



Física 3

V-2022

Parte 27

## La relatividad de campos magnéticos y eléctricos

The Feynman Lectures on Physics, Volumen 2, Capítulo 13.6

Summary Force on charge  $q$  is  $\vec{F} = q(\vec{E} + \vec{v} \times \vec{B})$   $\nabla \cdot \vec{j} = -\frac{\partial \rho}{\partial t}$

Current density  $\vec{j}$ : Charge passing per unit area/sec =  $\vec{j} \cdot \vec{n}$  Normal to area

Current in wire  $I = \text{area of wire} \times j$  Force on wire  $\vec{I} \times \vec{B}$  per unit length

Static Case  $\nabla \cdot \vec{B} = 0$ ;  $c^2 \nabla \times \vec{B} = \vec{j} / \epsilon_0$  (only if  $\nabla \cdot \vec{j} = 0$ )

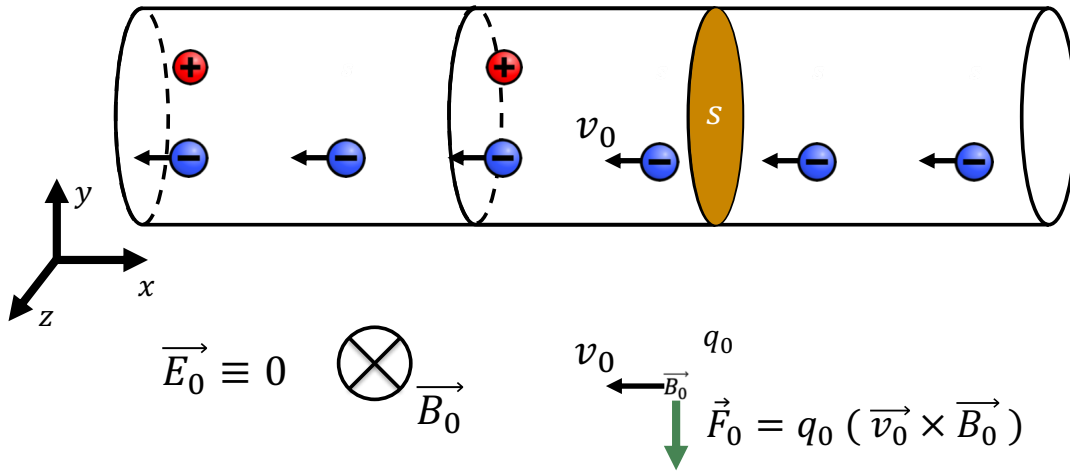
$\int_{\text{line}} \vec{B}_z d\vec{s} = \frac{1}{c^2 \epsilon_0}$  Current passing thru surface with line as edge.

Wire,  $B$  goes around =  $\frac{I}{2\pi r c^2 \epsilon_0}$  Solenoid  $B = \frac{NI}{c^2 \epsilon_0 l}$   $\left( \begin{array}{l} \text{No. of turns} \\ \text{length} \end{array} \right)$

Vector potential  $\vec{B} = \nabla \times \vec{A}$ ; can take  $\nabla \cdot \vec{A} = 0$ , then  $\nabla^2 \vec{A} = -\frac{\vec{j}}{c^2 \epsilon_0}$  (like  $\nabla^2 \phi = -\rho/\epsilon_0$ )

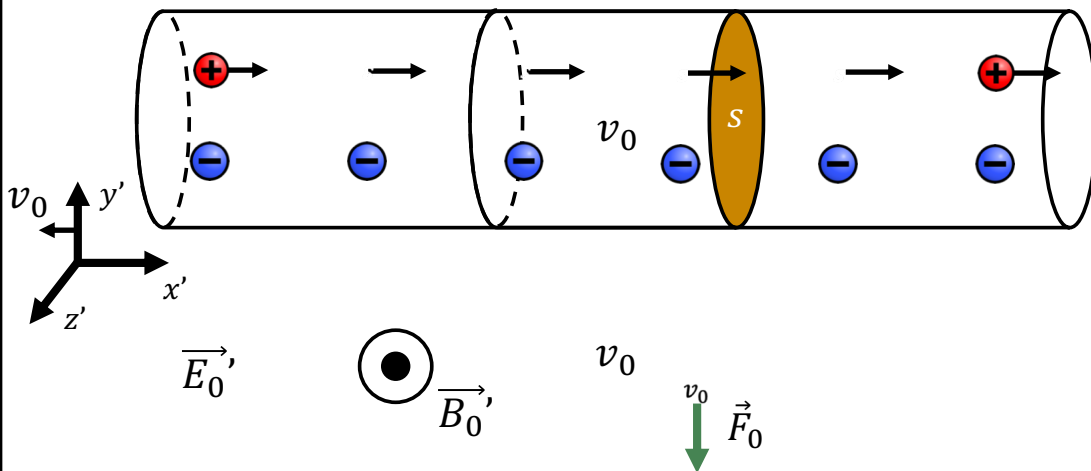
Relatividad de campos eléctricos y magnéticos

