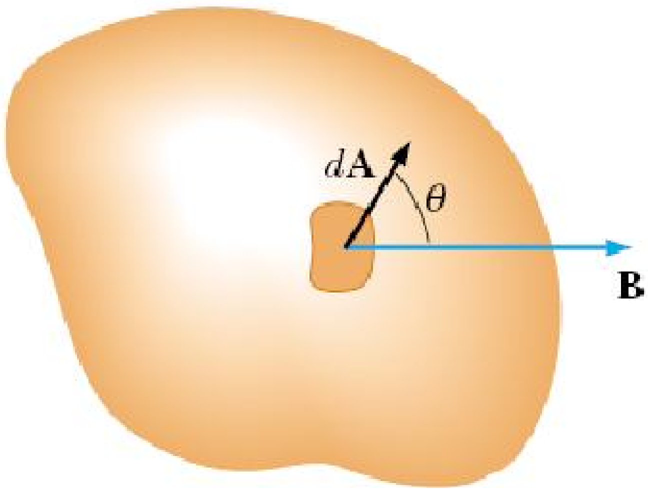
LEY DE AMPERE y Ley de Gauss

Bibliografía consultada

- **Sears- Zemasnky -Tomo II**
- **Fisica para Ciencia de la Ingeniería, Mckelvey**
- **Serway- Jewett --Tomo II**

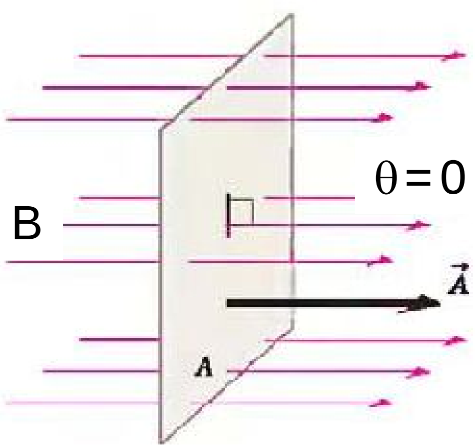
FLUJO DE B

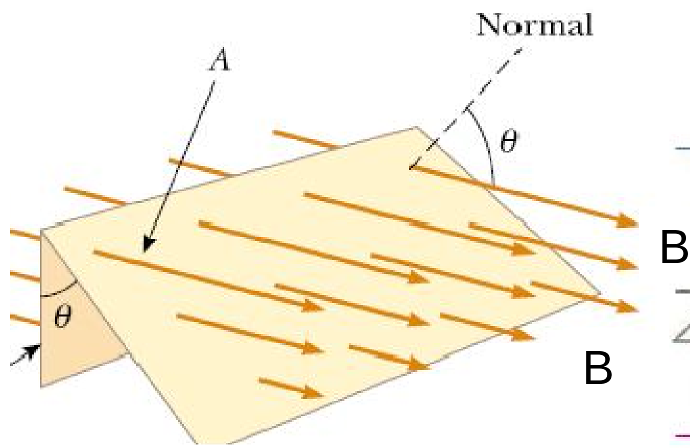


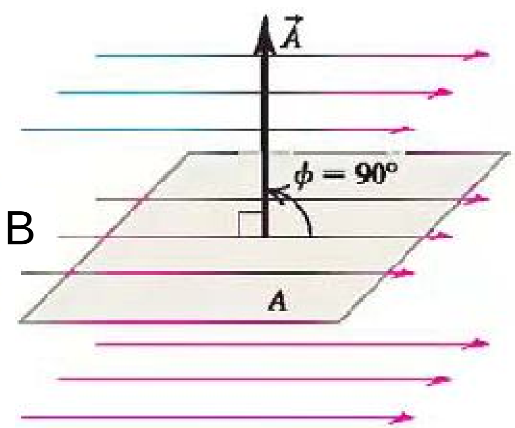
$$\phi_B = \iint \vec{B}.d\vec{A} \qquad d\vec{A} = \hat{n}.dA$$

$$\phi_B = \iint B.\cos\theta.\,dA$$

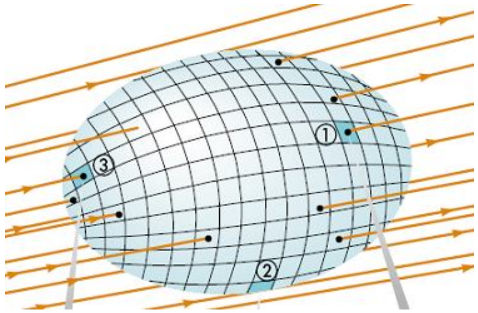
$[\Phi]$= Weber = Wb= $T.m^2$





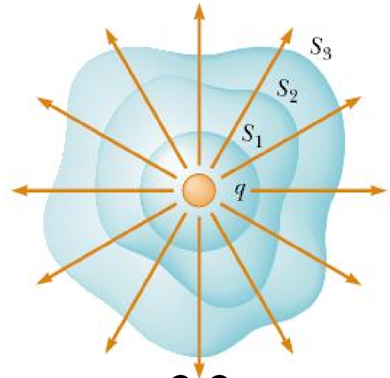


LEY DE GAUSS PARA B



$$\phi_B = \oint\!\!\oint B\cos\theta\, dA = \oint\!\!\oint B_n\, dA = ?$$

LEY DE GAUSS PARA E



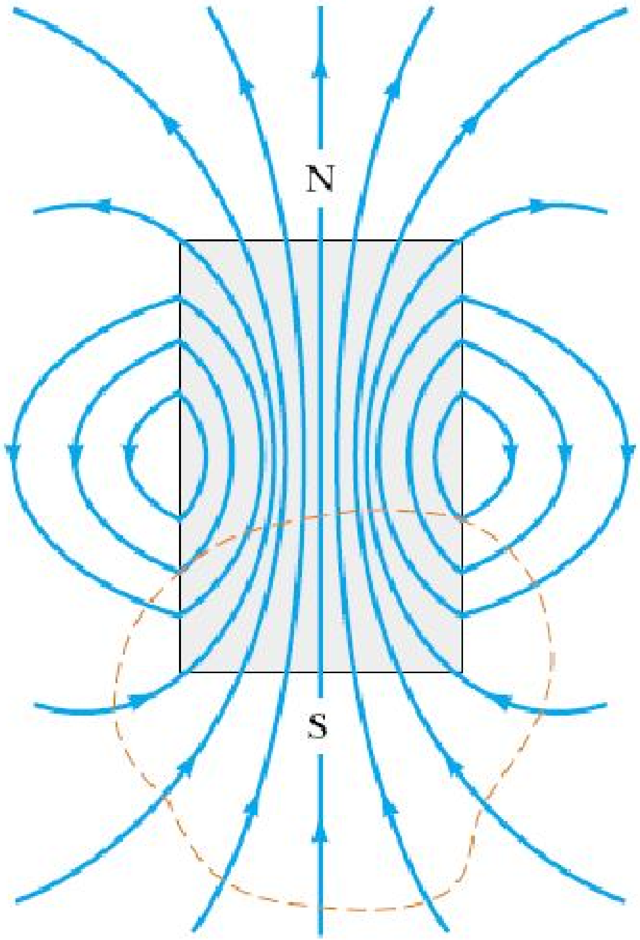
$$\phi_E = \oint\!\!\oint \vec{E}\,.d\vec{A} = \frac{Q_{enc}}{\varepsilon_0}$$

