Thermoelectricity, Atoms to Systems
L1.6 Quiz
Answers

1.6a. We were able to obtain all the results this week without using the full Boltzmann equation because we treated the channel as an elastic resistor, which is a good approximation for nanodevices, while longer devices can often be understood approximately in terms of elastic resistors in series.

Why are our expressions for the current

$$I = \frac{1}{q}\int_{-\infty}^{+\infty} dE\, G(E)\big(f_1(E) - f_2(E)\big)$$

and the energy current

$$I_Q \approx \frac{1}{q}\int_{-\infty}^{+\infty} dE\, \frac{E-\mu_0}{q}\, G(E)\big(f_1(E) - f_2(E)\big)$$

not applicable to long channels with inelastic scattering?

(a) Because the current at each energy cannot be calculated independently

(b)The functions $f_1(E)$ and $f_2(E)$ for the source and drain cannot be defined

(c) The energy distribution of electrons in the channel cannot be described by a Fermi function

(d) There is no interface resistance

(e) None of the above. The expression is still applicable.

1.6b. The conductance function G(E) appearing in the current equation is proportional to the number of modes M(E). For a 2D conductor of width W, with an energy-momentum relation $E(p) \sim p^{\alpha}$, the number of modes is given by

(a) $M(E) \sim W^2 E^{\alpha}$

(b) $M(E) \sim W E^{\alpha}$

(c) $M(E) \sim W E^{1/\alpha}$

(d) $M(E) \sim W^2 E^{1/\alpha}$

(e) $M(E) \sim W E^{\alpha/2}$