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



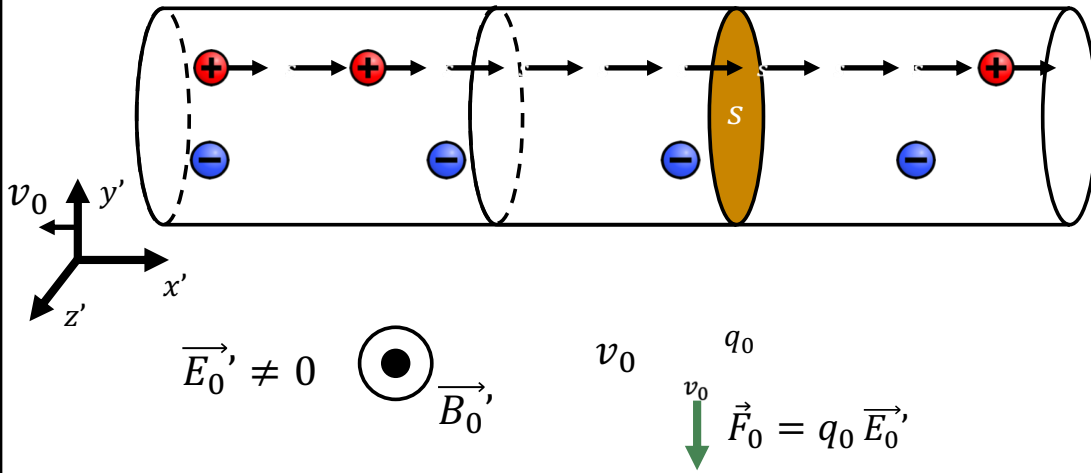
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**Relatividad** de campos eléctricos y magnéticos

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La relatividad de campos magnéticos y eléctricos

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 Wire,  $B$  goes around =  $\frac{I}{2\pi r c^2 \epsilon_0}$     Solenoid  $B = \frac{NI}{c^2 \epsilon_0 l}$  (No. of turns / length).  
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# Anteriormente en Física 3 A

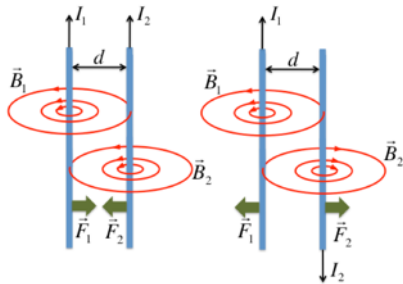


# Anteriormente en Física 3 A

Campo magnético de una carga en movimiento

$$\vec{B}(\vec{r}) = \frac{\mu_0}{4\pi} q_f \left( \vec{v}_f \times \frac{\vec{r} - \vec{r}_f}{|\vec{r} - \vec{r}_f|^3} \right)$$

$$\delta \vec{B}(\vec{r}) = \frac{\mu_0}{4\pi} I \left( \delta \vec{\ell} \times \frac{\vec{r} - \vec{r}_f}{|\vec{r} - \vec{r}_f|^3} \right)$$



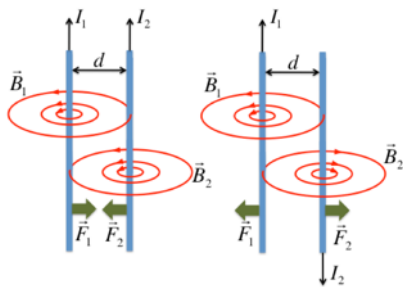
$$|\delta \vec{F}_{m,2}| = |I_2| |\delta \vec{\ell}| \frac{\mu_0}{2\pi} \frac{|I_1|}{d}$$