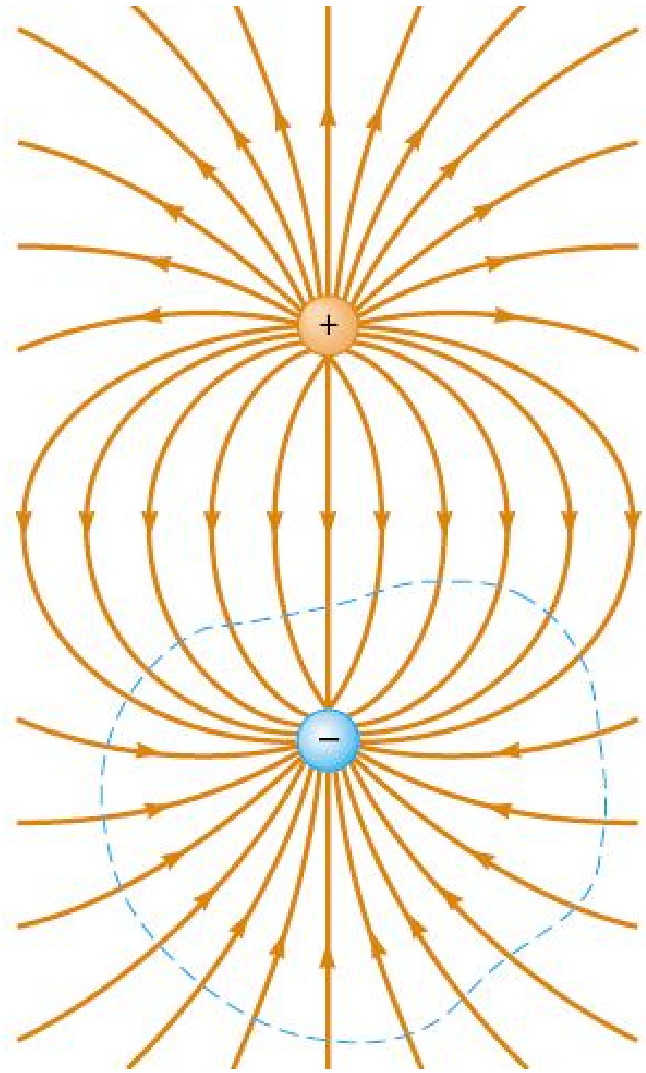
B y **E** decrecen como **1/r²** ⟶ $\phi_B = \oint\!\!\oint B_n\, dA \propto \text{cargas mag.}$

Como no existen los monopolos magnéticos, o no puede aislarse un monopolo

$$\phi_B = \oint\!\!\oint B_n\, dA = 0$$

$$\vec{\nabla}.\vec{B} = 0$$

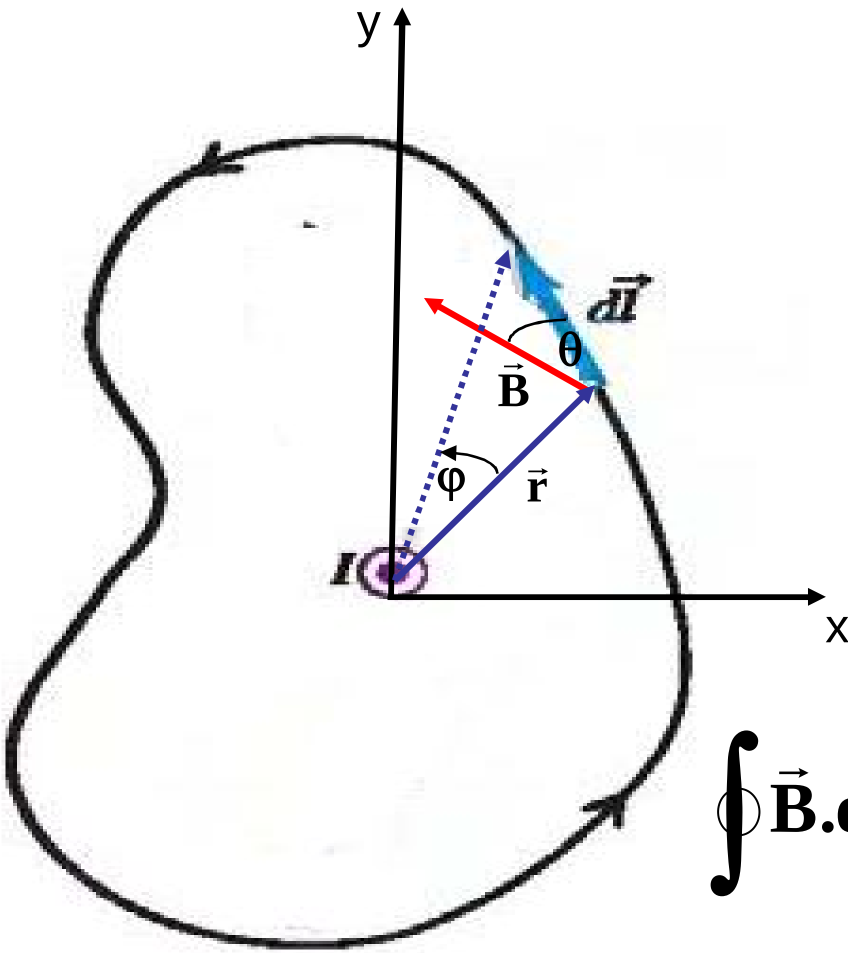

N
S


+
−

LEY DE AMPERE

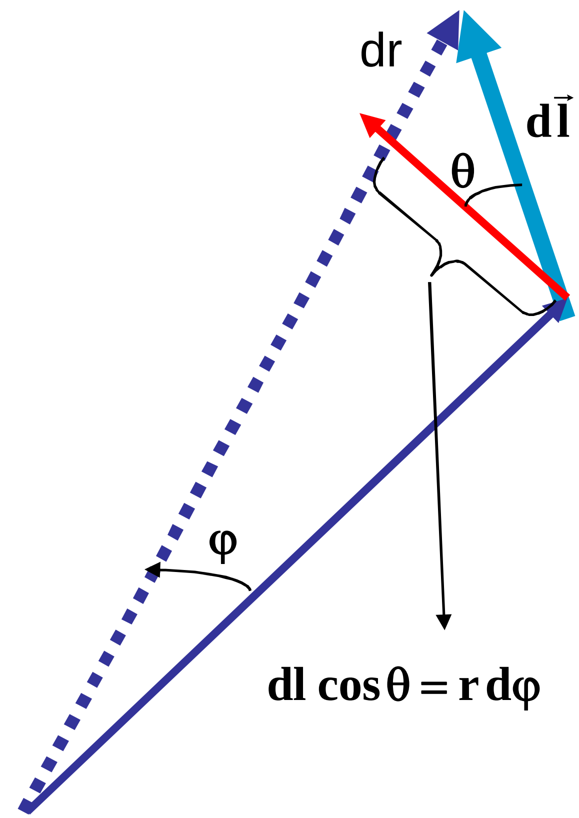
$$\oint \vec{B}.d\vec{l} = \mu_0 I_{concatenada}$$

