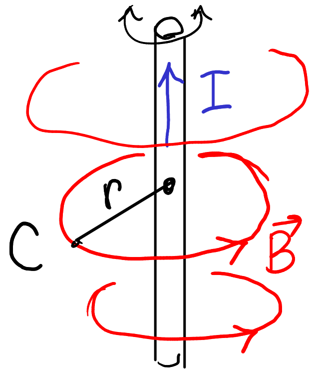
CAMPO DE UM CABO RETILÍNEO



não existem monopolos

Simetria cilíndrica ($\vec{\nabla}\cdot\vec{B}=0$)

$\Downarrow$

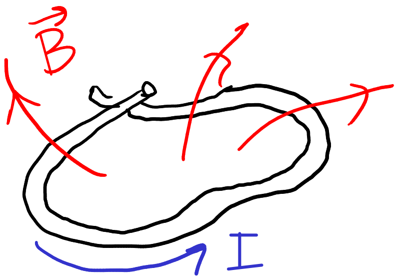
linhas de campo $\vec{B}$ circulares, perpendiculares ao cabo e centradas nele. ($B(r)$)

$$\begin{cases} \oint_C \vec{B}\cdot d\vec{r} = B\oint_C ds = 2\pi r B \\ \oint_C \vec{B}\cdot d\vec{r} = +4\pi k_m I \end{cases}$$

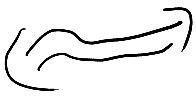
$$\boxed{B(r) = \frac{2k_m I}{r}}$$

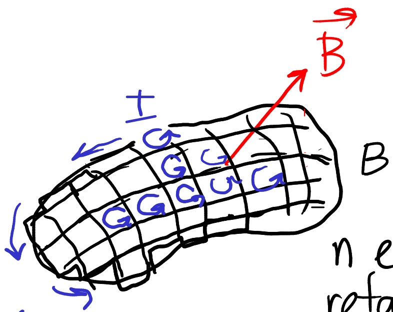
cabo retilíneo (infinito)

MOMENTO MAGNÉTICO

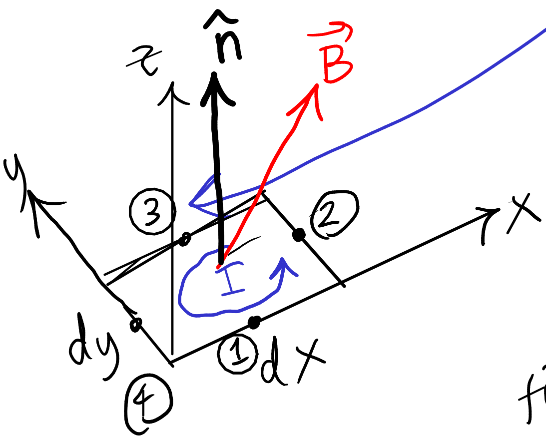


espira num campo $\vec{B}$ externo





n espiras retangulares infinitesimais todas com a mesma corrente I



$\vec{B} \approx$ constante $= B_x\hat{\imath} + B_z\hat{k}$

versor normal $= \hat{n} = \hat{k}$

fio ret., $\vec{B}$ constante: $\vec{F} = (\vec{I}\times\vec{B})\,\ell$

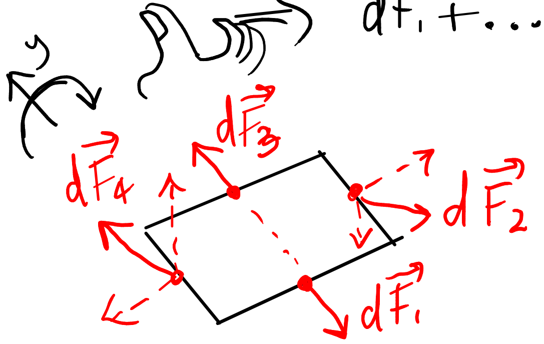
① $\vec{I}_1 = I\hat{\imath},\ \ell_1 = dx \Rightarrow d\vec{F}_1 = -IB_z\hat{\jmath}\,dx$

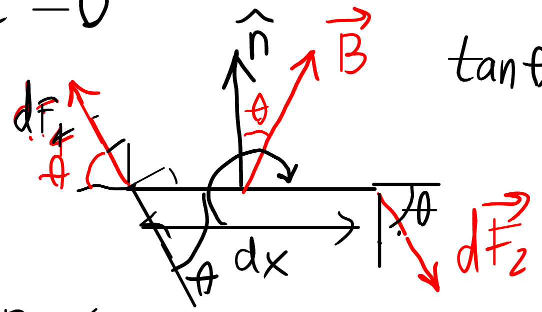
② $\vec{I}_2 = I\hat{\jmath},\ \ell_2 = dy \Rightarrow d\vec{F}_2 = IB_z\hat{\imath}\,dy - IB_x\hat{k}\,dy$

