Eletromagnetismo

$$\vec{\nabla} \cdot \vec{D} = \rho$$

$$\vec{\nabla} \times \vec{E} = -\frac{\partial \vec{B}}{\partial t}$$

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

$$\vec{\nabla} \times \vec{H} = \vec{j} + \epsilon_0 \frac{\partial \vec{D}}{\partial t}$$

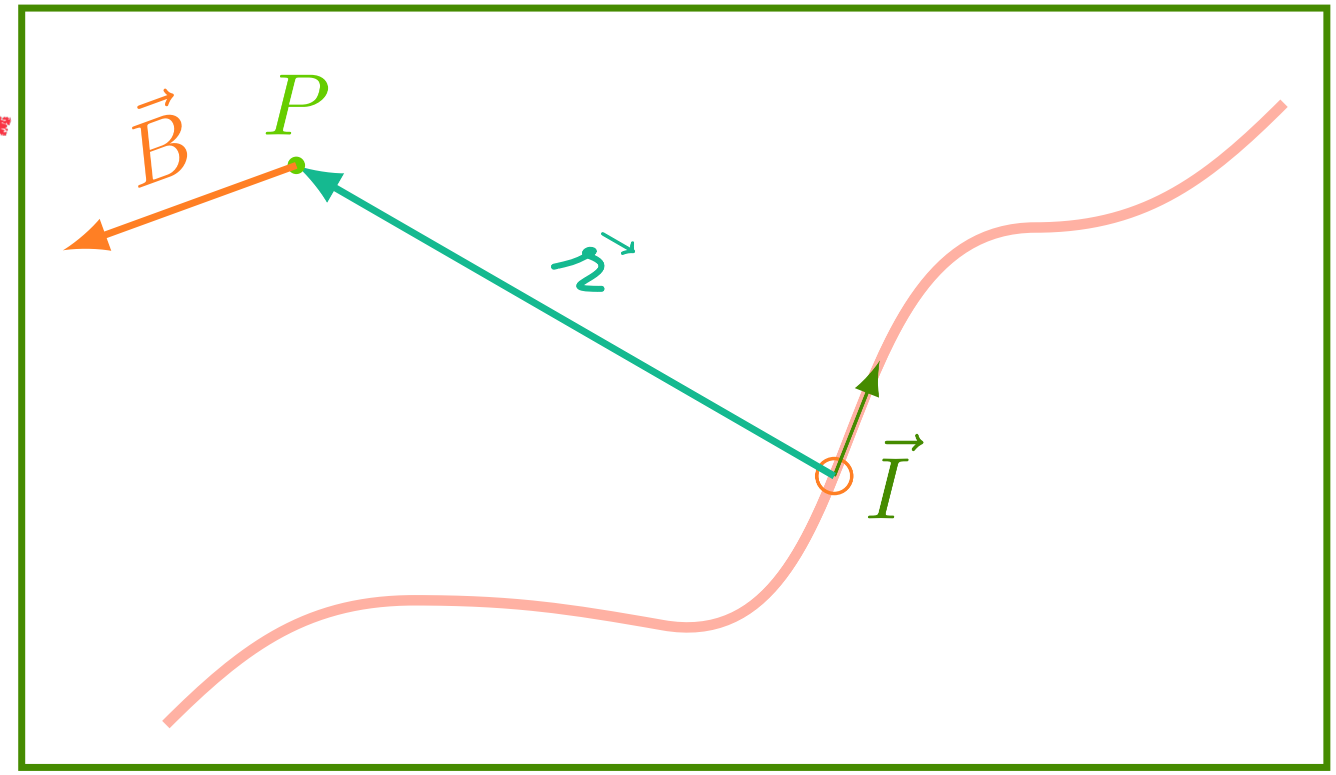
28 de junho de 2021

Magnetostática

Lei de Biot e Savart

$$\vec{B} = \frac{\mu_0}{4\pi} \int \frac{\vec{I} \times \hat{\mathscr{r}}}{\mathscr{r}^2}\, \mathrm{d}\ell'$$