Conductor infinito que transporta **I** en la dirección **z**

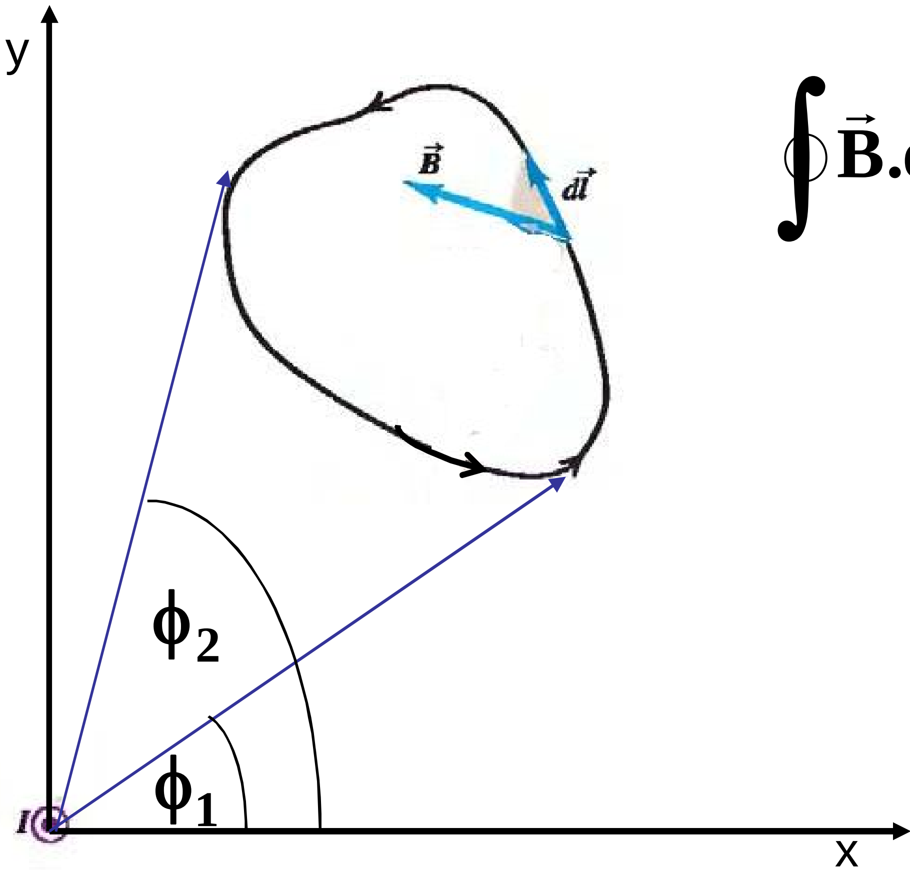


$$\vec{B}.d\vec{l} = B\cos\theta\, dl$$

$$B(r) = \frac{\mu_0}{2\pi}\frac{I}{r}$$



$$\oint \vec{B}.d\vec{l} = \oint \frac{\mu_0}{2\pi}\frac{I}{r} r d\varphi = \frac{\mu_0}{2\pi} I \int_0^{2\pi} d\varphi = \mu_0 I$$



$$\oint \vec{B}.d\vec{l} = \frac{\mu_0}{2\pi} I \left(\int_{\varphi_1}^{\varphi_2} d\varphi + \int_{\varphi_2}^{\varphi_1} d\varphi \right) = 0$$

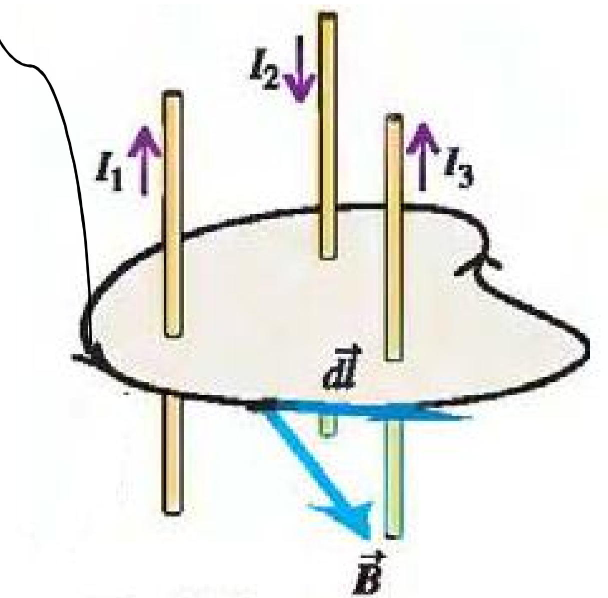
$$\oint \vec{B}.d\vec{l} = \mu_0 I_{concatenada}$$

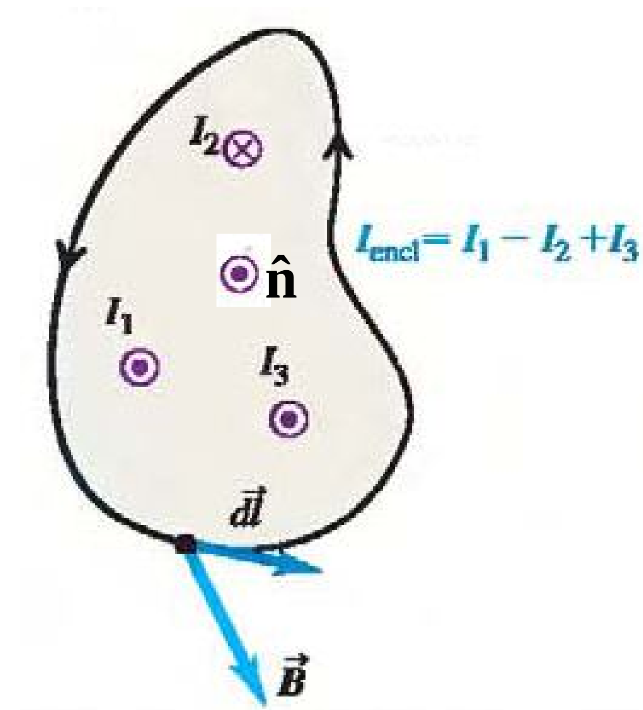
$\mathbf{I_{concatenada}}$ corriente total que atraviesa la superficie encerrada por la curva