③ $\vec{I}_3 = -I\hat{\imath},\ \ell_3 = dx \Rightarrow d\vec{F}_3 = +IB_z\hat{\jmath}\,dx$

④ $\vec{I}_4 = -I\hat{\jmath},\ \ell_4 = \ell_2 \Rightarrow d\vec{F}_4 = -IB_z\hat{\imath}\,dy + IB_x\hat{k}\,dy$

$d\vec{F}_1 + \dots + d\vec{F}_4 = \vec{0}$





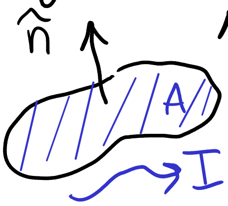
$\tan\theta = \frac{B_x}{B_z}$

Binário: $|d\vec{F}_2|\sin\theta\,dx$

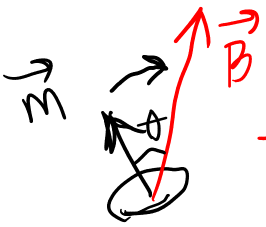
$$d\vec{M} = +IB_x\,dx\,dy\,\hat{\jmath} = \underbrace{I\,dx\,dy}_{I\,dA}(\hat{k}\times\vec{B})$$

$$d\vec{m} = (I\,dA)\hat{n}$$ Momento magnético da espira

$$\boxed{d\vec{M} = d\vec{m}\times\vec{B}}$$



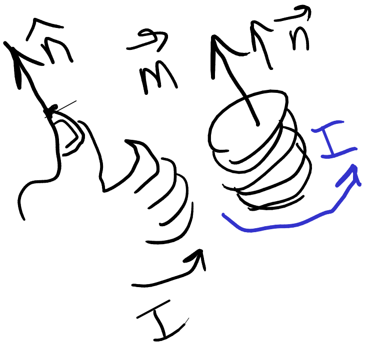
$\vec{m} = AI\hat{n}$



$\vec{M} = \vec{m}\times\vec{B}$

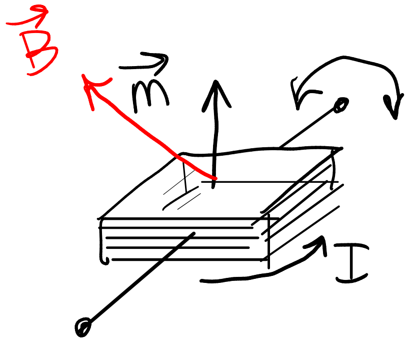
$$\sin\theta = \begin{cases} +1, & \theta = 90^\circ \\ -1, & \theta = 270^\circ \\ 0, & \theta = 0, 180^\circ \end{cases}$$

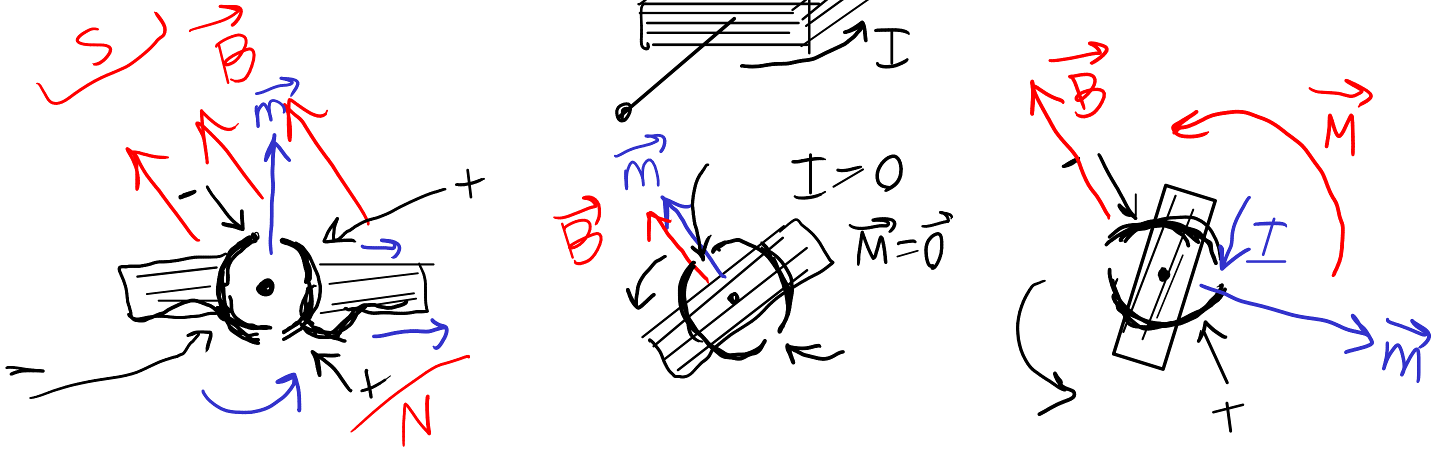
Bobina com N espiras, todas com área A:

