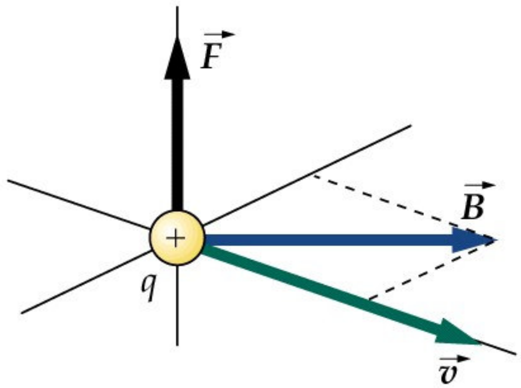
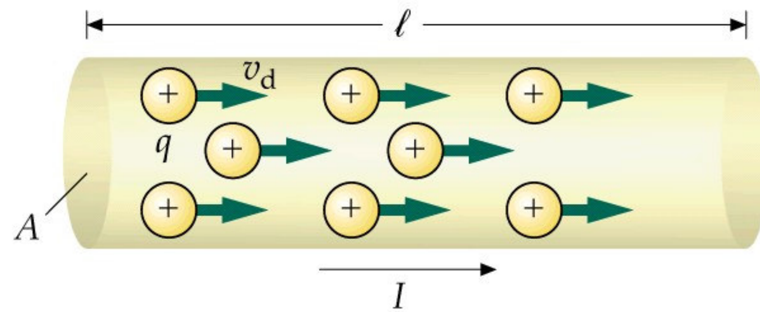
Força Magnética

$$\vec{F} = q\vec{v} \times \vec{B}$$



Força sobre um condutor



$$\vec{F} = (q\vec{v} \times \vec{B})nAl$$

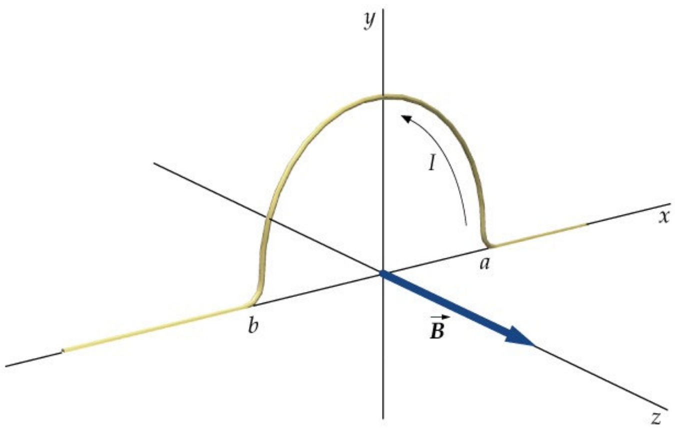
Onde, *n* é a densidade de portadores no condutor

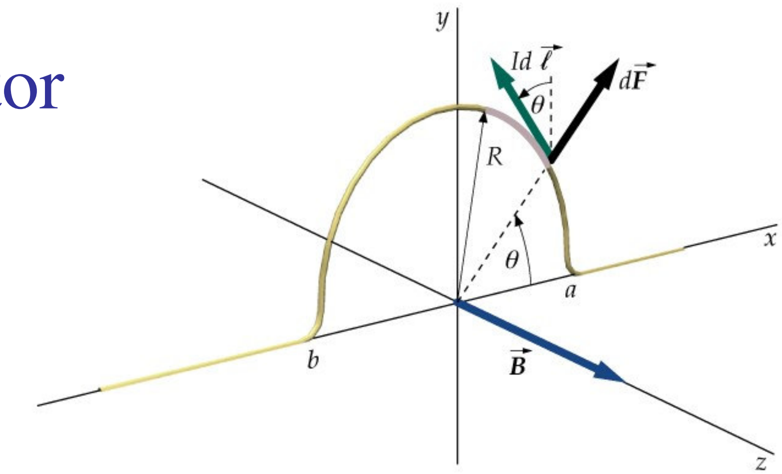
Mas, como a corrente no fio condutor é $I = nqv_d A$