$$\oint \vec{B}.d\vec{l} = \mu_0 \sum I_{concatenada}$$

LEY DE AMPERE

Curva arbitraria de Ampere

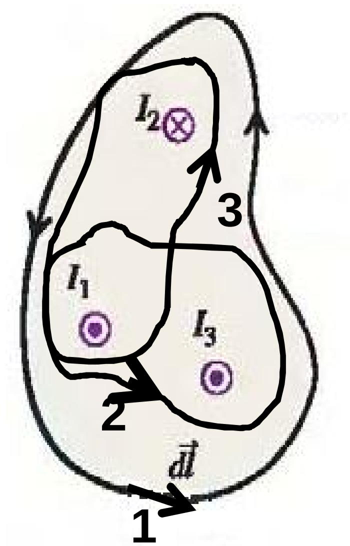




Indica dirección de la normal del área encerrada por la curva, y por lo tantos, sentido positivo de I

$$\oint \vec{B}.d\vec{l} = \mu_0 \sum I_{concatenada}$$

a) $$\text{si} \sum I_c = 0 \Rightarrow \oint \vec{B}.d\vec{l} = 0 \Longrightarrow \oint B\cos\theta\, dl = 0 \quad \begin{cases} B = 0 \\ \theta = 90^{o} \Rightarrow B \perp dl \end{cases}$$



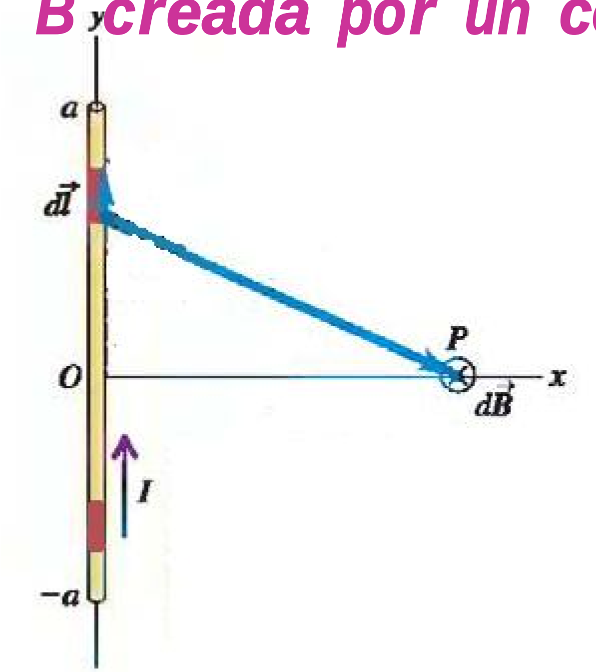
$$1)\ I_1 + I_3 - I_2 = \oint \vec{B}.d\vec{l}$$

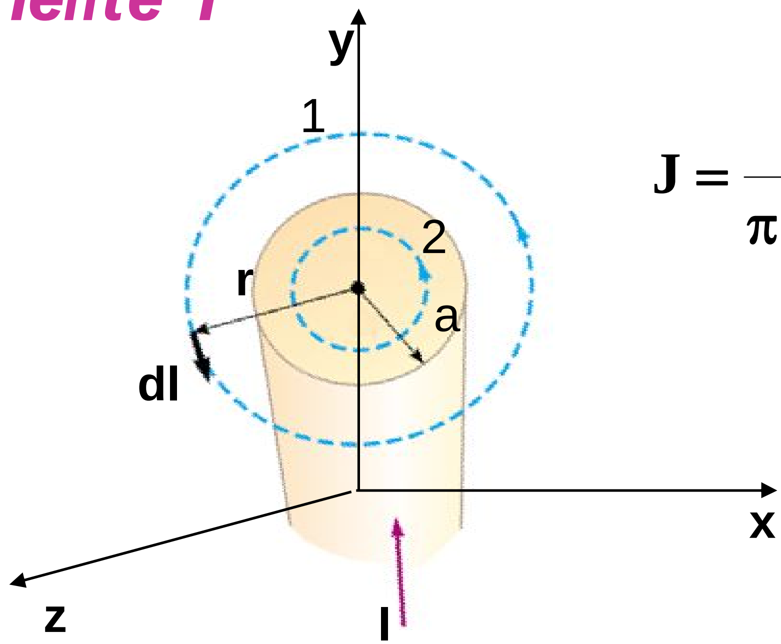
$$2)\ I_1 + I_3 = \oint \vec{B}.d\vec{l}$$

$$3)\ I_1 - I_2 = \oint \vec{B}.d\vec{l} \quad \text{si } I_1 = I_2 \Rightarrow \oint \vec{B}.d\vec{l} = 0$$

$$\text{b) Si } B = 0 \Rightarrow \oint \vec{B}.d\vec{l} = 0 \quad \Rightarrow \sum I_c = 0$$

B creada por un conductor infinito por el cual circula una corriente I





$$\mathbf{J} = \frac{\mathbf{I}}{\pi \mathbf{a}^2}$$

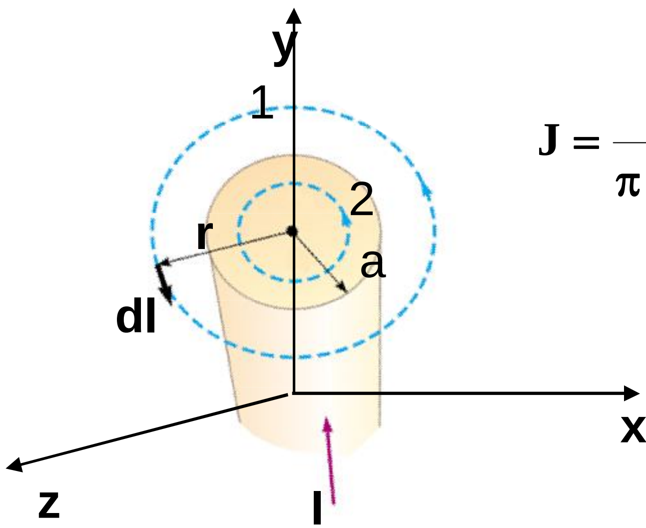
Por simetría conductor infinito

$$\vec{\mathbf{B}} = \mathbf{B}(\mathbf{r})\hat{\varphi}$$

$$\oint \vec{\mathbf{B}}.\mathbf{d}\vec{\mathbf{l}} = \mu_0 \sum \mathbf{I}_{\mathbf{concatenad\ a}}$$

$$1)\oint \vec{\mathbf{B}}.\mathbf{d}\vec{\mathbf{l}} = \oint \mathbf{B}(\mathbf{r})\,\mathbf{r}\,\mathbf{d}\varphi = \mathbf{B}(\mathbf{r})\oint \mathbf{r}\,\mathbf{d}\varphi = 2\pi\mathbf{r}\mathbf{B}(\mathbf{r}) = \mu_0\mathbf{I}$$

$$\boxed{\mathbf{B}(\mathbf{r} > \mathbf{a}) = \frac{\mu_0}{2\pi\mathbf{r}}\mathbf{I} = \frac{\mu_0}{2\mathbf{r}}\mathbf{J}\,\mathbf{a}^2}$$



