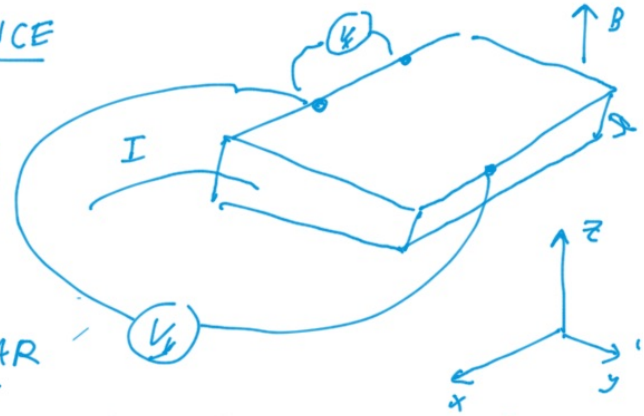
MAGNETO-RESISTANCE



$$\rho_{xx} = \frac{E_x}{j_x}\,; \quad \sigma_{xx} = \frac{j_x}{E_x} = \frac{1}{\rho_{xx}}$$

$$\rho_{xy} = \frac{E_y}{j_x} = R_H \cdot B$$

GENERAL FORMULAR

$$\vec{E} = \vec{\rho} \cdot \vec{j} \quad \text{where} \quad \vec{\rho} = \begin{pmatrix} \rho_{xx} & -\rho_{xy} \\ \rho_{xy} & \rho_{yy} \end{pmatrix} = \begin{pmatrix} \rho_{xx} & -R_H B \\ R_H B & \rho_{xx} \end{pmatrix}$$

$$\vec{E} = \begin{pmatrix} E_x \\ E_y \end{pmatrix}\,; \quad \vec{j} = \begin{pmatrix} j_x \\ j_y \end{pmatrix}$$

$$\vec{j} = \vec{\rho}^{\,-1} \vec{E} = \vec{\sigma} \vec{E} \quad \text{where} \quad \vec{\sigma} = \begin{pmatrix} \sigma_{xx} & \sigma_{xy} \\ \sigma_{xy} & \sigma_{xx} \end{pmatrix}$$

POINT 1:

$\sigma_{xx} \neq \frac{1}{\rho_{xx}}$ for $B \neq 0$

MULTI BAND SYSTEM: N-FERMI SURFACES

$$\vec{j}_n = \vec{\rho}_n^{\,-1} \vec{E}$$

$$\vec{j}_{total} = \sum_{n=1}^{N} \vec{\rho}_n^{\,-1} \vec{E}$$

$$\vec{E} = \vec{\rho}\, \vec{j}_{total} \quad \text{where} \quad \vec{\rho} = \left(\sum \rho_n^{-1}\right)^{-1}$$

CONSIDER N=2: TWO FERMI SURFACES

DERIVED IN MATHEMATICA SCRIPT:

$$\rho_{xx} = \frac{\rho_1 \rho_2 (\rho_1 + \rho_2) + (\rho_1 R_{H,2}^2 + \rho_2 R_{H,1}^2) \cdot B^2}{(\rho_1 + \rho_2)^2 + (R_{H,1} + R_{H,2}) \cdot B^2} = \alpha_1 + \alpha_2 B^2$$

where α_1, α_2 = constants

B → 0 Limit → $\rho_{xx} = \frac{\rho_1 \rho_2}{(\rho_1 + \rho_2)}$ ⟶ $\sigma_{xx} = \frac{1}{\rho_{xx}} = \frac{1}{\rho_1} + \frac{1}{\rho_2} = \sigma_1 + \sigma_2$

DERIVED IN MATHEMATICA SCRIPT

$$R_H = \frac{R_{H,1}\rho_2^2 + R_{H,2}\rho_1^2 + R_{H,1}R_{H,2}(R_{H,1}+R_{H,2})B^2}{(\rho_1+\rho_2)^2 + (R_{H,1}+R_{H,2})^2 \cdot B^2} \approx \frac{R_{H,1}\rho_2^2 + R_{H,2}\rho_1^2}{(\rho_1+\rho_2)^2}$$

ASSUMING ELECTRON- AND HOLE-LIKE FERMI SURFACE

$R_{H,1} \sim -R_{H,2}$

$R_{H,1} = \frac{1}{p \cdot e}$

$R_{H,2} = \frac{-1}{ne}$

$\rho_1 = p \cdot e \cdot \mu_h$

$\rho_2 = n e \mu_h$

$$R_H = \frac{p\mu_h^2 - n\mu_e^2}{e(p\mu_h + n\mu_e)^2}$$

Compare to single-Band formular

$$R_H = \frac{-1}{en}$$