CORRENTE EM FIO



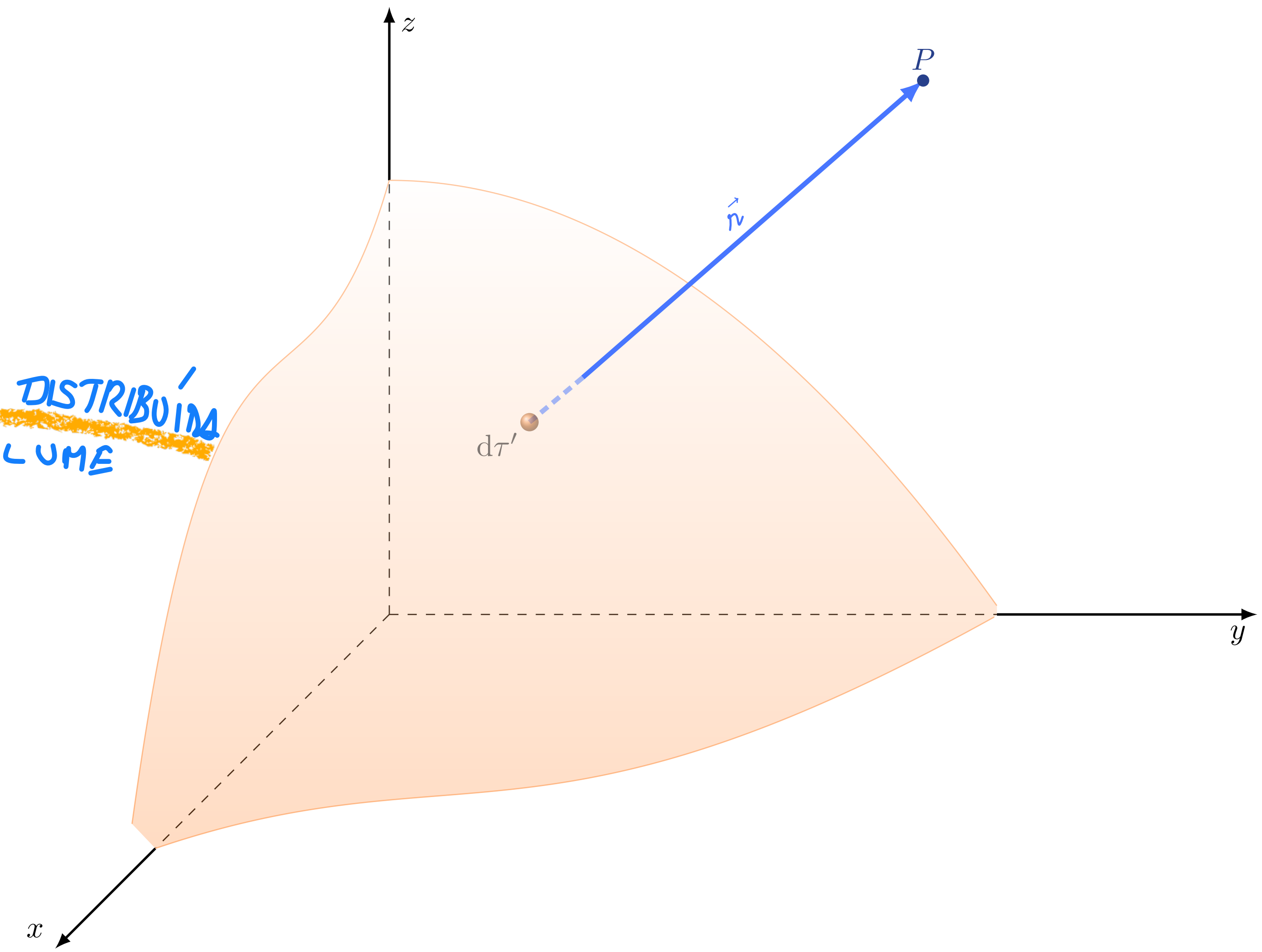
Lei de Biot e Savart

$$\vec{B} = \frac{\mu_0}{4\pi} \int \frac{\vec{I} \times \hat{\mathscr{r}}}{\mathscr{r}^2}\, \mathrm{d}\ell'$$

$$\vec{B} = \frac{\mu_0}{4\pi} \int \frac{\vec{J} \times \hat{\mathscr{r}}}{\mathscr{r}^2}\, \mathrm{d}\tau'$$

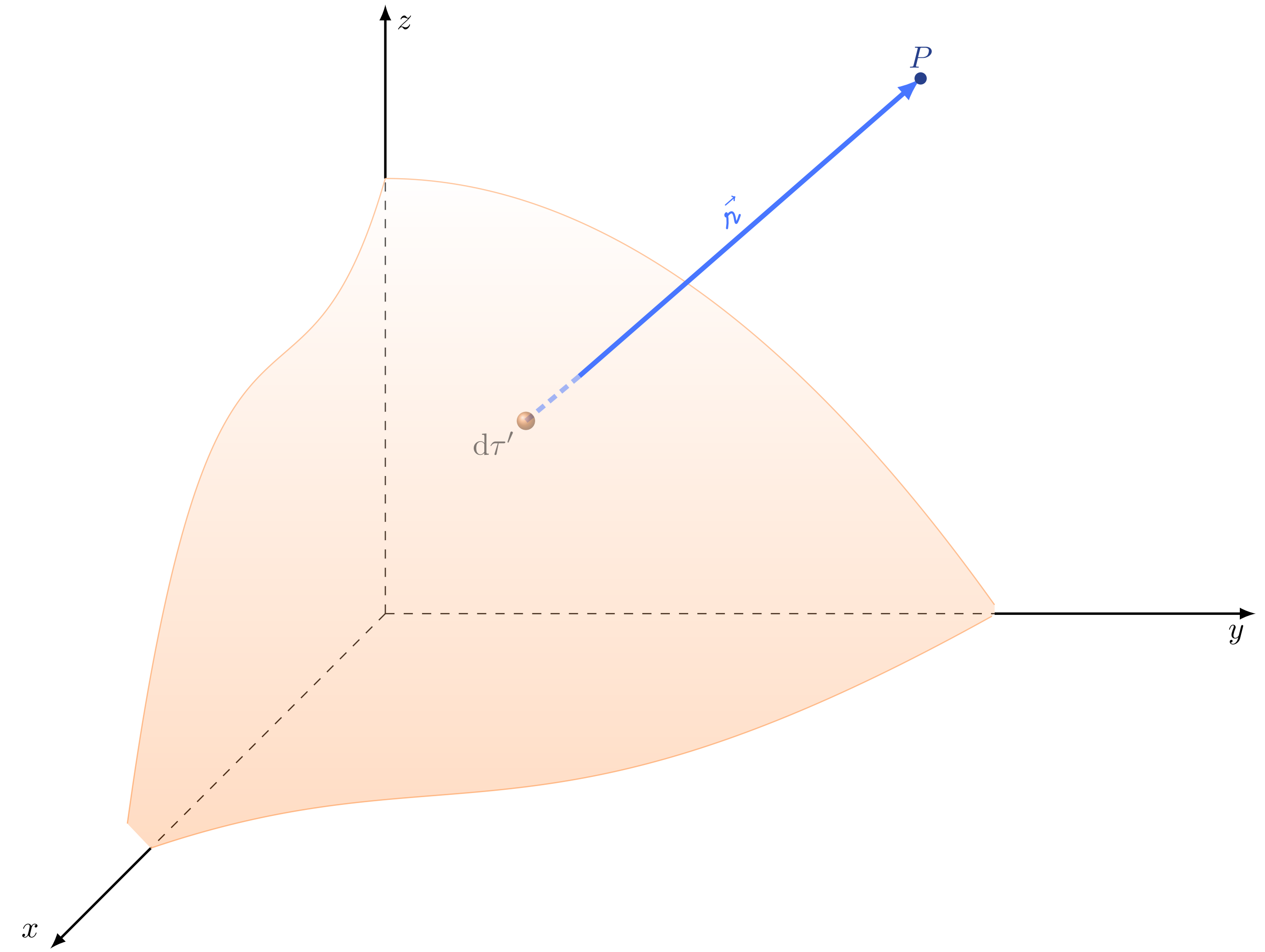
CORRENTE DISTRIBUÍDA EM VOLUME

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



Lei de Biot e Savart

$$\vec{B} = \frac{\mu_0}{4\pi} \int \frac{\vec{J} \times \hat{\mathscr{r}}}{\mathscr{r}^2} \, \mathrm{d}\tau'$$