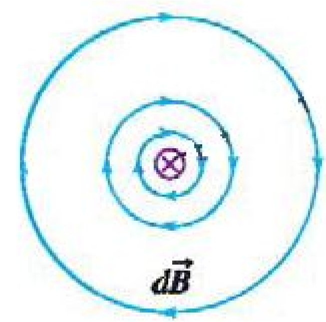
$$J = \frac{I}{\pi a^2}$$

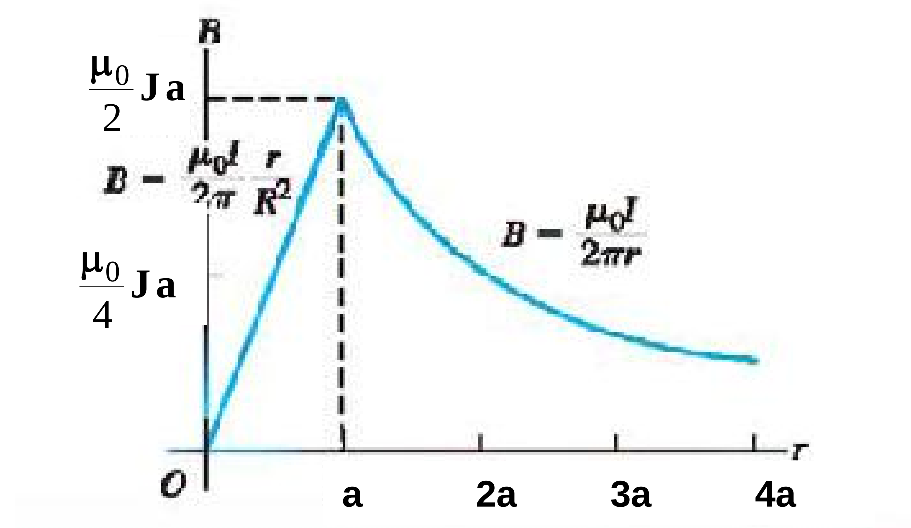
$$2)\oint \vec{B}.d\vec{l} = \oint B(r)\, r\, d\varphi = B(r)\oint r\, d\varphi = 2\pi r B(r)$$

$$2\pi r B(r) = \mu_0 \iint \vec{J}.d\vec{S} = \mu_0 \iint \vec{J}.\hat{n}dS = \mu_0 J \pi r^2$$

$$B(r \le a) = \frac{\mu_0}{2} J\, r$$

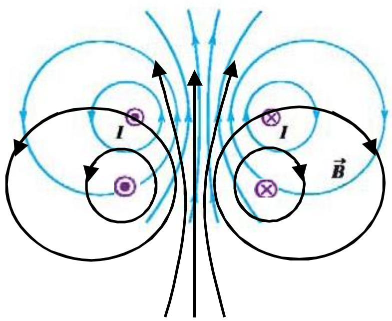
$$B(r \ge a) = \frac{\mu_0}{2} J \frac{a^2}{r}$$

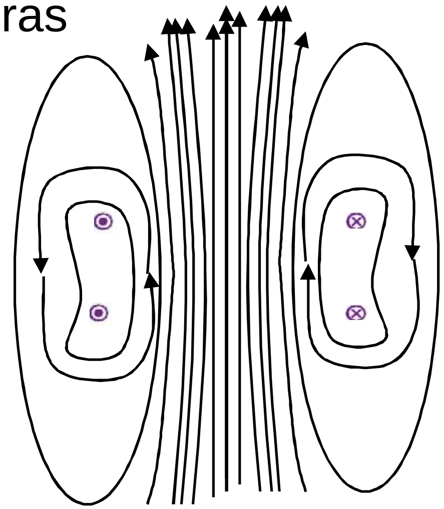


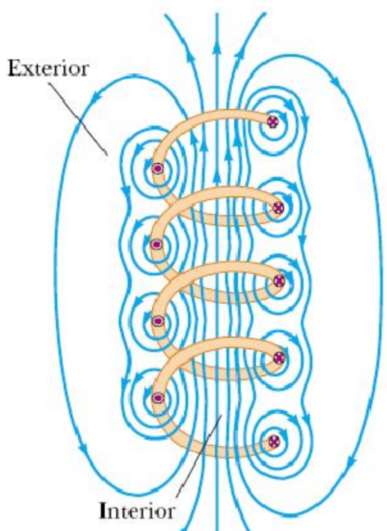


B creada por un solenoide

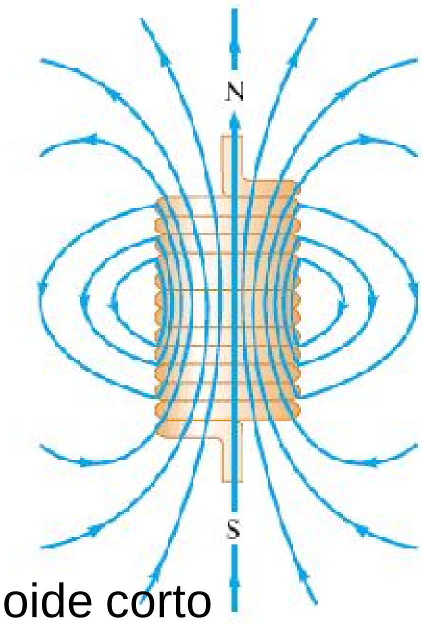
Suma de B de dos espiras





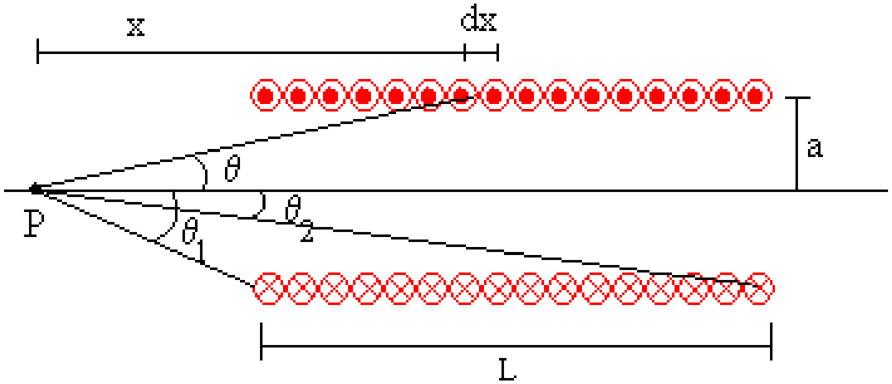


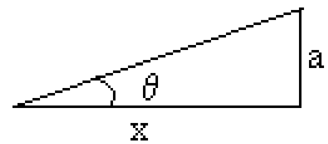
Suma de B de cuatro espiras



B Solenoide corto

B creada por un solenoide corto N espiras longitud L





$$\vec{B}(x,o,o) = \frac{\mu_0}{2\pi} \frac{I\pi a^2}{\left(x^2 + a^2\right)^{3/2}} \hat{x}$$

