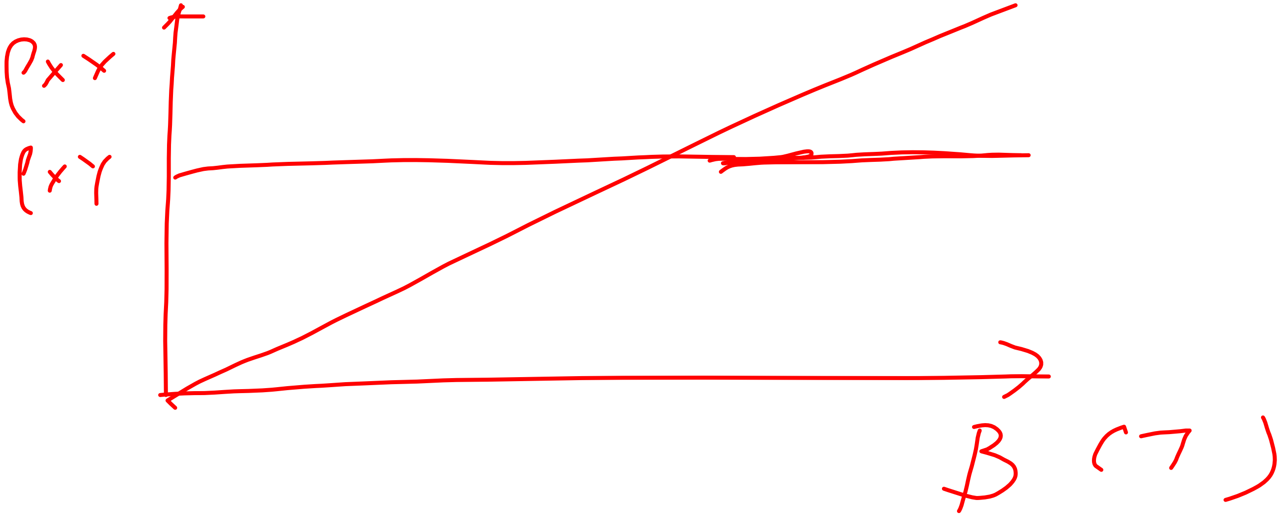


ρ_{xx} : B-independent

2D

ρ_{xy} : $\dfrac{B}{ne}$

$= R_{xy}$

$$\boxed{\rho_{xx}\frac{L}{W} = R_{xx}}$$

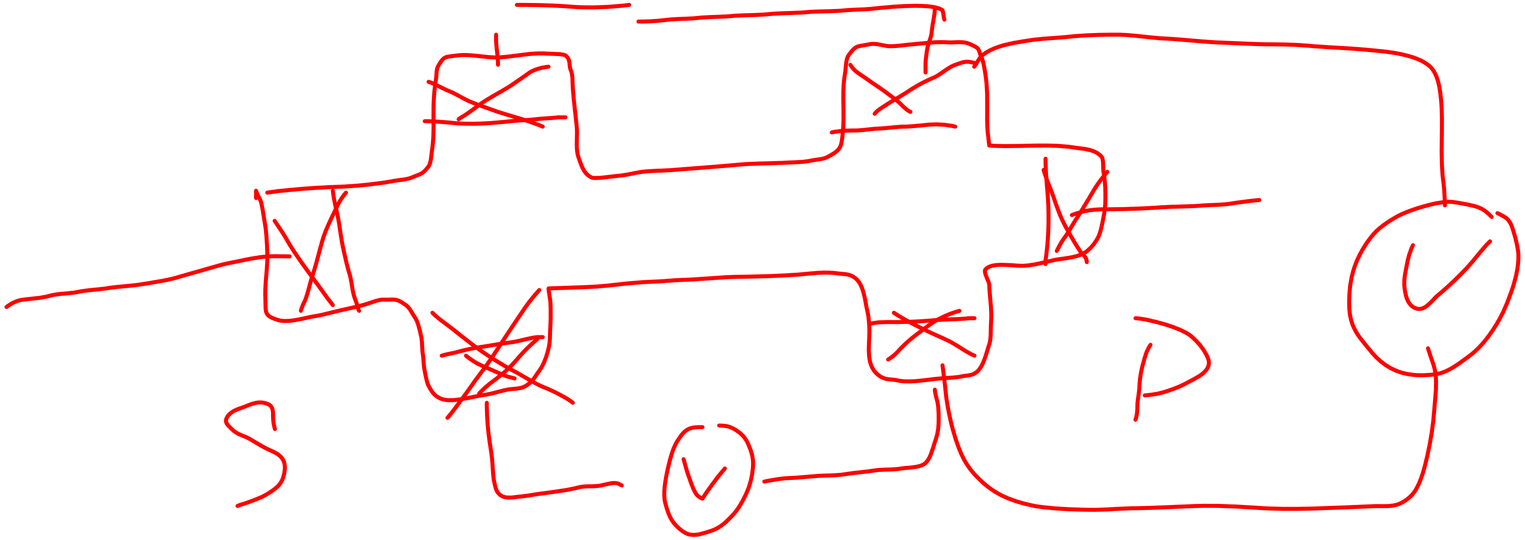
(Ω)

$$\boxed{\rho_{xx}\frac{L}{A} = R_{xx}\,(\Omega) \text{ in 3D} \qquad \rho_{xx} : \Omega m}$$