Lei de Biot e Savart

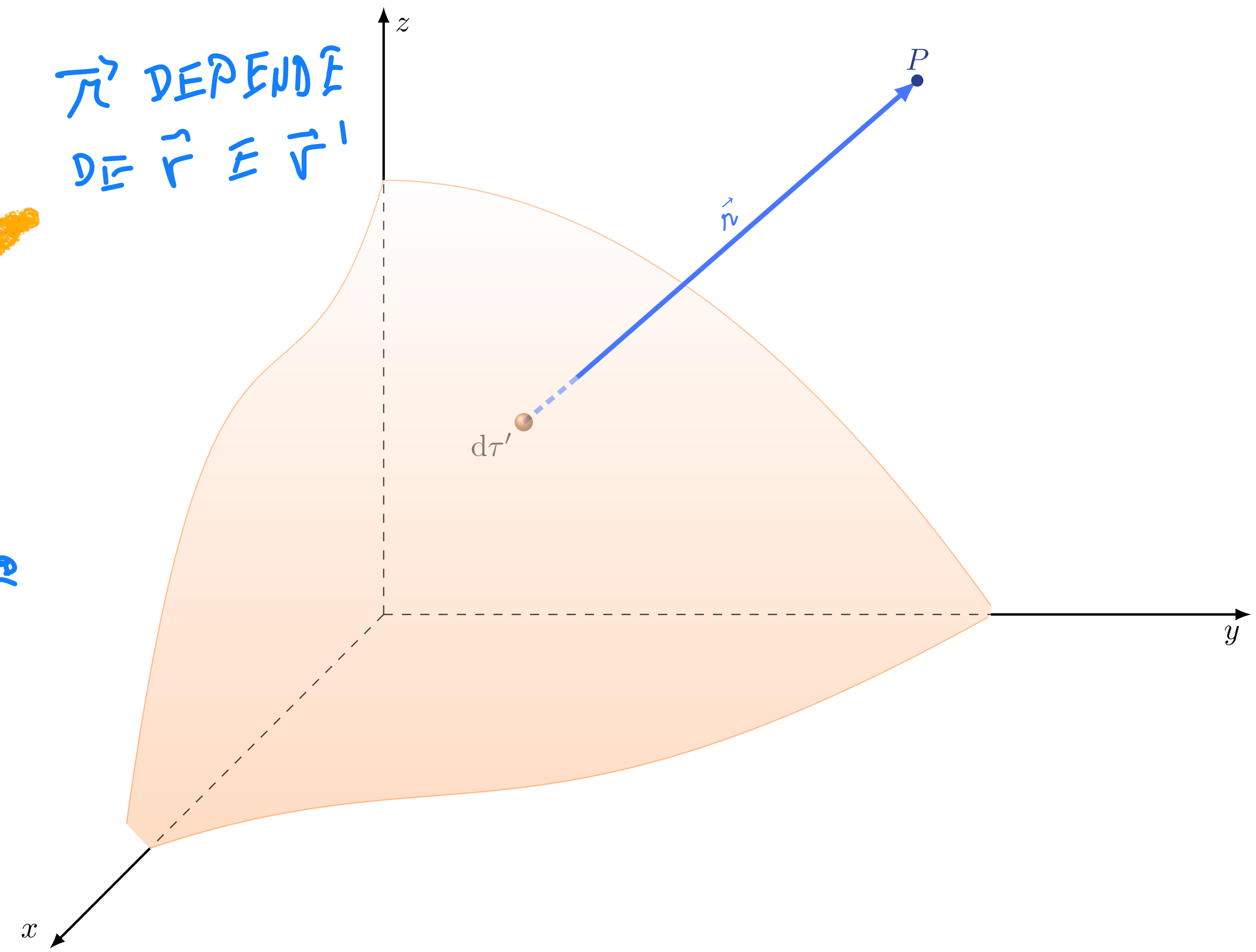
$$\vec{B} = \frac{\mu_0}{4\pi}\int \frac{\vec{J}\times\hat{\mathscr{r}}}{\mathscr{r}^2}\,\mathrm{d}\tau'$$

