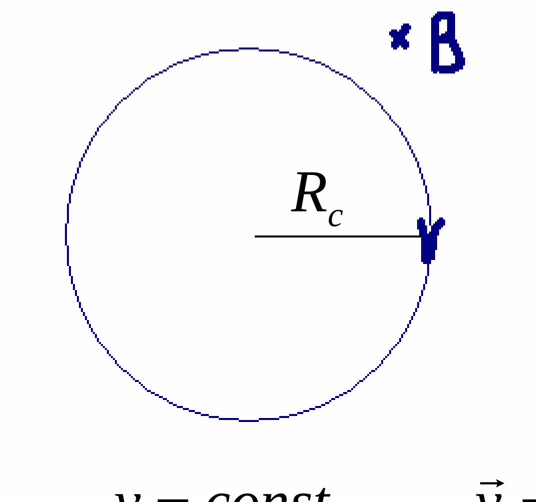
Cyclotron motion in a magnetic field



$$\frac{d\vec{v}}{dt} = \frac{\vec{F}_{Lorentz}}{m} = \frac{eB}{mc}\vec{l}_z \times \vec{v}$$

$$R_c = \frac{v}{\omega_c}$$
cyclotron radius

$$\omega_c = \frac{eB}{mc}$$
cyclotron frequency

$$v = const \qquad \vec{v} = \left(\vec{l}_x \cos \omega_c t + \vec{l}_y \sin \omega_c t\right) \cdot v$$

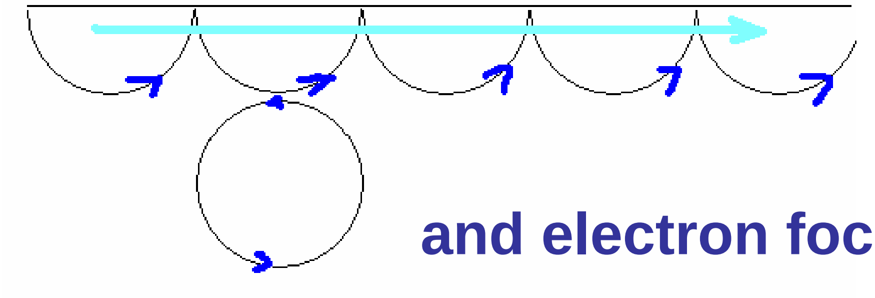
Cyclotron motion represents classical dynamics of electron in a magnetic field.

Cyclotron resonance: electrons efficiently absorb energy from an external EM field when the EM field frequency is $\omega = \omega_c$