# Anteriormente en Física 3 A

Campo magnético de una carga en movimiento

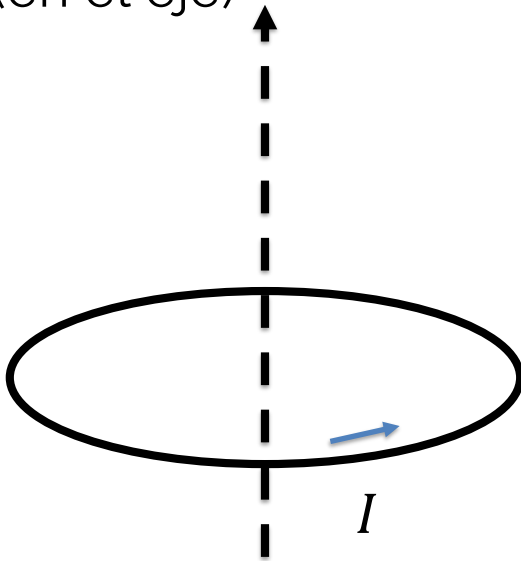
$$\vec{B}(\vec{r}) = \frac{\mu_0}{4\pi} q_f \left( \vec{v}_f \times \frac{\vec{r} - \vec{r}_f}{|\vec{r} - \vec{r}_f|^3} \right)$$

$$\vec{B}(\vec{r}) = \frac{\mu_0}{4\pi} \int_c I \frac{\delta \vec{\ell} \times (\vec{r} - \vec{r}_f)}{|\vec{r} - \vec{r}_f|^3}$$



$$|\delta \vec{F}_{m,2}| = |I_2| |\delta \vec{\ell}| \frac{\mu_0 |I_1|}{2\pi d}$$

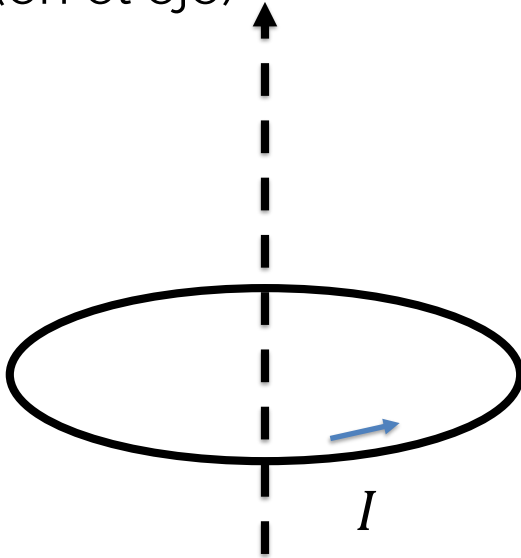
Campo magnético de una **espira circular** (en el eje)



$$\vec{B}(\vec{r}) = \frac{\mu_0}{4\pi} \int_c I \frac{\delta \vec{\ell} \times (\vec{r} - \vec{r}_f)}{|\vec{r} - \vec{r}_f|^3}$$