A força é dada por $$\vec{F} = (I\vec{l} \times \vec{B})$$

E, para um segmento infinitesimal do condutor $$d\vec{F} = (Id\vec{l} \times \vec{B})$$

Força magnética sobre um condutor





$$d\vec{l} = -dl\sin\theta\hat{i} + dl\cos\theta\,\hat{j}$$

$$d\vec{l} = -R\sin\theta d\theta\hat{i} + R\cos\theta d\theta\,\hat{j}$$

$$\vec{B} = B\hat{k}$$

$$d\vec{F} = (Id\vec{l} \times \vec{B})$$

$$dl = Rd\theta$$

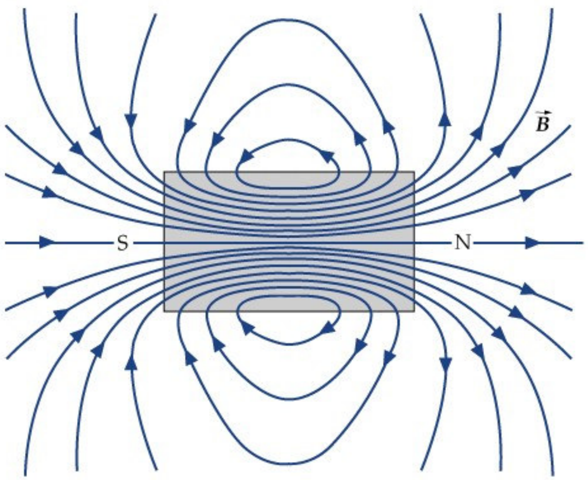
⇨ $$d\vec{F} = IRB\sin\theta d\theta\hat{j} + IRB\cos\theta d\theta\hat{i}\,)$$

A força é dada por

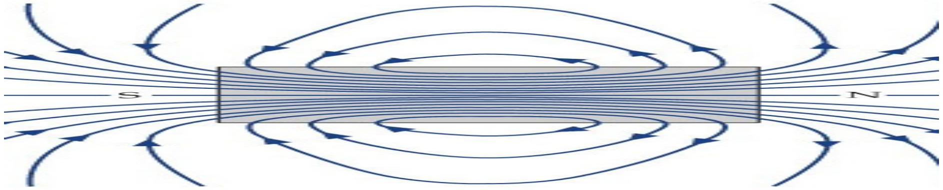
$$\vec{F} = IRB\hat{j}\int_0^{\pi}\sin\theta d\theta + IRB\hat{i}\int_0^{\pi}\cos\theta d\theta$$

Que se reduz a $\vec{F} = 2IRB\hat{j}$

Linhas de Campo Magnético

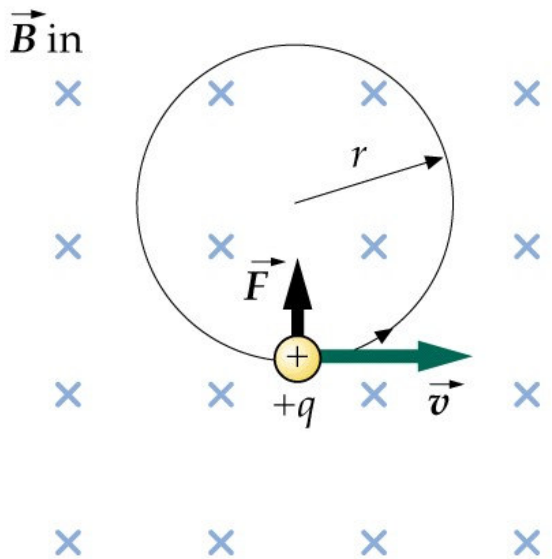


(a)



1) São perpendiculares à força magnética.
2) São fechadas. (Não existe monopolo magnético)

