1) $I = \bar{j}_x A$

$$\bar{j}_x = e \int_{\varepsilon_F^0}^{\varepsilon_F^0 + eV} dE \int_0^{\pi/2} d\theta \; v_F \cos\theta \; 2\pi \sin\theta \; \frac{\partial^2 n}{\partial E \partial \Omega}$$

Ω = solid angle

$$\frac{\partial^2 n}{\partial E \partial \Omega} = \frac{1}{4\pi} \frac{\partial n}{\partial E} = \frac{1}{4\pi} D(E) \quad \text{(isotropic)}$$

$$j_x = e v_F \frac{D(E)}{2} \int_{\varepsilon_F^0}^{\varepsilon_F^0 + eV} dE \underbrace{\int_0^{\pi/2} d\theta \cos\theta \sin\theta}_{1/2}$$

$$= e^2 V \; v_F \frac{D(E)}{2} \times \frac{1}{2}$$

$$= e^2 V \; v_F \frac{3n}{2\varepsilon_F} \times \frac{1}{4} \qquad \underbrace{n = \frac{k_F^3}{3\pi^2} \quad \varepsilon_F = \frac{m v_F^2}{2}}$$

$$= \frac{e^2 V}{4} \frac{3 k_F^3}{3\pi^2} \frac{1}{m v_F} = \frac{e^2 V}{4\pi^2} \frac{k_F^3}{\hbar k_F}$$

$$= \frac{2e^2}{h} \frac{k_F^2}{4\pi} V$$

3

$$I = J \times A = \frac{2e^2}{h} \frac{k_F^2 A}{4\pi} V$$

$$G = \frac{I}{V} = \frac{2e^2}{h} \frac{k_F^2 A}{4\pi}$$

3) Bessel function zeros:

J_0	J_1	J_2	J_3
2.4048	3.8317	5.1356	6.3802
5.5201	7.0156	8.4172	9.7610

nanowire mode lies below ε_F if

$$\frac{\hbar^2 \gamma_{mn}^2}{2mR^2} < \frac{\hbar^2 k_F^2}{2m}$$

$$\gamma_{mn} < k_F R = 6$$

$\gamma_{01}, \gamma_{02}, \gamma_{11}, \gamma_{12}$ all ~~the~~ are < 6.

modes with $m=0$ are nondegenerate;
modes with $m \neq 0$ are 2-fold degenerate.

$$G = N \frac{2e^2}{h}, \quad N = 1+1+2+2 = 6.$$