FUNDAMENTALS OF NANOELECTRONICS

Basic Concepts

The New Perspective

2. Energy Band Model

3. What and Where is the Voltage?

4. Heat & Electricity: Second Law & Information

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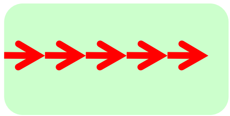
http://nanohub.org/groups/lnebook

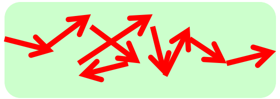
$$G_B = q^2 \frac{D\bar{\nu}}{2L}\ , \quad \sigma = q^2 \frac{\bar{D}}{AL} D$$

Ballistic



$$G = \frac{q^2 D}{2t}$$

Diffusive



$$G = \frac{\sigma A}{L+\lambda},$$

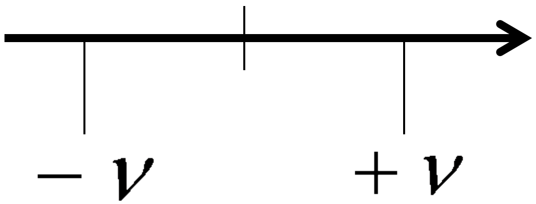
General

$$\sigma = G_B \lambda\ , \quad \lambda \equiv \frac{2\bar{D}}{\bar{\nu}}$$

1.8a Angular Averaging

$$\bar{\nu} : \left\langle |\nu_z| \right\rangle\ , \quad \bar{D} : \left\langle \nu_z^2 \tau \right\rangle$$

1-D



$$\bar{\nu} = \nu\ , \quad \bar{D} = \nu^2 \tau$$

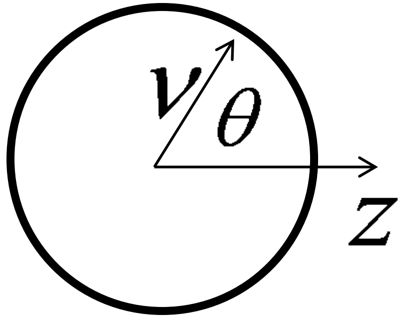
$$\lambda = 2\nu\tau$$

mfp for backscattering

1.8b Angular Averaging

2-D

$$\bar{v} = \frac{\int_{-\pi}^{+\pi} d\theta \left| v\cos\theta \right|}{\int_{-\pi}^{+\pi} d\theta}$$

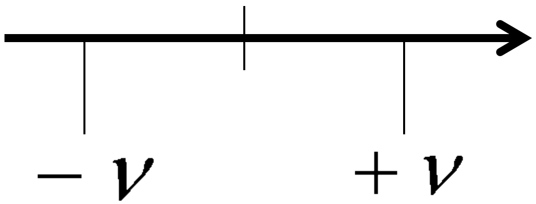


$$= v \frac{\int_{-\pi/2}^{+\pi/2} d\theta \cos\theta}{\int_{-\pi/2}^{+\pi/2} d\theta} = \frac{2v}{\pi}$$

$$\bar{D} = v^2\tau \frac{\int_{0}^{2\pi} d\theta \cos^2\theta}{\int_{0}^{2\pi} d\theta} = \frac{v^2\tau}{2}$$

$$\bar{v} : \left\langle \left| v_z \right| \right\rangle \quad , \quad \bar{D} : \left\langle v_z^2 \, \tau \right\rangle$$

1-D



$$\bar{v} = v \; , \; \bar{D} = v^2\tau$$

$$\lambda = 2v\tau$$

mfp for backscattering

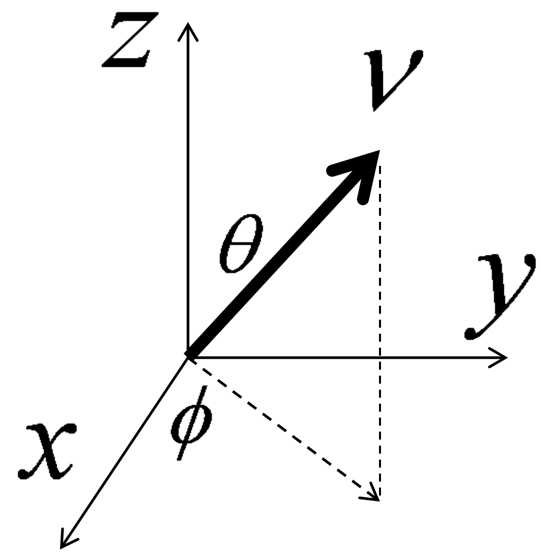
1.8c Angular Averaging

$$\bar{v} = \frac{\int_0^{2\pi} d\phi \int_0^{\pi} d\theta \sin\theta \; |\, v\cos\theta \,|}{\int_0^{2\pi} d\phi \int_0^{\pi} d\theta \sin\theta}$$

$$= v \; \frac{\int_0^{2\pi} d\phi \int_0^{\pi/2} d\theta \sin\theta \;\; \cos\theta}{\int_0^{2\pi} d\phi \int_0^{\pi/2} d\theta \sin\theta} = \frac{v}{2}$$

$$\bar{D} = v^2 \tau \; \frac{\int_0^{2\pi} d\phi \int_0^{\pi/2} d\theta \sin\theta \cos^2\theta}{\int_0^{2\pi} d\phi \int_0^{\pi/2} d\theta \sin\theta} = \frac{v^2 \tau}{3}$$

3-D



$$r^2 \int_0^{2\pi} d\phi \int_0^{\pi} d\theta \sin\theta$$

$$= 4\pi r^2$$

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Ballistic

$$G_B = q^2 \frac{D\bar{v}}{2L}$$

$$G = \frac{G_B \lambda}{L+\lambda}, \quad \lambda \equiv \frac{2\bar{D}}{\bar{v}}$$

$$\bar{v}: \quad \langle |v_z| \rangle = v \left\{ 1 \ , \ \frac{2}{\pi} \ , \ \frac{1}{2} \right\}$$

$$1D \quad 2D \quad 3D$$

$$\bar{D}: \quad \langle v_z^2 \tau \rangle = v^2 \tau \left\{ 1 \ , \ \frac{1}{2} \ , \ \frac{1}{3} \right\}$$

$$1D \quad 2D \quad 3D$$

$$\lambda \equiv \frac{2\bar{D}}{\bar{v}} = v\tau \left\{ 2 \ , \ \frac{\pi}{2} \ , \ \frac{4}{3} \right\}$$

Coming up next ..