μB : dimensionless

μ : $m^2/V \cdot s$ $\left(\frac{1}{T}\right)$

SI unit



$$MR = \frac{R_{xx}(B) - R_{xx}(B=0)}{R_{xx}(B=0)}$$

Boltzmann transport

$MR = 0$

$R_{xx}(B) = R_{xx}(B=0)$

$$\sigma_{xx} = \frac{1}{\rho_{xx}} \quad \text{at} \quad B = 0$$

Conductivity resistivity

$$\boxed{\sigma_{xx} = \frac{\overset{\to 0}{\rho_{xx}}}{\underbrace{\rho_{xx}^2}_{\text{negligible}} + \underbrace{\rho_{xy}^2}_{\text{big}}}}$$

As $\rho_{xx} \to 0$, is it a superconductor? X

$\sigma_{xx} \propto \rho_{xx}$

$$\boxed{\begin{gathered}\rho_{xx} \to 0 \\ \sigma_{xx} \to 0\end{gathered}}$$ as well

$$\rho_{xy} = \frac{h}{\underbrace{\nu}_{\text{filling factor}} e^2}$$

Quantum Hall Conductor

state : an insulator

because $\boxed{\sigma_{xx}} \to 0$

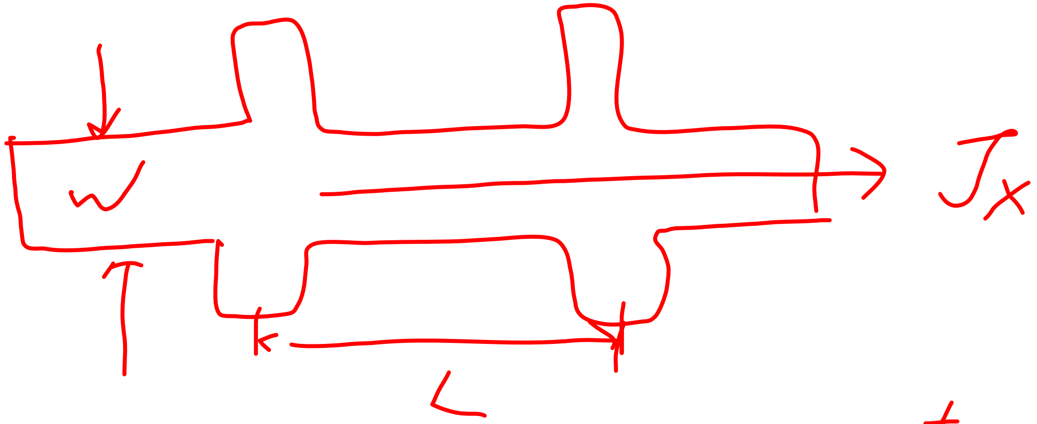
Insulator – QHC transition

T-dependence of a state

$\rho_{xx} \searrow$ as $T \nearrow$: I

$\rho_{xx} \nearrow$ as $T \nearrow$

$\sigma_{xx} \nearrow$ as $T \nearrow$



center-to-center distance

$p + eA$

Angular momentum (角動量)