$\vec{B} = \vec{B}(\vec{r})$ $\vec{J}(\vec{r}\,')$

$\vec{\mathscr{r}}$ DEPENDE DE $\vec{r}$ E $\vec{r}\,'$

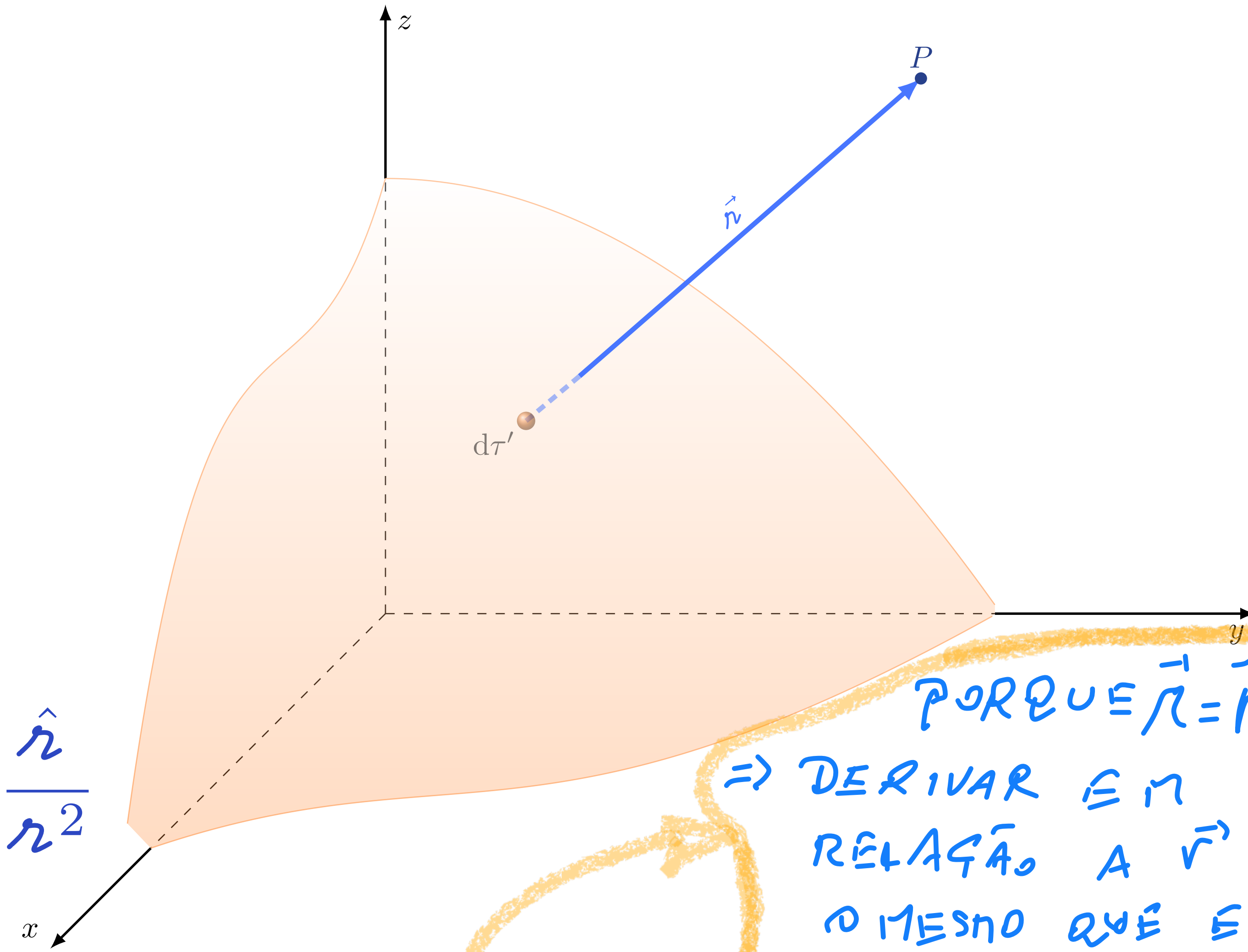
$$\vec{\nabla}\times\vec{B} = \frac{\mu_0}{4\pi}\int \vec{\nabla}\times\frac{\vec{J}\times\hat{\mathscr{r}}}{\mathscr{r}^2}\,\mathrm{d}\tau'$$

DERIVADAS EM RELAÇÃO A $\vec{r}$



Lei de Biot e Savart

$$\vec{B} = \frac{\mu_0}{4\pi}\int \frac{\vec{J}\times\hat{\mathscr{r}}}{\mathscr{r}^2}\,\mathrm{d}\tau'$$



$$\vec{\nabla}\times\vec{B} = \frac{\mu_0}{4\pi}\int \vec{\nabla}\times\frac{\vec{J}\times\hat{\mathscr{r}}}{\mathscr{r}^2}\,\mathrm{d}\tau'$$

$$\vec{\nabla}\times\frac{\vec{J}\times\hat{\mathscr{r}}}{\mathscr{r}^2} = \vec{J}\underbrace{\left(\vec{\nabla}\cdot\frac{\hat{\mathscr{r}}}{\mathscr{r}^2}\right)}_{4\pi\,\delta^{(3)}(\vec{\mathscr{r}})} - (\vec{J}\cdot\vec{\nabla})\frac{\hat{\mathscr{r}}}{\mathscr{r}^2}$$

$$= (\vec{J}\cdot\vec{\nabla}')\frac{\hat{\mathscr{r}}}{\mathscr{r}^2} = (\vec{J}\cdot\vec{\nabla}')\frac{\vec{\mathscr{r}}}{\mathscr{r}^3}$$

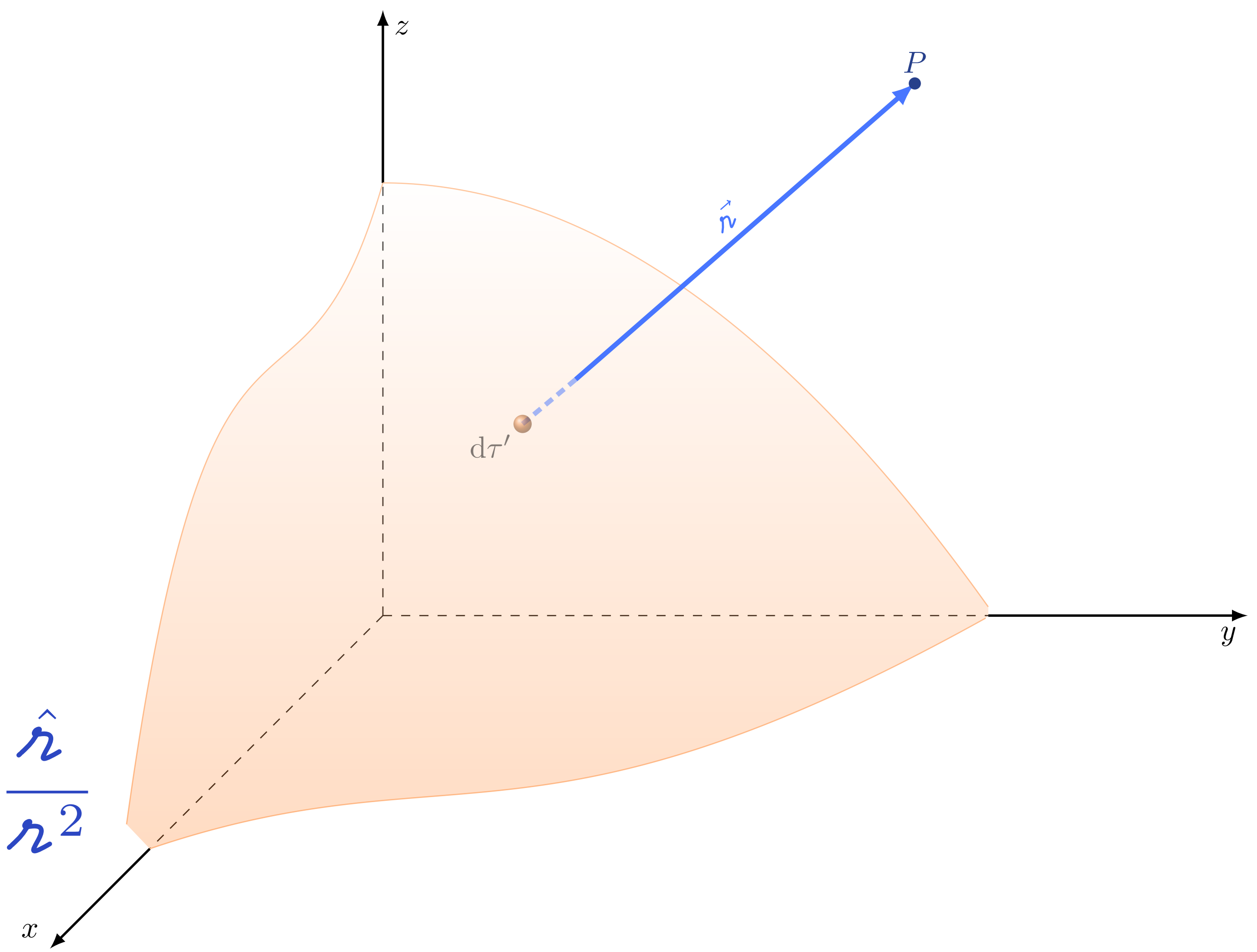
PORQUE $\vec{\mathscr{r}} = \vec{r} - \vec{r}'$
⇒ DERIVAR EM RELAÇÃO A $\vec{r}$ É O MESMO QUE EM RELAÇÃO A $\vec{r}'$, COM SINAL TROCADO

