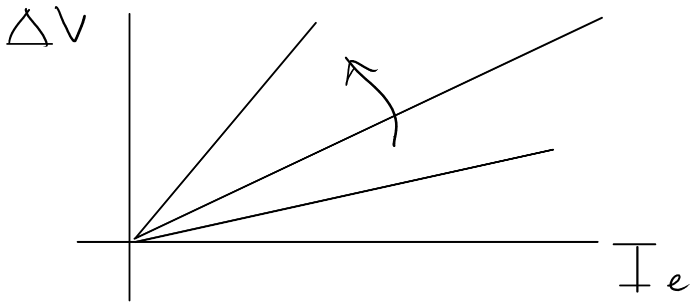
$$I_e \cdot L = -\sigma A \int_{V(0)}^{V(L)} dV = \sigma A \overbrace{[V(0) - V(L)]}^{\Delta V}$$

$$I_e L = \sigma A \Delta V$$

$$\Delta V = \frac{L}{\sigma A} I_e$$

Resistenza elettrica

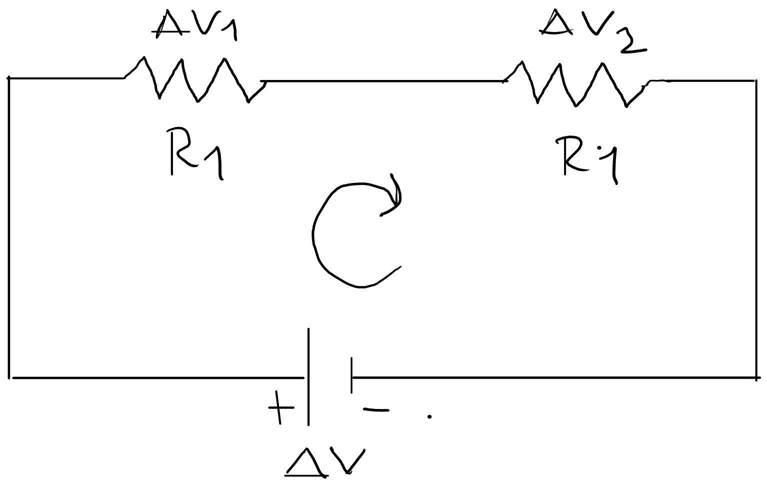
$$R \equiv \frac{L}{\sigma A} \quad (\equiv R_e) \qquad SI: \frac{V}{A} \equiv \Omega \text{ (ohm)}$$



$$R = \frac{\Delta V}{I_e} \qquad \Delta V = R I_e$$

$$[\sigma] = \frac{L}{[R] L^2} = \frac{1}{[R] L} \qquad SI: \frac{1}{\Omega m}$$

1) Resistenze in serie



—/\/\/\— conduttore con resistenza $\neq 0$

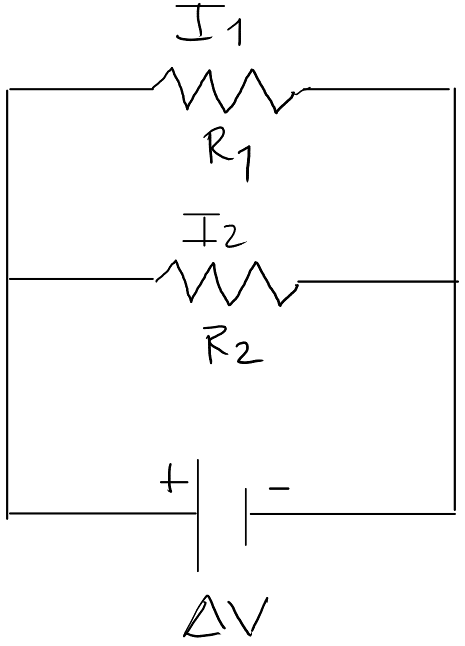
$$I = I_1 = I_2 \quad \text{(stazionario)}$$

$$\Delta V = \Delta V_1 + \Delta V_2 = R_1 I + R_2 I = R_{tot} I$$

$$\Rightarrow R_{tot} = R_1 + R_2$$

$$R_{tot} = \sum_{i=1}^{M} R_i$$

2) Resistenze in parallelo



$$I = I_1 + I_2 = \frac{\Delta V}{R_1} + \frac{\Delta V}{R_2} = \frac{\Delta V}{R_{tot}}$$