Campo de una espira sobre el eje a una distancia x de su centro

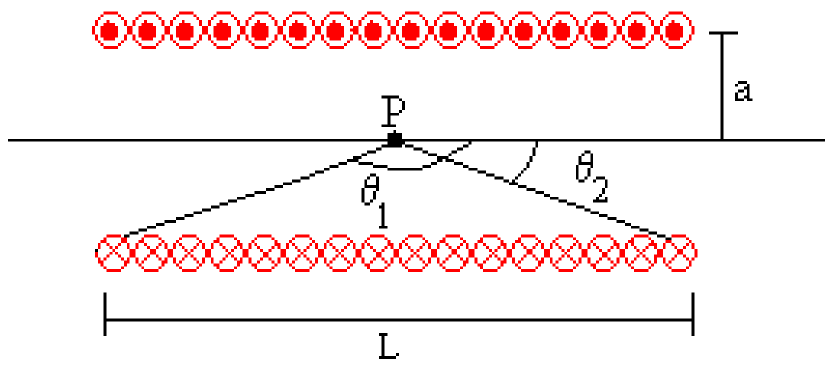
Todas las espiras del solenoide producen en **P** un **B** que tiene la misma dirección y sentido, pero distinto módulo, dependiendo de su distancia ***x*** al punto **P**.
El número de espiras que hay en el intervalo comprendido entre ***x*** y ***x+dx*** es ***dn=N·dx/L*.**

$$dB = \frac{\mu_0}{2} \frac{I a^2}{\left(x^2 + a^2\right)^{3/2}} \frac{N}{L} dx$$

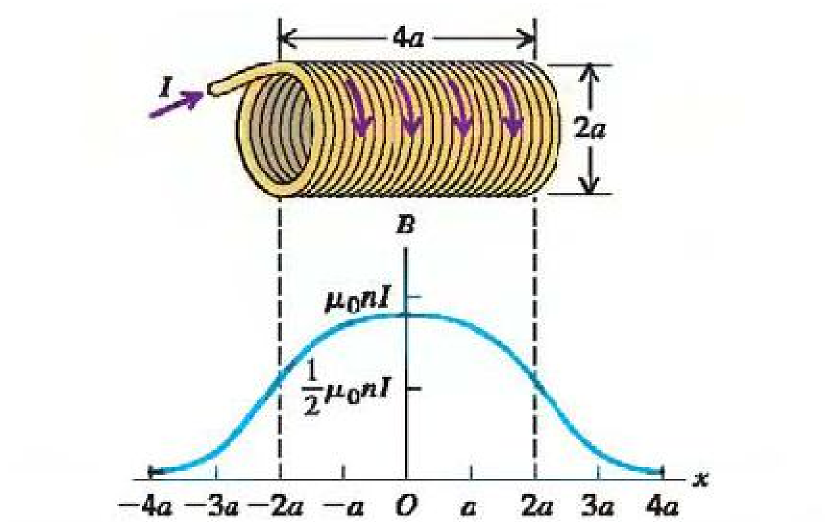
Realizando el cambio de variable ***a=x·tanq***,

$$B = \frac{\mu_0 IN}{2L} \int_{\theta_1}^{\theta_2} -\operatorname{sen}\theta \, d\theta = \frac{\mu_0 IN}{2L} \left(\cos\theta_2 - \cos\theta_1\right)$$

Si **L>> *a*** , y **P** está situado en el centro, que **q**$_{1} \to \pi$, y **q**$_{2} \to 0$.

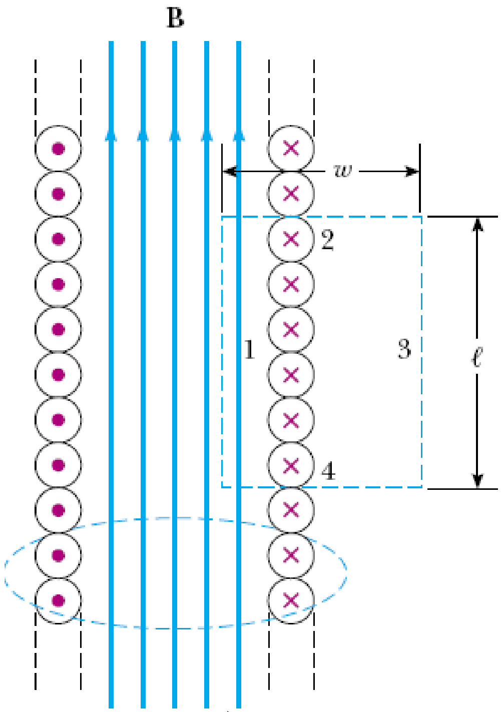


$$B = \frac{\mu_0 IN}{2L}\left(\cos\theta_2 - \cos\theta_1\right) = \frac{\mu_0 IN}{L}$$



B creada por un solenoide infinito

$$\oint \vec{B}.d\vec{l} = \mu_0 \sum I_{concatenada}$$

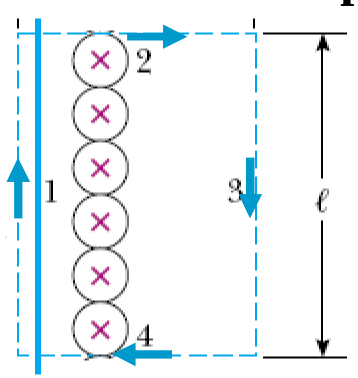


$$\oint \vec{B}\bullet d\vec{l} = \int_1 \vec{B}\bullet d\vec{l} + \underbrace{\int_2 \vec{B}\bullet d\vec{l}}_{B \perp dl} + \underbrace{\int_3 \vec{B}\bullet d\vec{l}}_{B=0} + \underbrace{\int_4 \vec{B}\bullet d\vec{l}}_{B \perp dl}$$

$$\oint \vec{B}\bullet d\vec{l} = \int_1 \vec{B}\bullet d\vec{l} = \int_1 B(x)dy = Bl$$