INTEGRAL DÁ ZERO

INTEGRAR POR PARTES:
- UM TERMO É PROPORCIONAL A $\vec{\nabla}'\cdot\vec{J} = 0$ (POIS $\frac{\partial\rho}{\partial t} = 0$)
- O OUTRO É $\vec{\nabla}'\cdot\vec{J}\,\frac{\hat{\mathscr{r}}}{\mathscr{r}^2}$ → TEOREMA GAUSS → INTEGRAL SUPERFÍCIE → 0 QDO $\vec{r}' \to \infty$

Lei de Biot e Savart

$$\vec{B} = \frac{\mu_0}{4\pi} \int \frac{\vec{J} \times \hat{\mathscr{r}}}{\mathscr{r}^2} \, \mathrm{d}\tau'$$



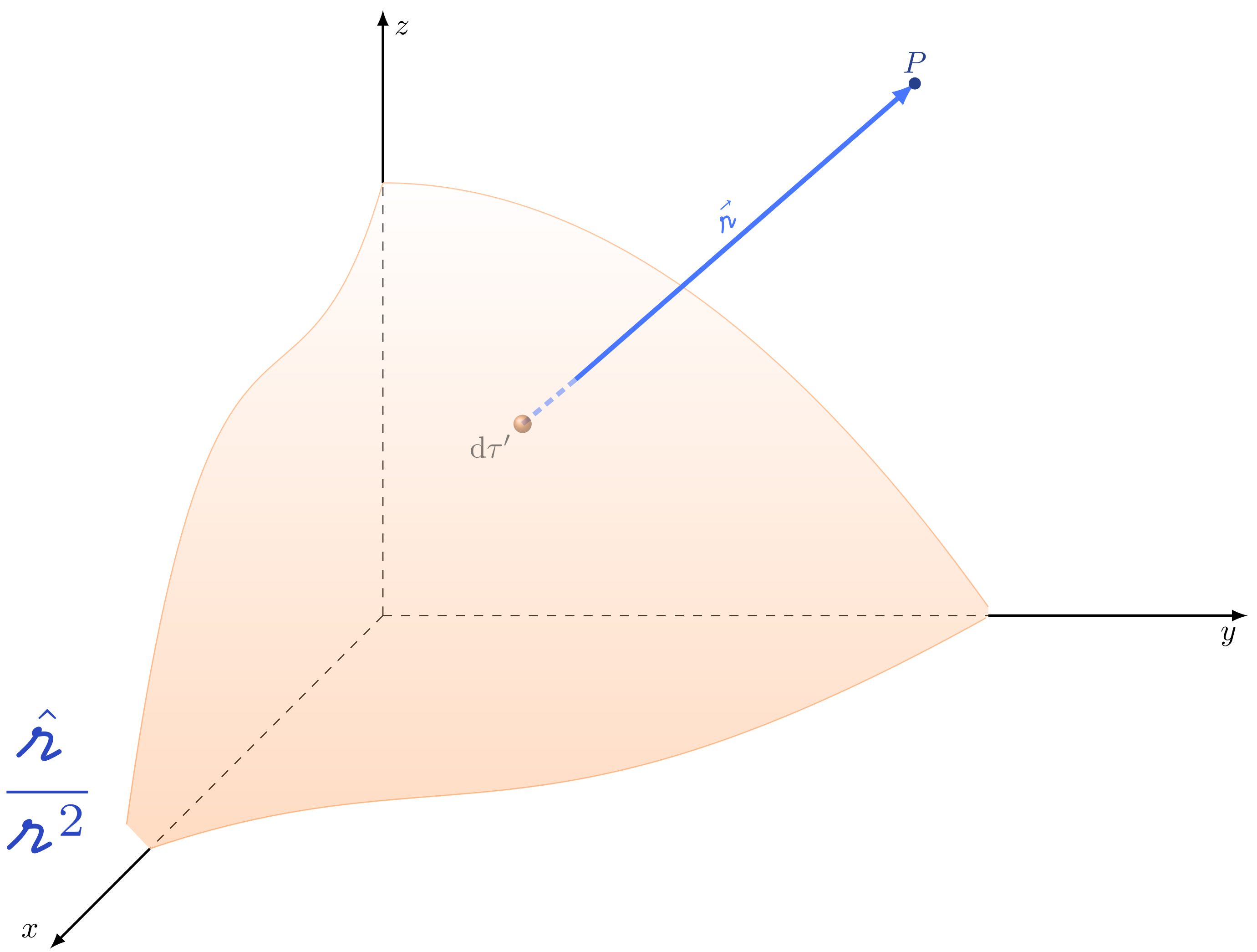
$$\vec{\nabla} \times \vec{B} = \frac{\mu_0}{4\pi} \int \vec{\nabla} \times \frac{\vec{J} \times \hat{\mathscr{r}}}{\mathscr{r}^2} \, \mathrm{d}\tau'$$

$$\vec{\nabla} \times \frac{\vec{J} \times \hat{\mathscr{r}}}{\mathscr{r}^2} = \vec{J}\left(\vec{\nabla} \cdot \frac{\hat{\mathscr{r}}}{\mathscr{r}^2}\right) - (\vec{J} \cdot \vec{\nabla})\frac{\hat{\mathscr{r}}}{\mathscr{r}^2}$$

$$\vec{\nabla} \times \vec{B} = \frac{\mu_0}{4\pi} \int \vec{J}\, 4\pi \delta(\vec{r} - \vec{r}') \, \mathrm{d}\tau' = \mu_0 \vec{J}(\vec{r})$$