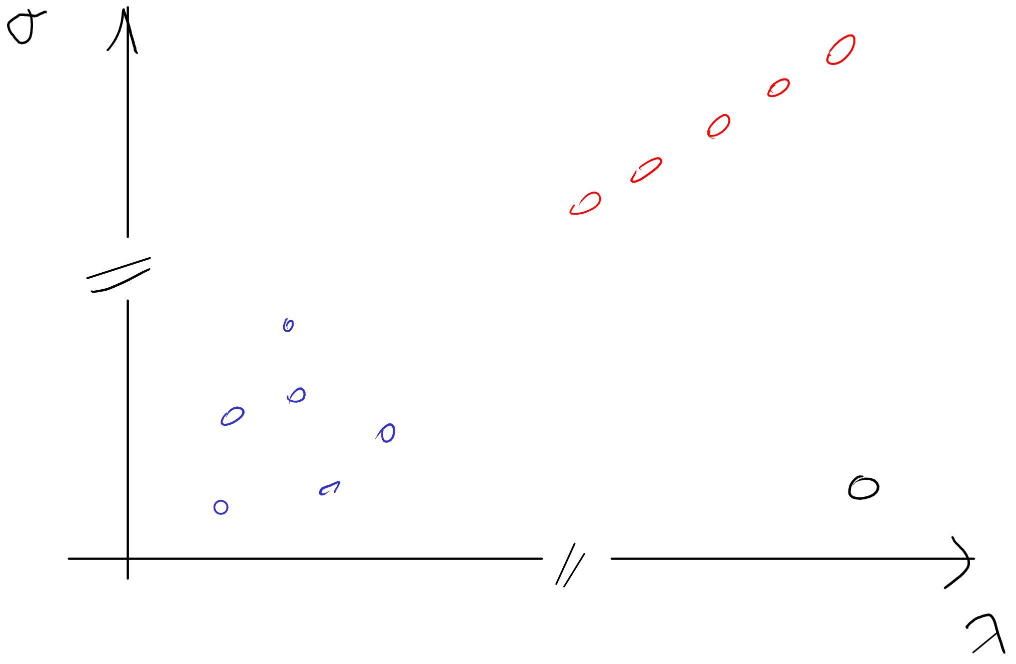
$$\Delta V = \Delta V_1 = \Delta V_2$$

$$\Rightarrow \frac{1}{R_{tot}} = \frac{1}{R_1} + \frac{1}{R_2} \Rightarrow R_{tot} = \frac{R_1 R_2}{R_1 + R_2}$$

$$\frac{1}{R_{tot}} = \sum_{i=1}^{M} \frac{1}{R_i}$$

Conducibilità elettrica e conducibilità termica

@ Tamb



metalli : $\sigma \sim \lambda$ Cu, Ag, Au

isolanti : bassa σ, bassa λ

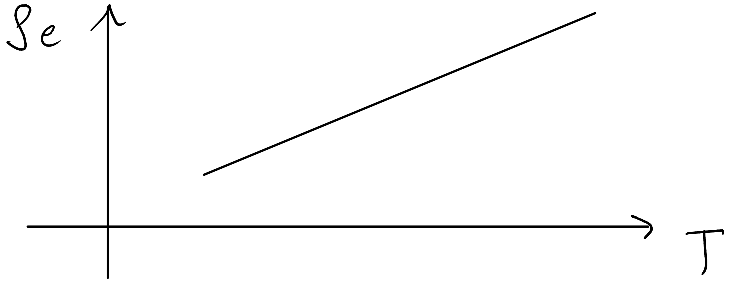
outlier : alta λ, bassa λ
diamante (es.)

Resistività elettrica

$$\rho_e \equiv \frac{1}{\sigma} \qquad SI : \Omega m$$

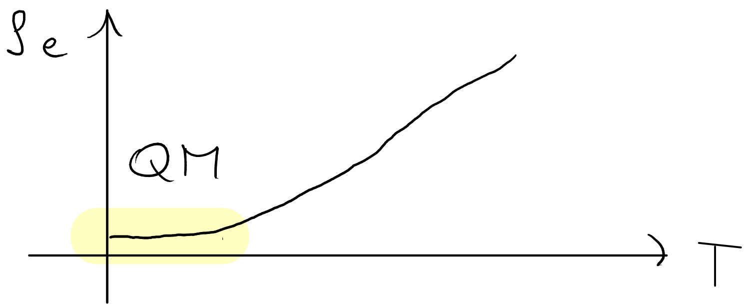
Dipendenza della resistività ρ_e dalla temperatura

- Alta temperatura [es. Cu, Ag ...]

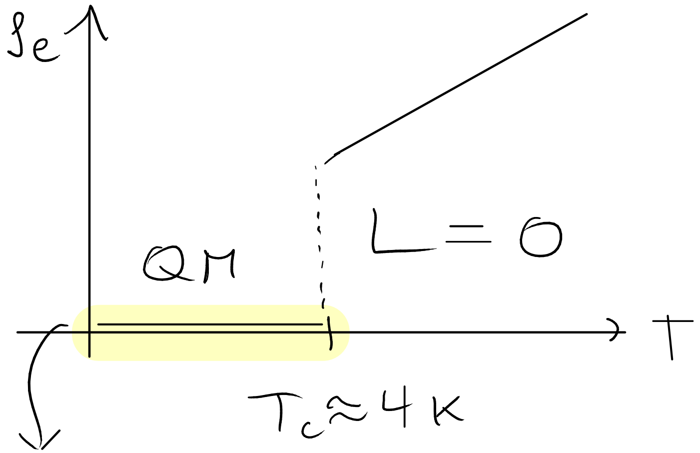


$\rho_e \sim T$

- Bassa temperatura



- Superconduttori



10^{-25} Ωm

Onnes 1911

Hg

- materiali ceramici $T_c \sim 100K - 200K$

transizione di fase di II ordine