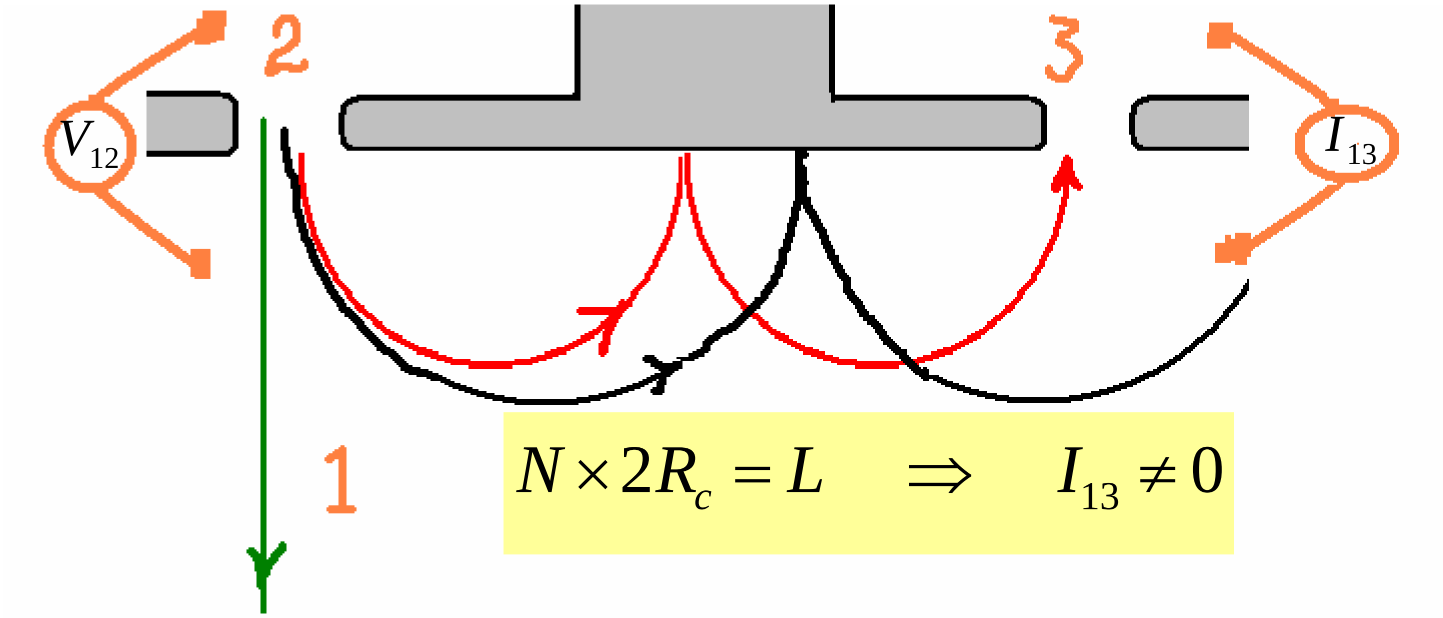
In a metal or 2DEG in a heterostructure, conductance is formed by electrons near the Fermi level which have velocity equal to the Fermi velocity, v_F **and, therefore, have the same radius of the cyclotron orbit:**

$$R_c = \frac{v_F}{\omega_c}$$

Skipping orbits



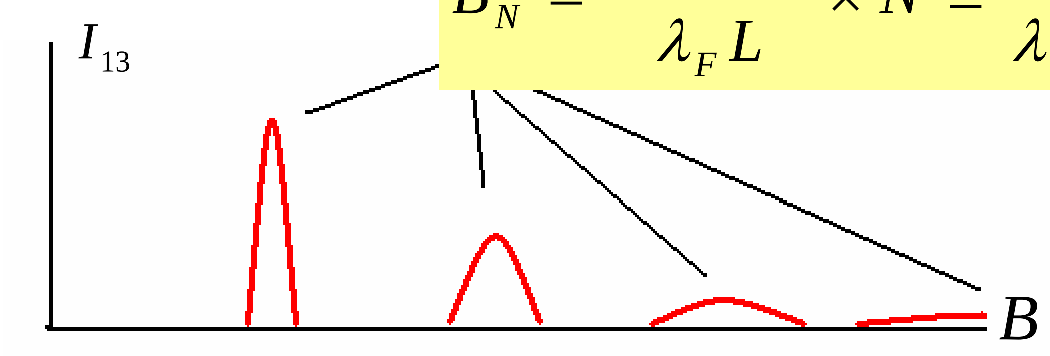
and electron focusing



$$N \times 2R_c = L \quad \Rightarrow \quad I_{13} \neq 0$$

$$\frac{2N}{L} = \frac{1}{R_c} = \frac{\omega_c}{v_F} = \frac{eB}{mcv_F} = \frac{eB}{cp_F} = \frac{e\lambda_F}{2\pi\hbar c} B$$

$$B_N = \frac{4\pi\hbar c / e}{\lambda_F L} \times N \equiv \frac{2\Phi_0}{\lambda_F L} \times N$$



van Wees 1989

Electron focusing is a non-local ‘classical’ ballistic effect, which indicates the existence of Fermi surface in the electron gas.

For the future references: magnetic flux quantum

$$\Phi_0 = \frac{2\pi\hbar c}{e}$$

(this will be used in the description of quantum effects in a magnetic field)