Lei de Biot e Savart

$$\vec{B} = \frac{\mu_0}{4\pi} \int \frac{\vec{J} \times \hat{\mathscr{r}}}{\mathscr{r}^2} \, \mathrm{d}\tau'$$



$$\vec{\nabla} \times \vec{B} = \frac{\mu_0}{4\pi} \int \vec{\nabla} \times \frac{\vec{J} \times \hat{\mathscr{r}}}{\mathscr{r}^2} \, \mathrm{d}\tau'$$

$$\vec{\nabla} \times \frac{\vec{J} \times \hat{\mathscr{r}}}{\mathscr{r}^2} = \vec{J}\left(\vec{\nabla} \cdot \frac{\hat{\mathscr{r}}}{\mathscr{r}^2}\right) - (\vec{J} \cdot \vec{\nabla})\frac{\hat{\mathscr{r}}}{\mathscr{r}^2}$$

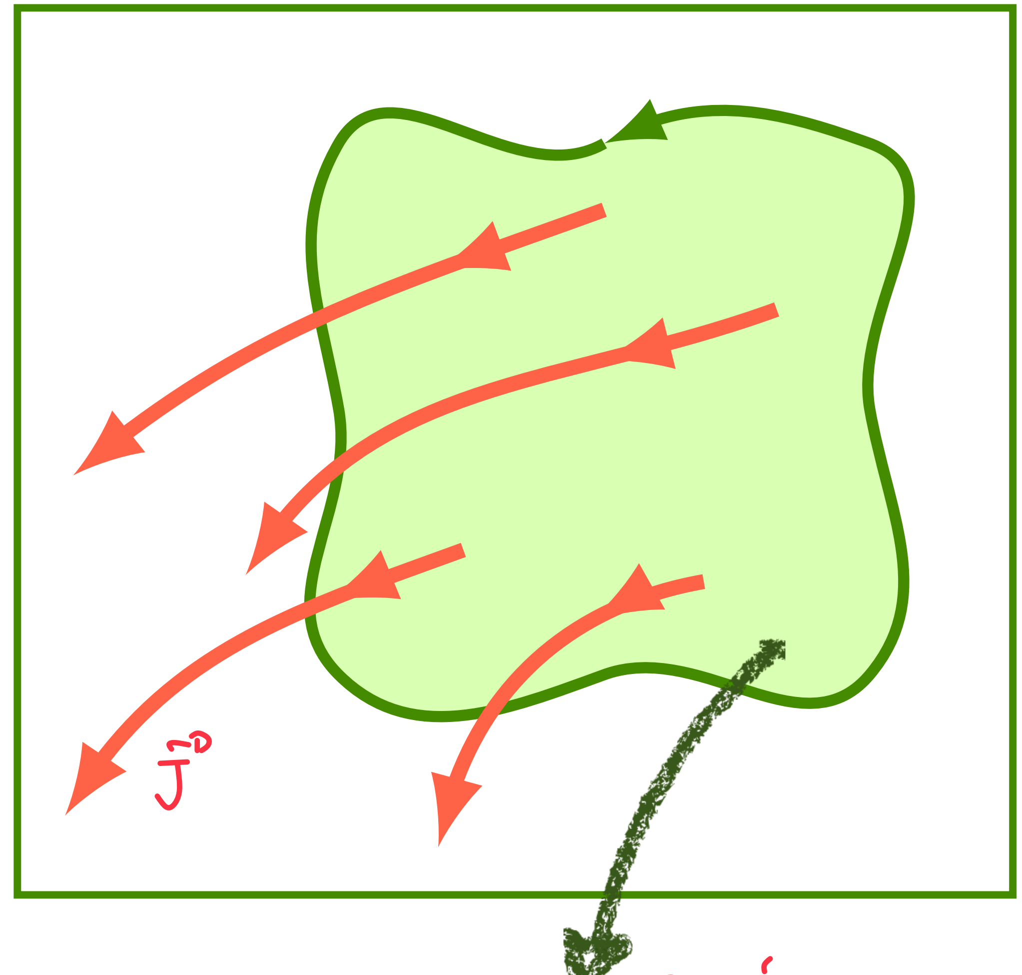
$$\vec{\nabla} \times \vec{B} = \frac{\mu_0}{4\pi} \int \vec{J} \, 4\pi\delta(\vec{r} - \vec{r'}) \, \mathrm{d}\tau'$$