$$\vec{B}(z) = \frac{\mu_0}{4} I \frac{a^2}{(a^2 + z^2)^{3/2}}$$

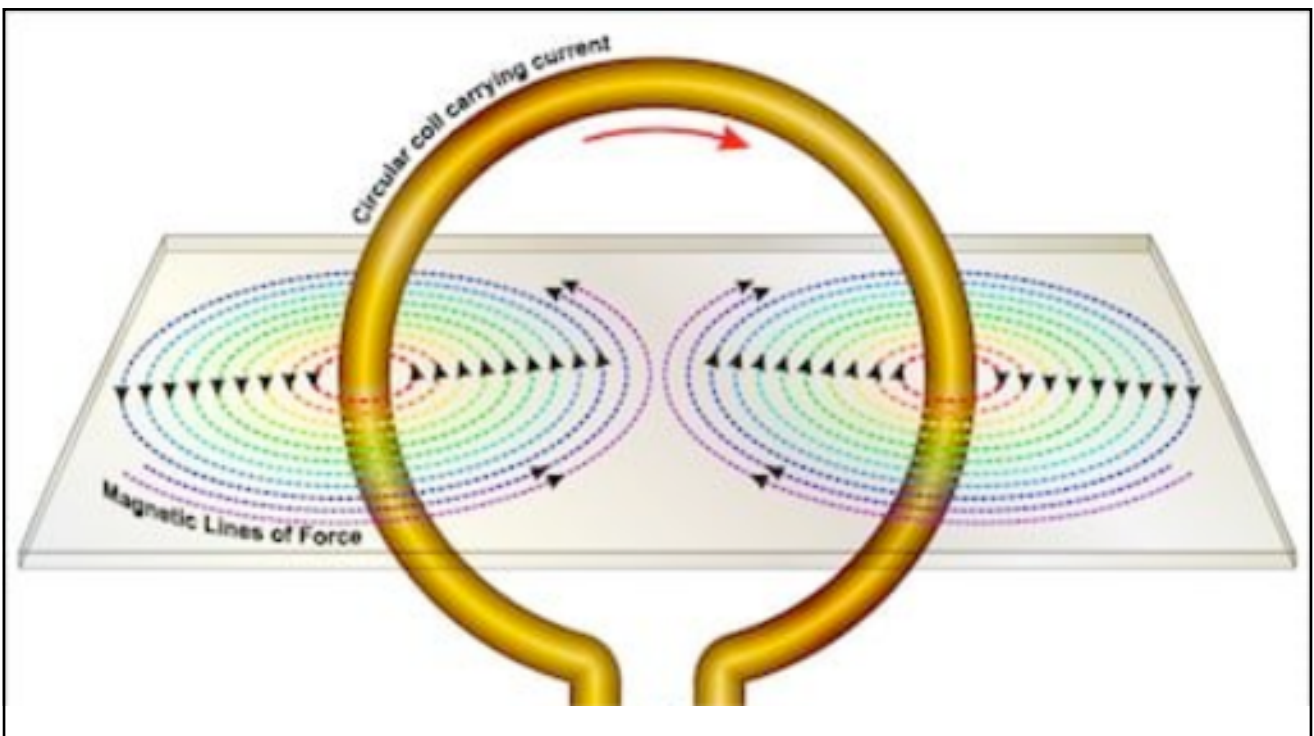
Campo magnético de una **espira circular**  
(en el eje)



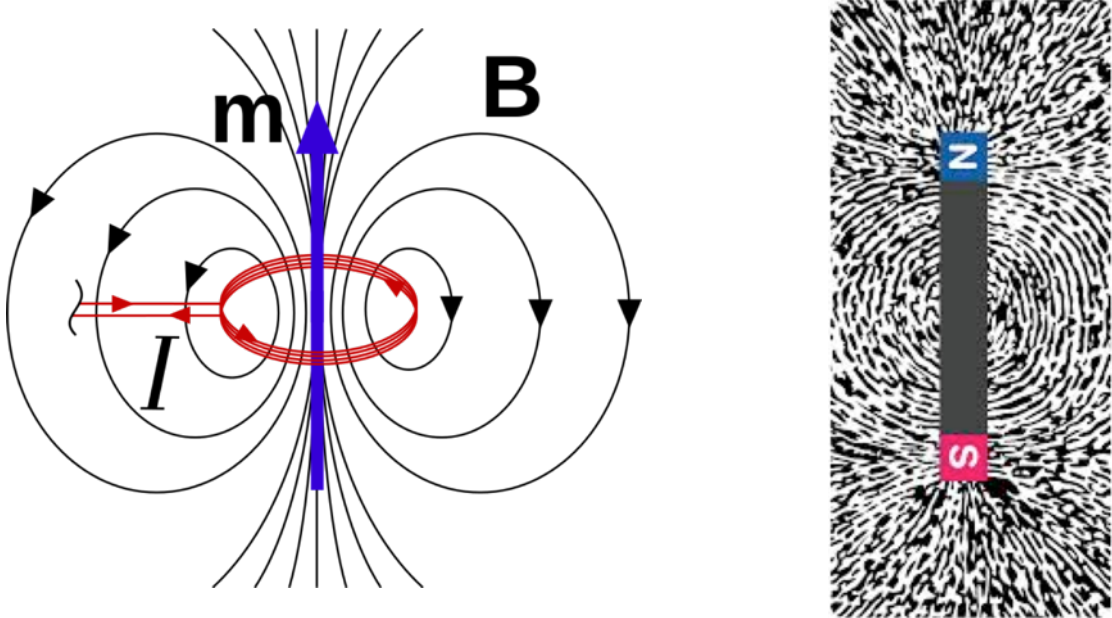
$$\vec{B}(z) = \frac{\mu_0}{4} I \frac{a^2}{(a^2 + z^2)^{3/2}}$$