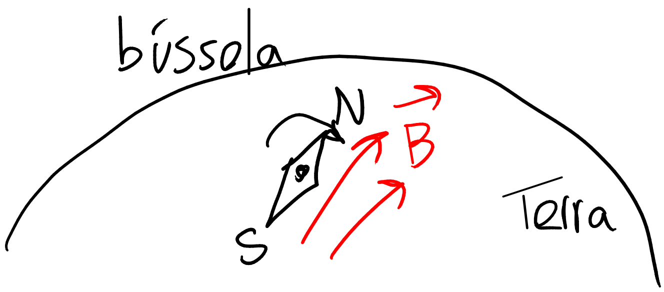


$$\vec{m} = NAI\hat{n}$$

Efeito motor:







$\vec B \approx$ constante (na bússola)

$\Rightarrow \vec F = \vec 0 \quad \vec M \neq \vec 0$

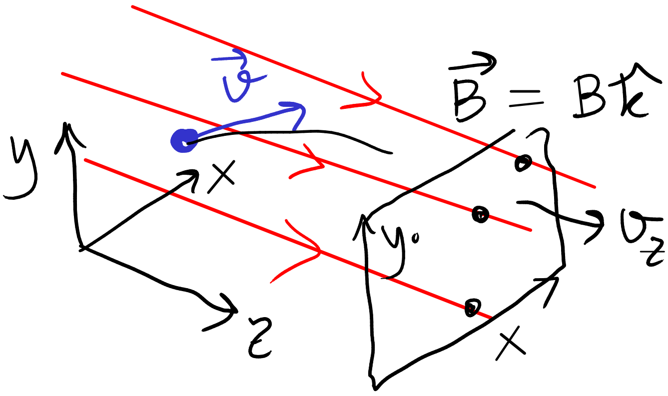
partícula elementar com spin:

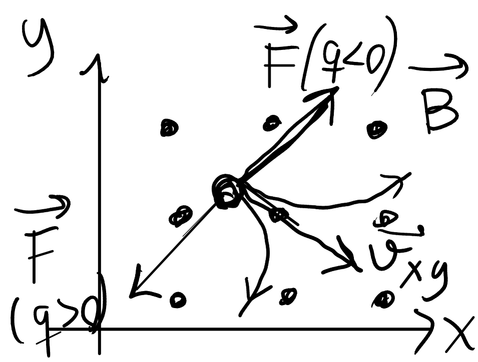
$\vec F = \vec 0$

$\vec M \neq 0$

MOVIMENTO DE CARGAS PONTUAIS NO CAMPO MAGNÉTICO.

campo $\vec B$ constante

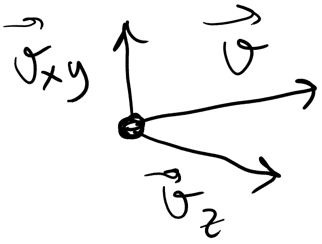




$\vec F = q(\vec v \times \vec B)$ perpendicular a $\vec v$ e a $\hat e_t$

$\Rightarrow F_t = 0 \Rightarrow a_t = 0 \Rightarrow \frac{dv}{dt} = 0$

$v = \text{constante}$ ($\vec{F}$ não realiza trabalho)

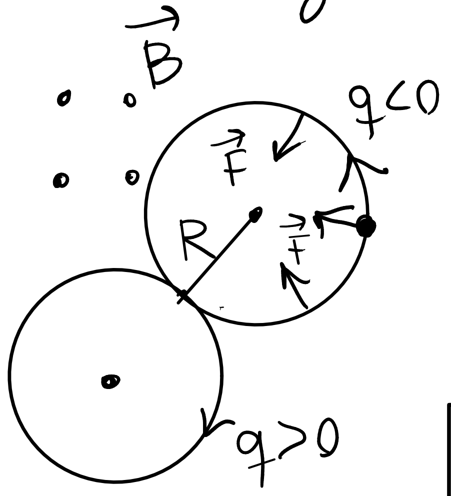


$$\vec{F} = q(\vec{v} \times \vec{B}) = q(v_x\hat{i} + v_y\hat{j} + v_z\hat{k}) \times B\hat{k}$$

$$= q(v_y B\hat{i} - v_x B\hat{j}) \quad (F_z = 0)$$

$$a_z = 0 \Rightarrow v_z = \text{constante}$$

movimento segundo z uniforme + movimento circular no plano xy uniforme



$$|\vec{F}| = |q|\,|\vec{v}_{xy}|\,B \quad (\theta = 90^\circ)$$

$$F_n = \frac{m v_{xy}^{\cancel{2}}}{R} = |q|\,\cancel{v_{xy}}\,B$$

$$\boxed{R = \frac{m v_{xy}}{|q|\,B}}$$