Trajetórias de partículas carregadas em Campo Magnético

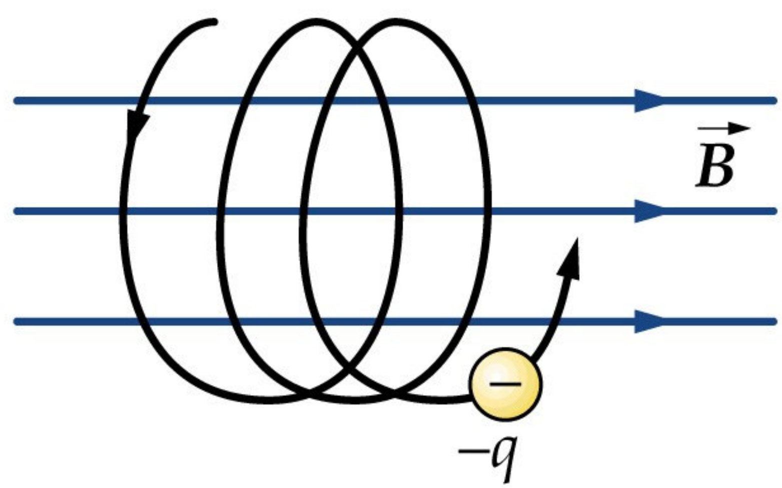


$$r = \frac{mv}{qB}$$

$$T = \frac{2\pi}{\omega} = \frac{2\pi r}{v} = \frac{2\pi m}{qB} = \frac{1}{f}$$

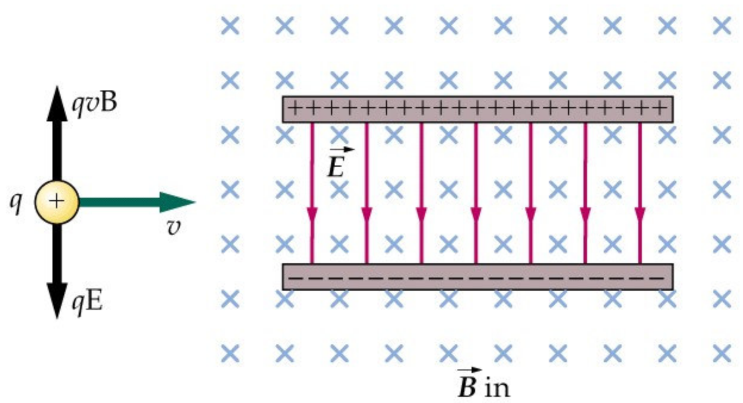
f= frequência de Cíclotron

$$F = ma = m\frac{v^2}{r} = qvB$$



Filtro de velocidades

E, B, v são ortogonais



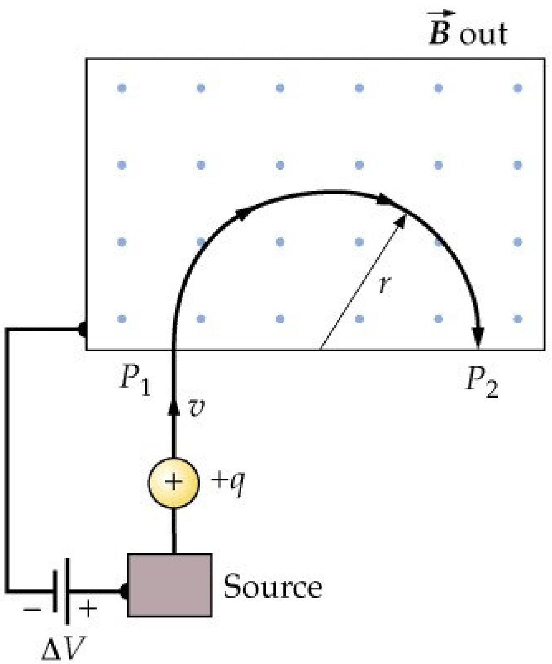
Força de Lorentz

$$\vec{F} = q\vec{E} + q\vec{v} \times \vec{B}$$

$$\vec{F} = 0 \quad \Rightarrow \quad v = \frac{E}{B}$$

A partícula não sofre desvio.