Por simetría $\vec{B} = B(x)\hat{y}$

$$n = \text{densidad de espiras} = \frac{N}{L}$$



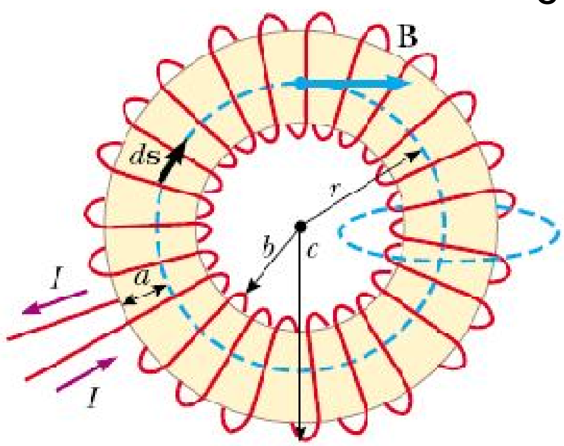
$$Bl = \mu_0 \frac{N}{L} lI$$

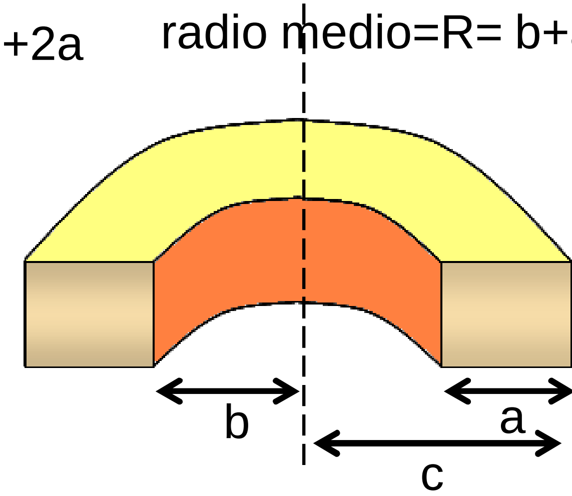
I entrante positiva

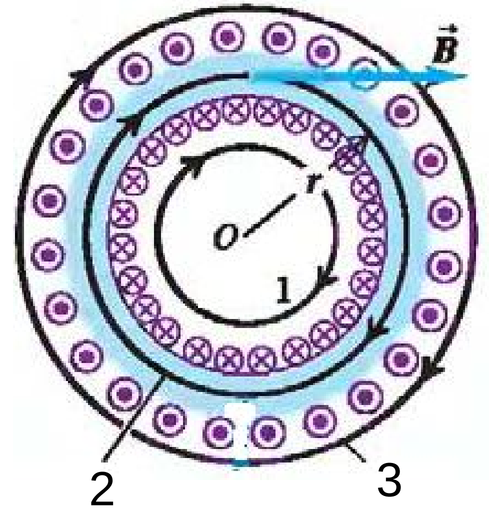
$$B = \mu_0 \frac{N}{L} I = \mu_0 n I$$

B creada por un Toroide de N espiras

c=b+2a   radio medio=R= b+a







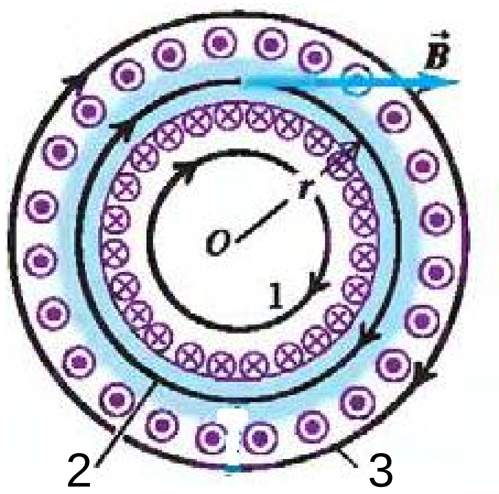
Por simetría $\vec{\mathbf{B}} = \mathbf{B(r)}\hat{\varphi}$ $\oint \vec{\mathbf{B}}.\mathbf{d}\vec{\mathbf{l}} = \mu_0 \sum \mathbf{I}_{\mathbf{concatenada}}$

En **1** las **I** **concatenadas=0** ⟹ $\oint \vec{\mathbf{B}}.\mathbf{d}\vec{\mathbf{l}} = \oint \mathbf{B(r)}\,\mathbf{dl} = \oint \mathbf{B(r)}\,\mathbf{r}\,\mathbf{d}\varphi = \mathbf{B(r)}\,2\pi\mathbf{r} = 0$

$$\boxed{\mathbf{B(r<b)} = 0}$$

En **2** las **I** **concatenadas=NI** ⟹ $\oint \vec{\mathbf{B}}.\mathbf{d}\vec{\mathbf{l}} = \oint \mathbf{B(r)}\,\mathbf{dl} = \oint \mathbf{B(r)}\,\mathbf{r}\,\mathbf{d}\varphi = \mathbf{B(r)}\,2\pi\mathbf{r} = \mu_0\mathbf{NI}$