$$\vec{r} \times \vec{p} = \vec{L}$$

→ magnetic length $\boxed{\sqrt{\frac{\hbar}{eB}}}$

→ cyclotron radius

Different $\frac{\hbar\sqrt{2\pi \textcircled{n}}}{eB}$

$$E = \hbar\omega\left(n+\frac{1}{2}\right)$$

$$n = 0, 1, 2, \ldots$$

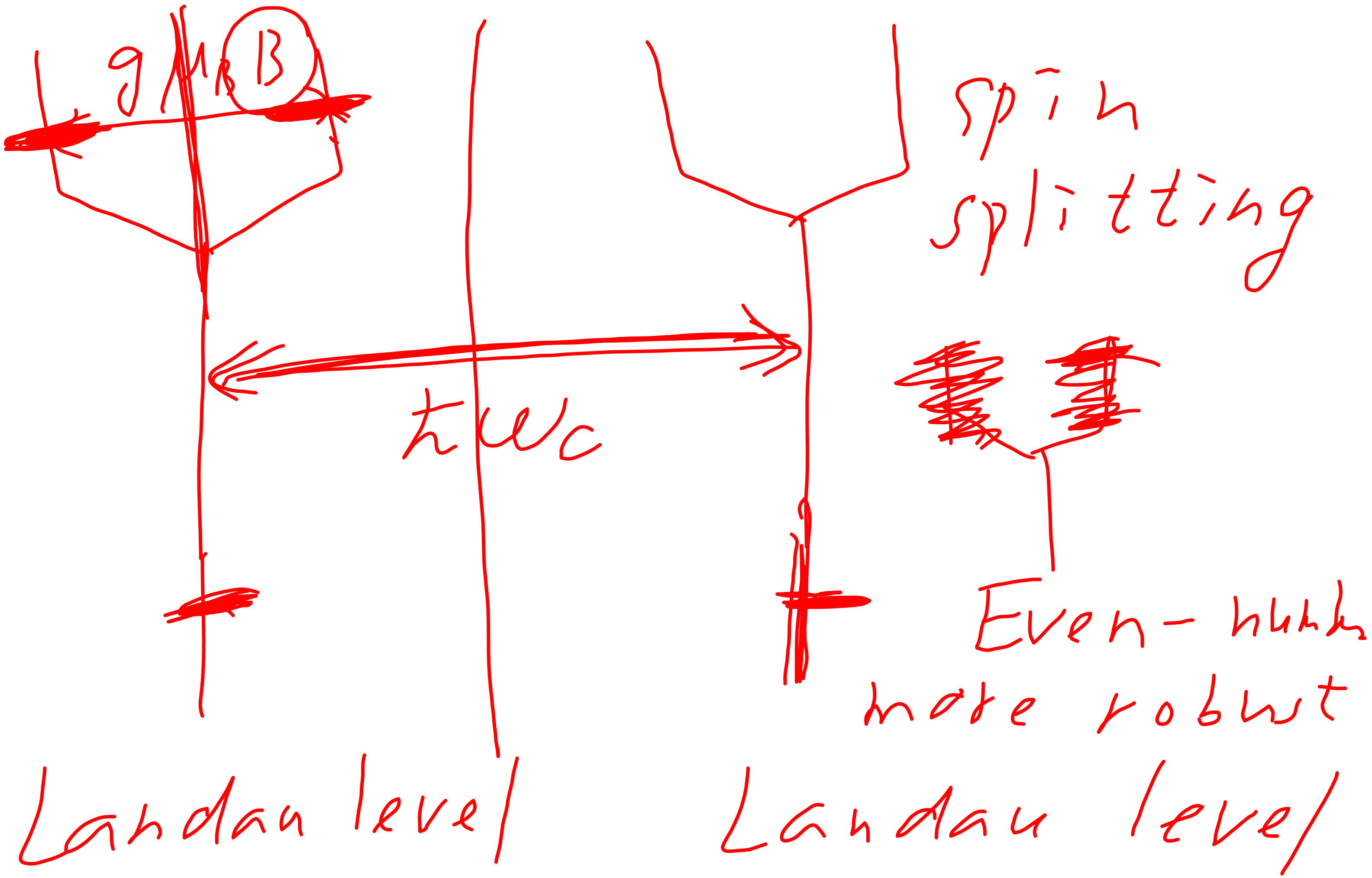
ω

simple harmonic oscillator

Eigenstates in a B

$$E = \hbar\omega_{\underline{\boxed{c}}}\left(n+\frac{1}{2}\right)$$

$$\omega_c = \frac{eB}{m^*}$$



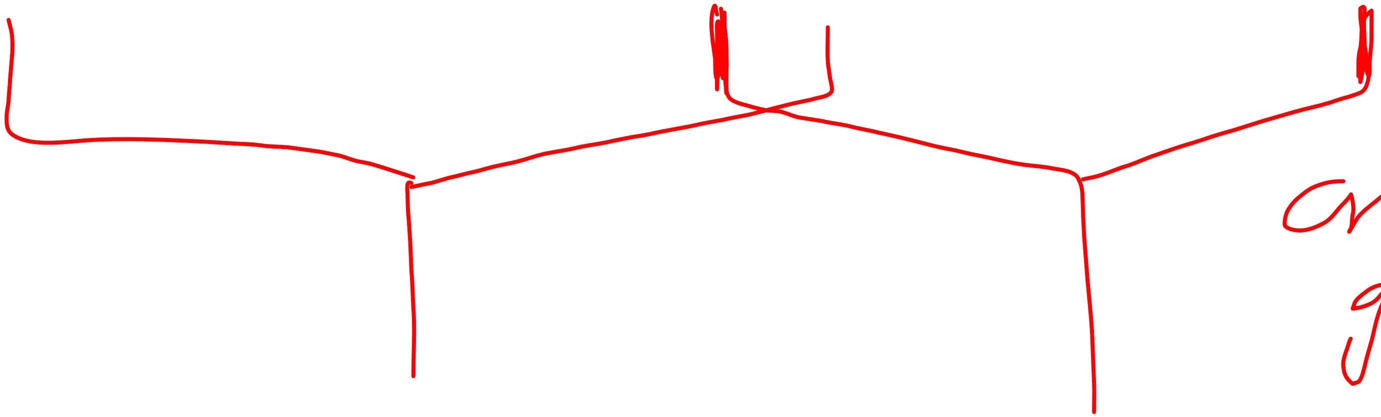
GaAs electron gas

$\hbar\omega_c >> g\mu_B B$

SiGe hole gas

$$\boxed{g\mu_B B} \sim \boxed{\hbar\omega_c}$$

odd-number structures are more robust!



crossed gap