¿Dónde toma su valor máximo

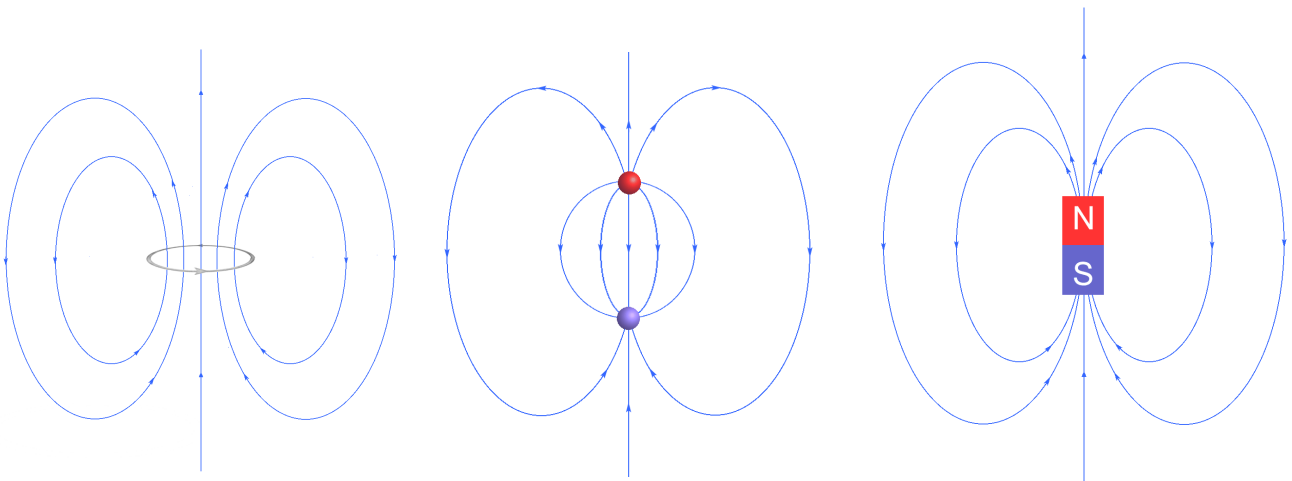
¿Cuanto vale muy lejos? ( $m = \pi a^2 I$ )



La **espira circular** es un dipolo magnético



Dipolo magnético



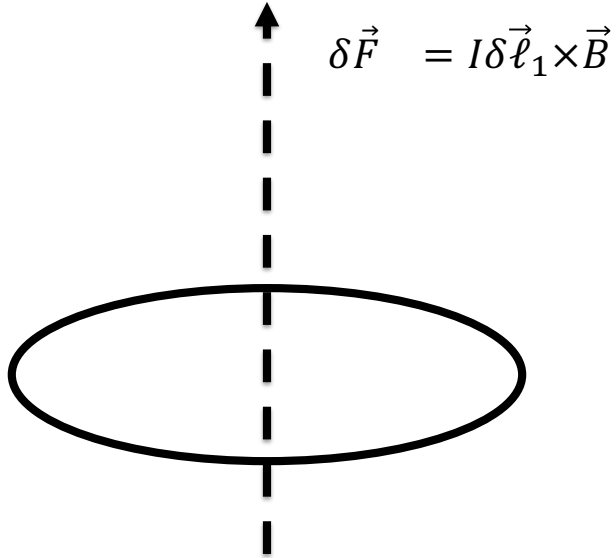
Una espira

Dos "cargas magnéticas"

Una imán

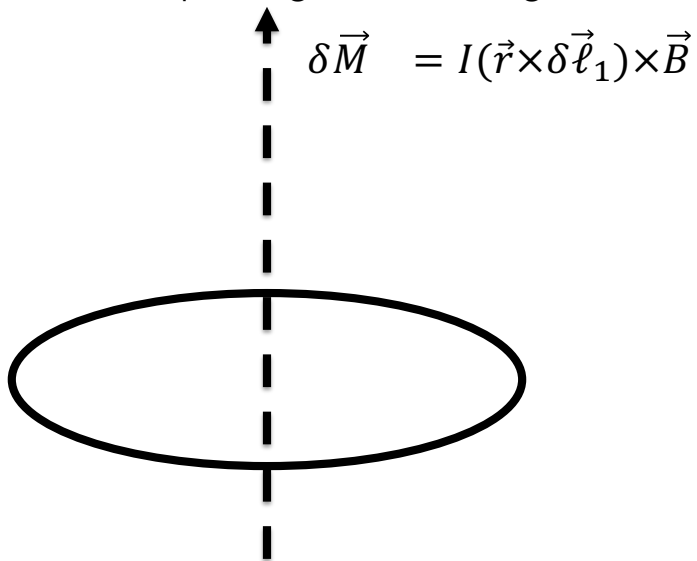
## Fuerza sobre una **espira circular**

(en un campo magnético homogéneo)