$$\boxed{\mathbf{B(b<r<c)} = \mu_0 \frac{\mathbf{NI}}{2\pi\mathbf{r}}}$$

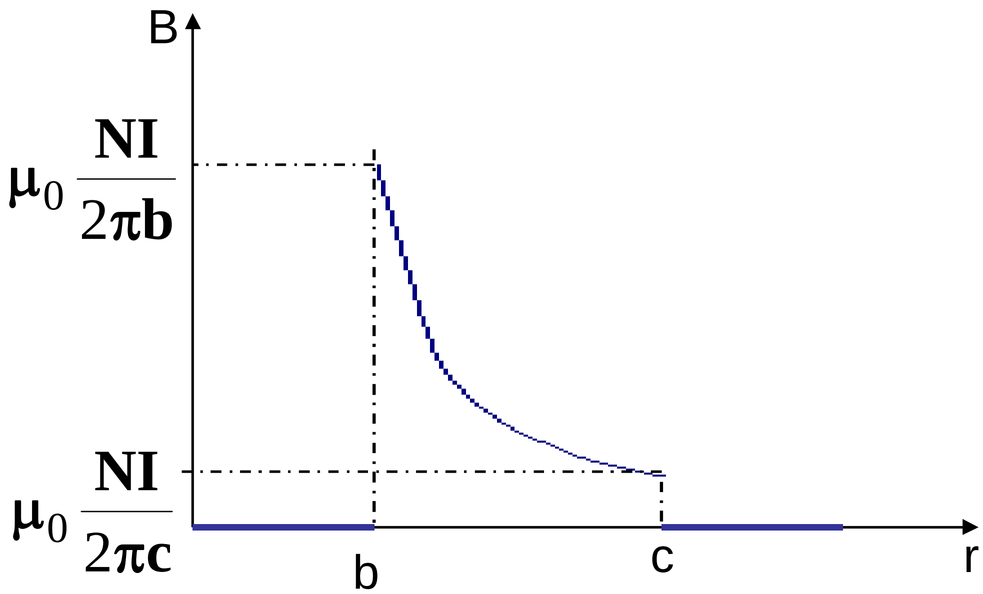


En **3** las **I** $_{\textbf{concatenadas}}$**=NI-NI=0** ⟹

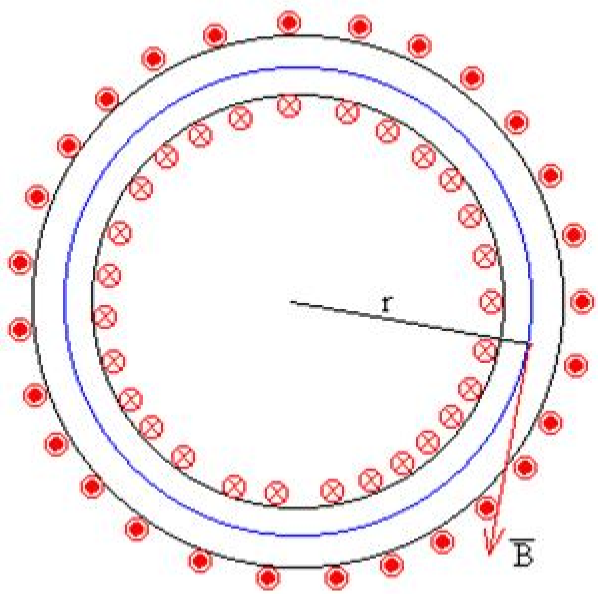
$$\oint \vec{B}.d\vec{l} = \oint B(r)\,dl = \oint B(r)\,r\,d\varphi = B(r)\,2\pi r = 0$$

$$\boxed{B(r<b, r>c) = 0}$$

$$\boxed{B(b<r<c) = \mu_0 \frac{NI}{2\pi r}}$$



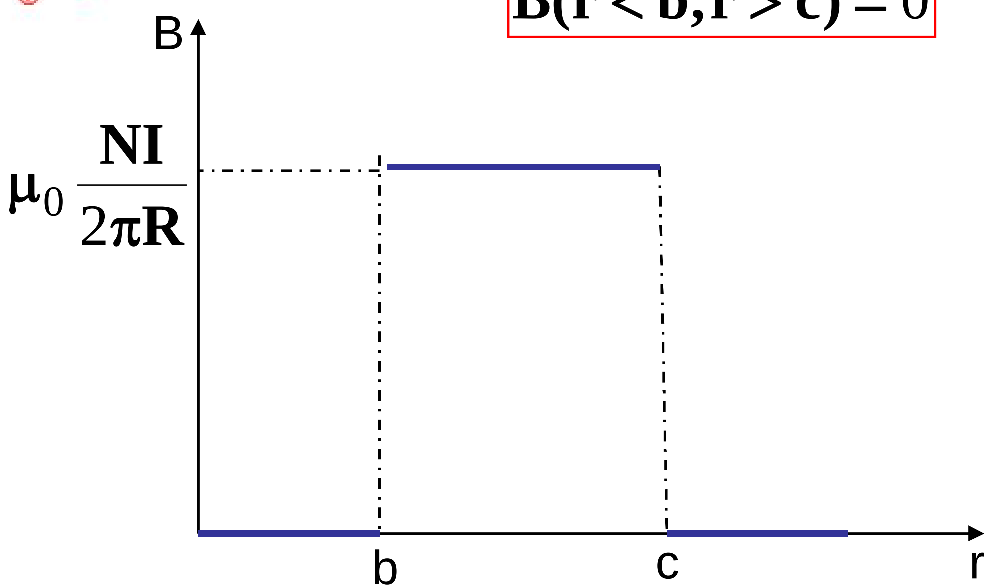
B creada por un Toroide angosto de N espiras



Si a<<b ➡ $\mathbf{b \approx R}$

$$\mathbf{B(b<r<c, a<<b)} = \mu_0 \frac{\mathbf{NI}}{2\pi \mathbf{R}} = \mu_0 \mathbf{nI}$$

$$\mathbf{B(r<b, r>c)} = 0$$

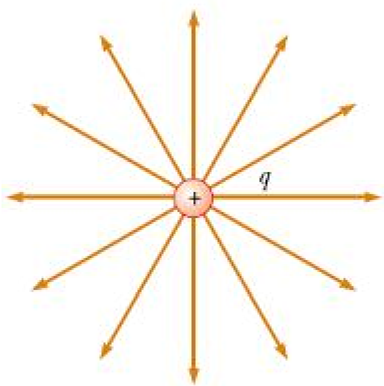


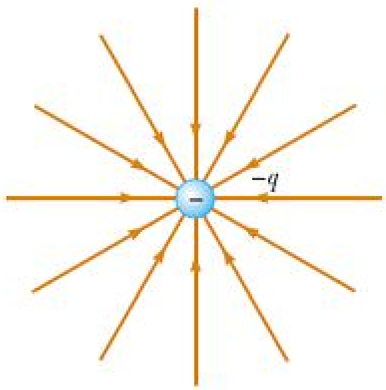
E EN EL VACIO

$$\phi_E = \oint\!\!\oint \vec{E}\,.d\vec{A} = \frac{Q_{enc}}{\varepsilon_0} \qquad \vec{\nabla}.\vec{E} = \frac{\rho}{\varepsilon_0}$$

$$\oint \vec{E}.d\vec{l} = 0 \qquad \vec{\nabla}\times\vec{E} = 0$$

Campo Electrostático conservativo.
Líneas de E nacen en q+ y mueren en q-

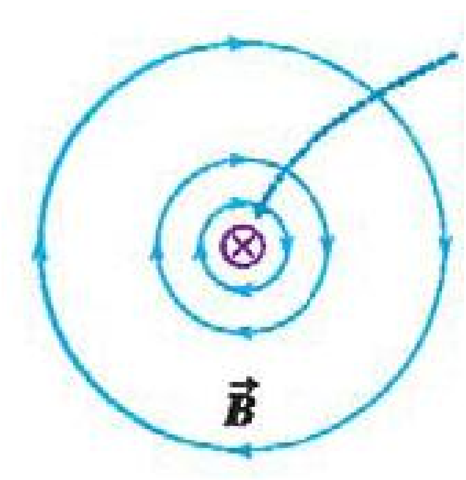




$$\phi_B = \oint\!\!\oint B_n\,dA = 0 \qquad \vec{\nabla}.\vec{B} = 0$$

$$\oint \vec{B}.d\vec{l} = \mu_0 I_c \qquad \vec{\nabla}\times\vec{B} = \mu_0\,\vec{J}$$

Campo Magnetostático no conservativo.
Líneas de B cerradas. No existen los monopolos magnéticos



I entrante al pizarrón