Espectrômetro de massa
(F.W. Aston, 1919)



$$r = \frac{mv}{qB}$$

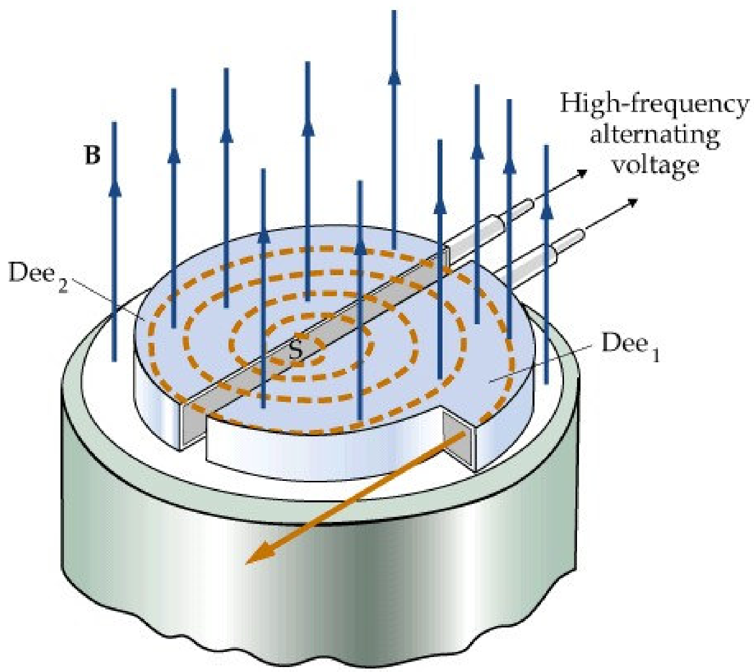
$$\frac{mv^2}{2} = q\Delta V$$

$$\Rightarrow \quad \frac{m}{q} = \frac{B^2 r^2}{2\Delta V}$$

Precisão de 1/10000, na deteção de isótopos.

Ciclotron
(Lawrence e Livingston, 1934)

$$r = \frac{mv}{qB} \Rightarrow v = \frac{qBr}{m}$$



$$K = \frac{mv^2}{2} = \frac{q^2B^2r^2}{2m}$$

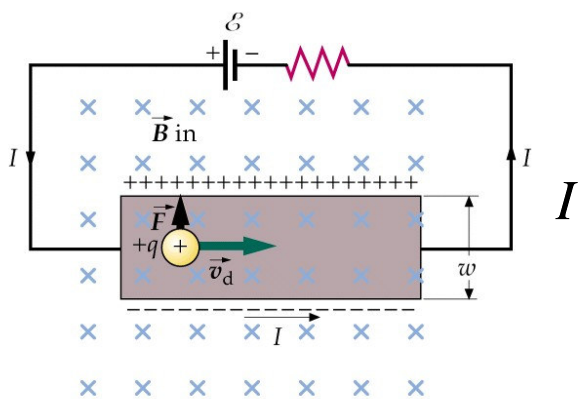
Em ~100 voltas obtêm-se energias de centenas de MeV.

Efeito Hall (E.H. Hall, 1879)

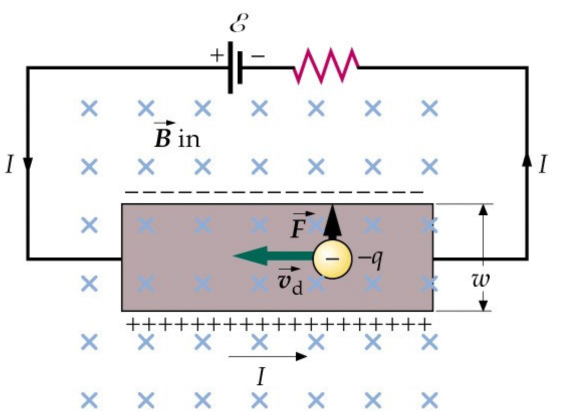
$$\vec{F} = q\vec{E} + q\vec{v}_d \times \vec{B} = 0$$