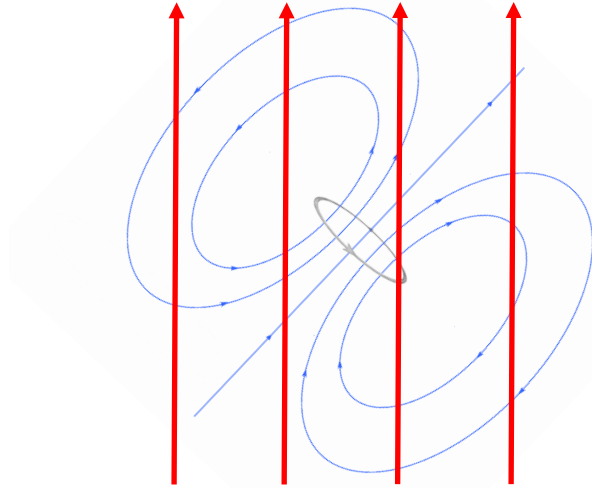
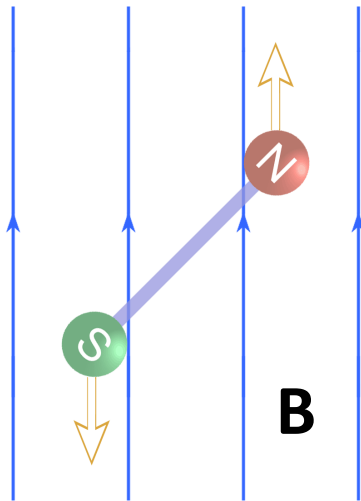
## Momento sobre una **espira circular**

(en un campo magnético homogéneo)

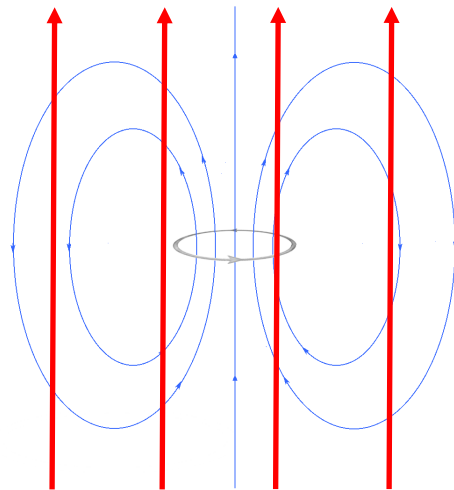
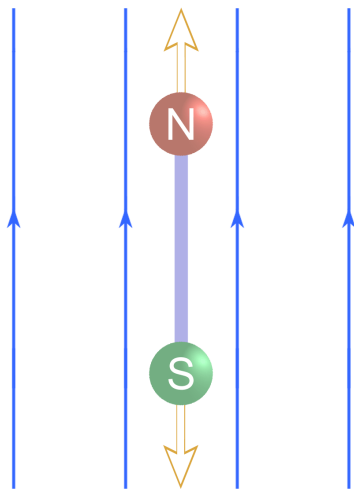




## Torque sobre un dipolo magnético

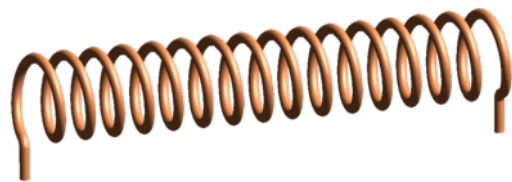


## Torque sobre un dipolo magnético





Campo magnético de un solenoide  
(en el eje)



$$\vec{B}(\vec{r}) = \frac{\mu_0}{4\pi} \int \frac{I \delta\vec{\ell} \times (\vec{r} - \vec{r}_f)}{|\vec{r} - \vec{r}_f|^3}$$