$$\vec{\nabla} \times \vec{B} = \mu_0 \vec{J}$$

Lei de Ampère

$$\vec{\nabla} \times \vec{B} = \mu_0 \vec{J}$$

FORMA DIFERENCIAL

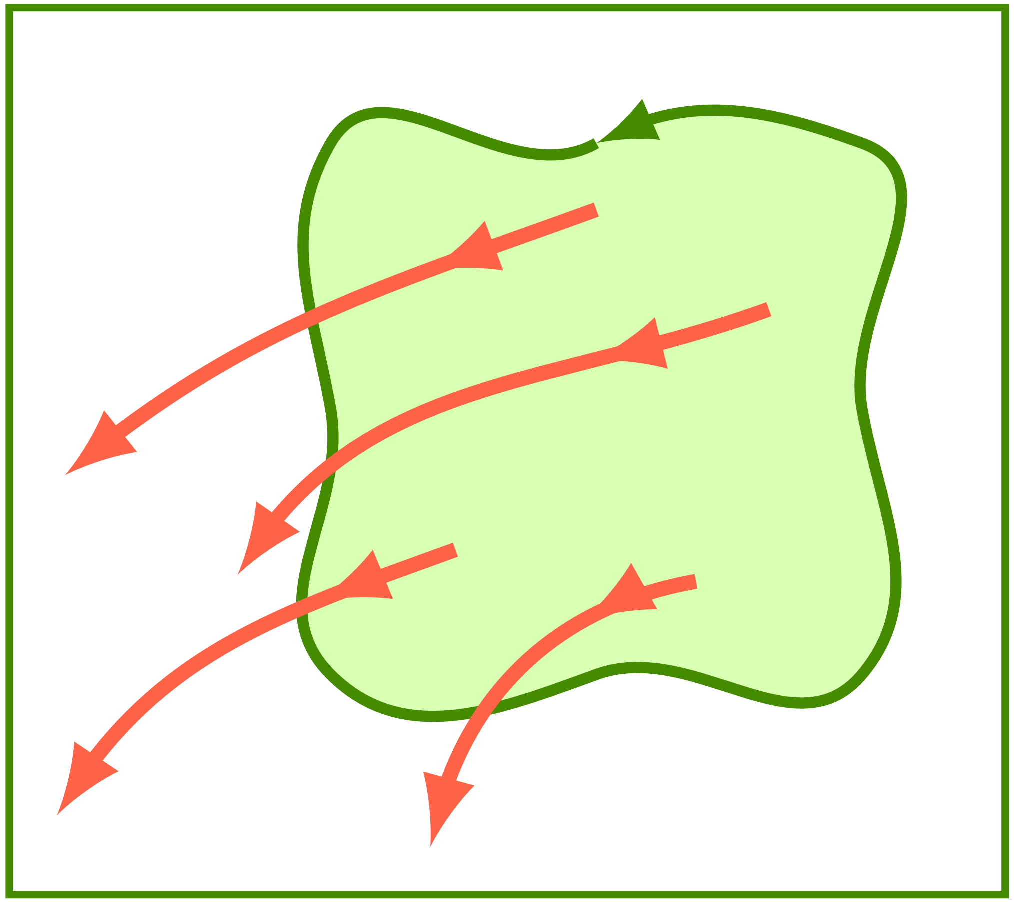


Lei de Ampère

$$\vec{\nabla} \times \vec{B} = \mu_0 \vec{J}$$

STOKES

$$\oint \vec{B} \cdot \mathrm{d}\vec{\ell} = \mu_0 \int_{\mathcal{A}} \vec{J} \cdot \mathrm{d}\vec{a}$$



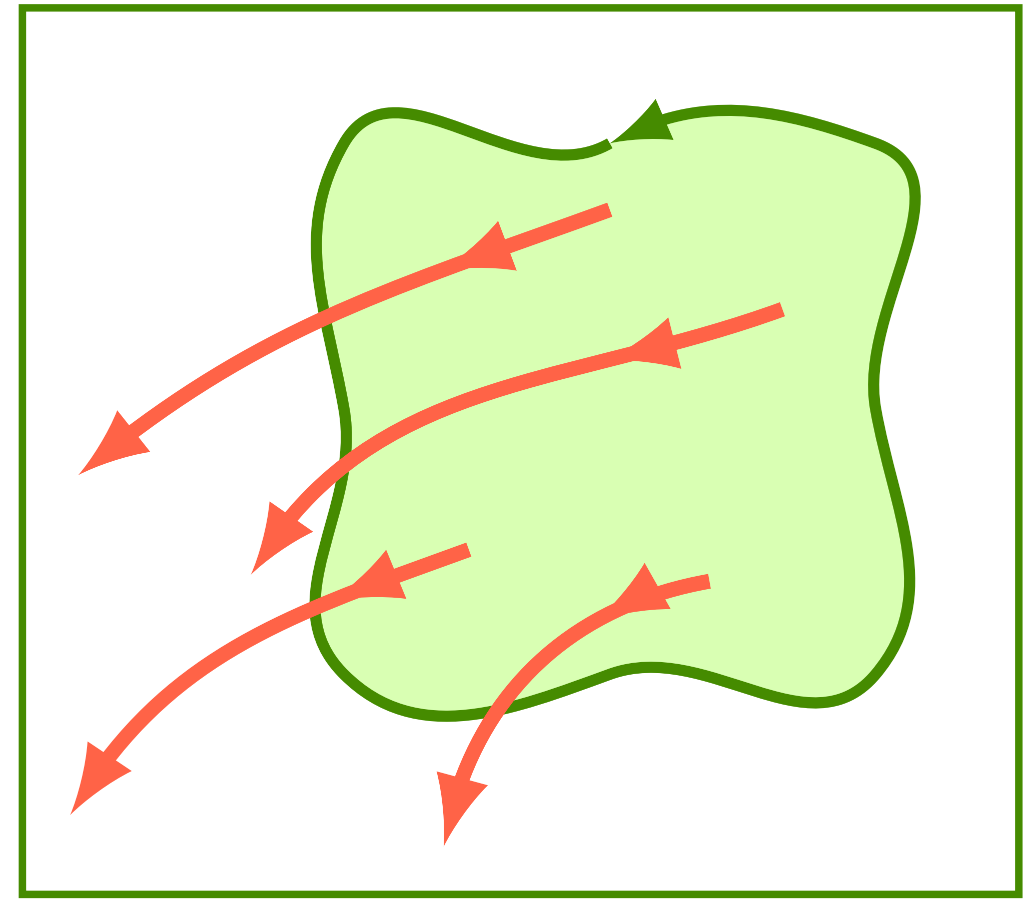
Lei de Ampère

$$\vec{\nabla} \times \vec{B} = \mu_0 \vec{J}$$

$$\oint \vec{B} \cdot \vec{\mathrm{d}\ell} = \mu_0 \int_{\mathcal{A}} \vec{J} \cdot \mathrm{d}\vec{a}$$