$$\Rightarrow \quad v_d = \frac{E}{B}$$

$$V_H = Ew = v_d B w$$

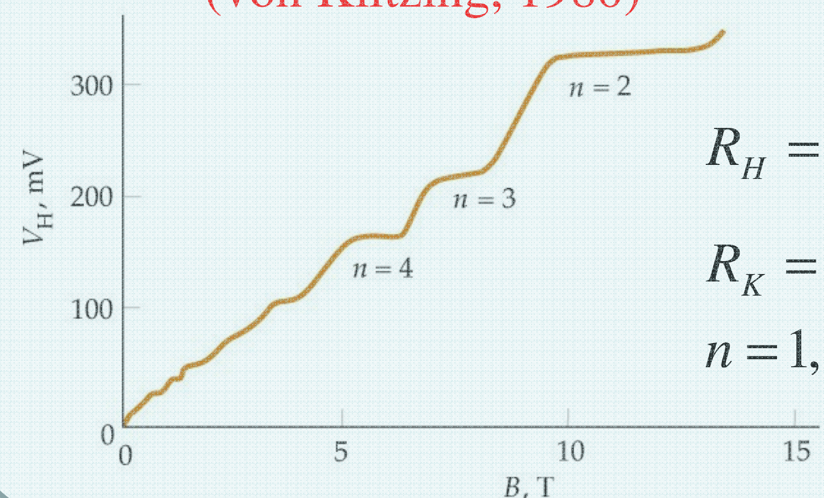


$$I = nqv_d A$$



Efeito Hall Quântico

(von Klitzing, 1980)

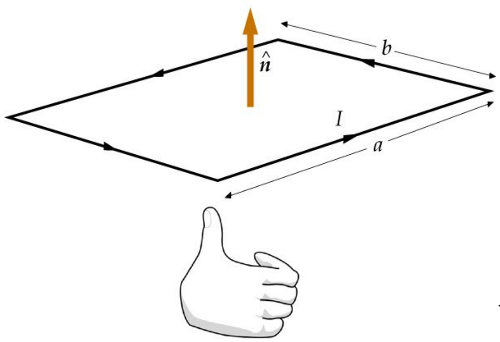


$$R_H = \frac{V_H}{I} = \frac{R_K}{n}$$

$$R_K = 25{,}812807\Omega$$

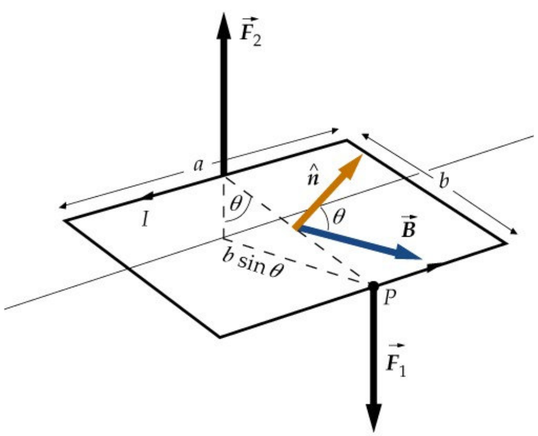
$$n = 1,2,3,\ldots$$

Torques sobre espiras



Área da espira

$$A = ab$$



$$\vec{F} = (I\vec{l} \times \vec{B})$$

$$d\vec{F} = (Id\vec{l} \times \vec{B})$$

$$F_1 = F_2 = IaB$$

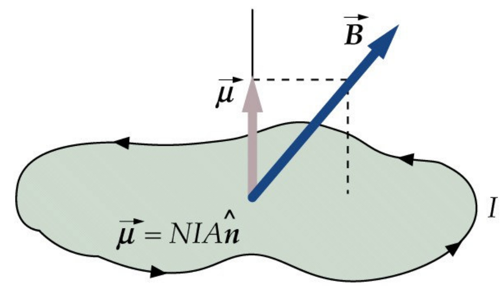
$$\tau = F_2 b \sin\theta = IaBb\sin\theta = IAB\sin\theta$$

Para N espiras

$$\tau = NIAB\sin\theta$$

Momento de dipolo magnético

$$\vec{\mu} = NIA\vec{n}$$



$$\vec{\tau} = \vec{\mu} \times \vec{B}$$