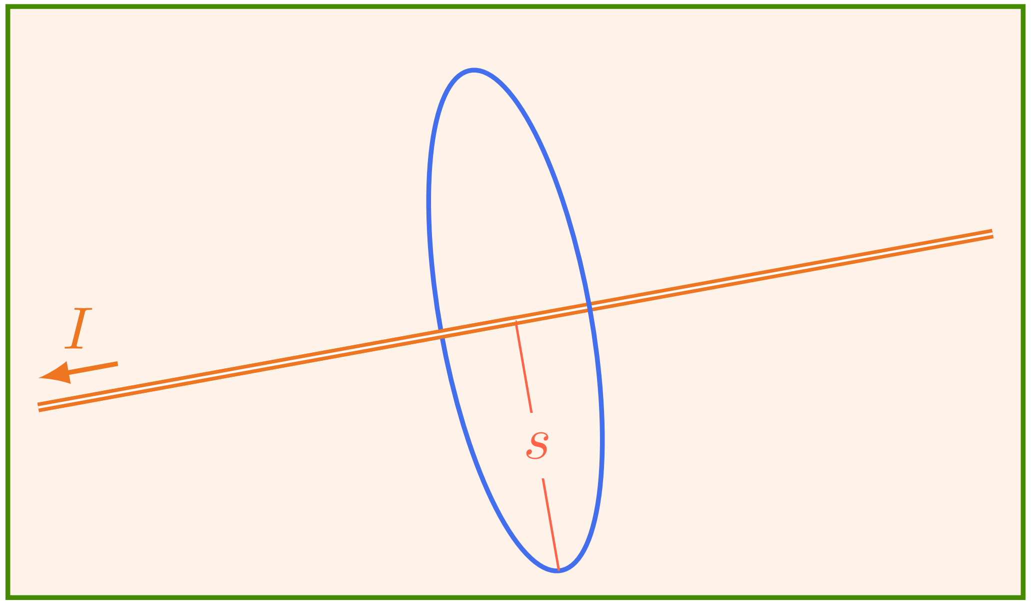
$$\oint \vec{B} \cdot \vec{\mathrm{d}\ell} = \mu_0 I_{\mathrm{int}}$$

CORRENTE QUE ATRAVESSA CIRCUITO



Pratique o que aprendeu

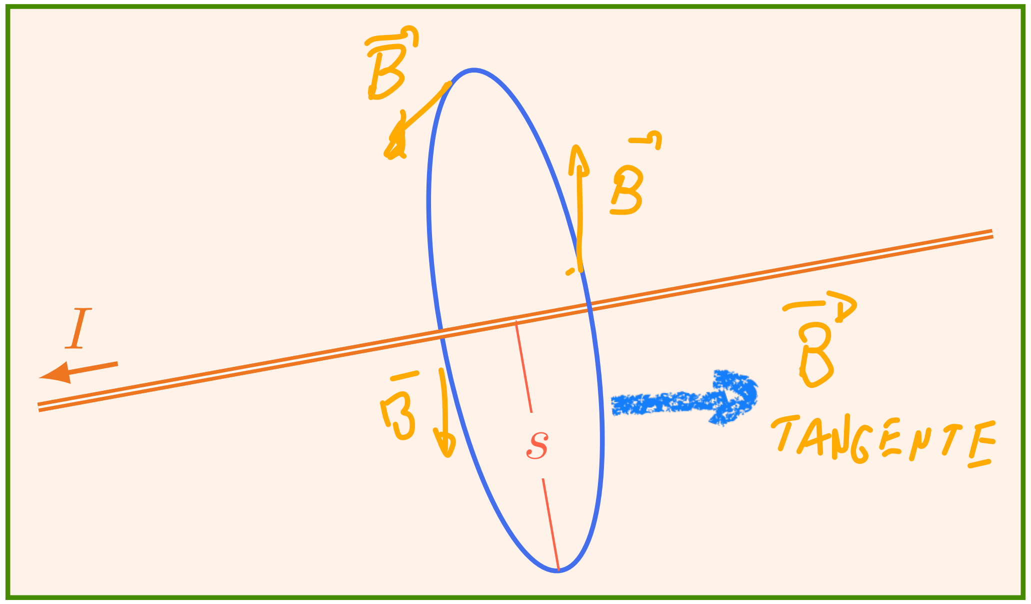
$$\oint \vec{B} \cdot \vec{\mathrm{d}}\ell = \mu_0 I_{\text{int}}$$



Pratique o que aprendeu

$$\oint \vec{B} \cdot \vec{\mathrm{d}}\ell = \mu_0 I_{\text{int}}$$

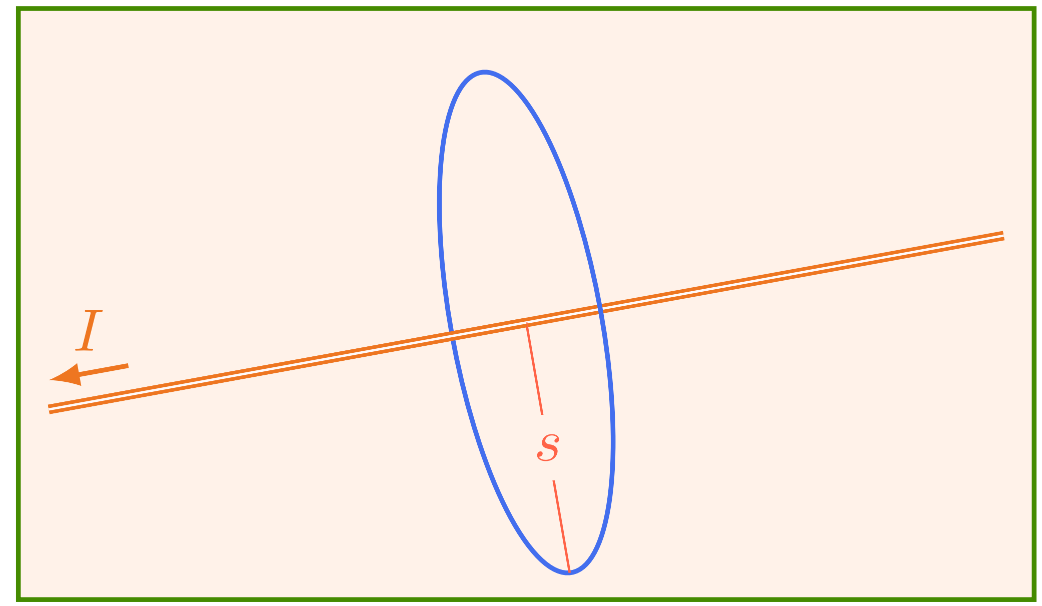
$$B = \frac{\mu_0 I}{2\pi s}$$

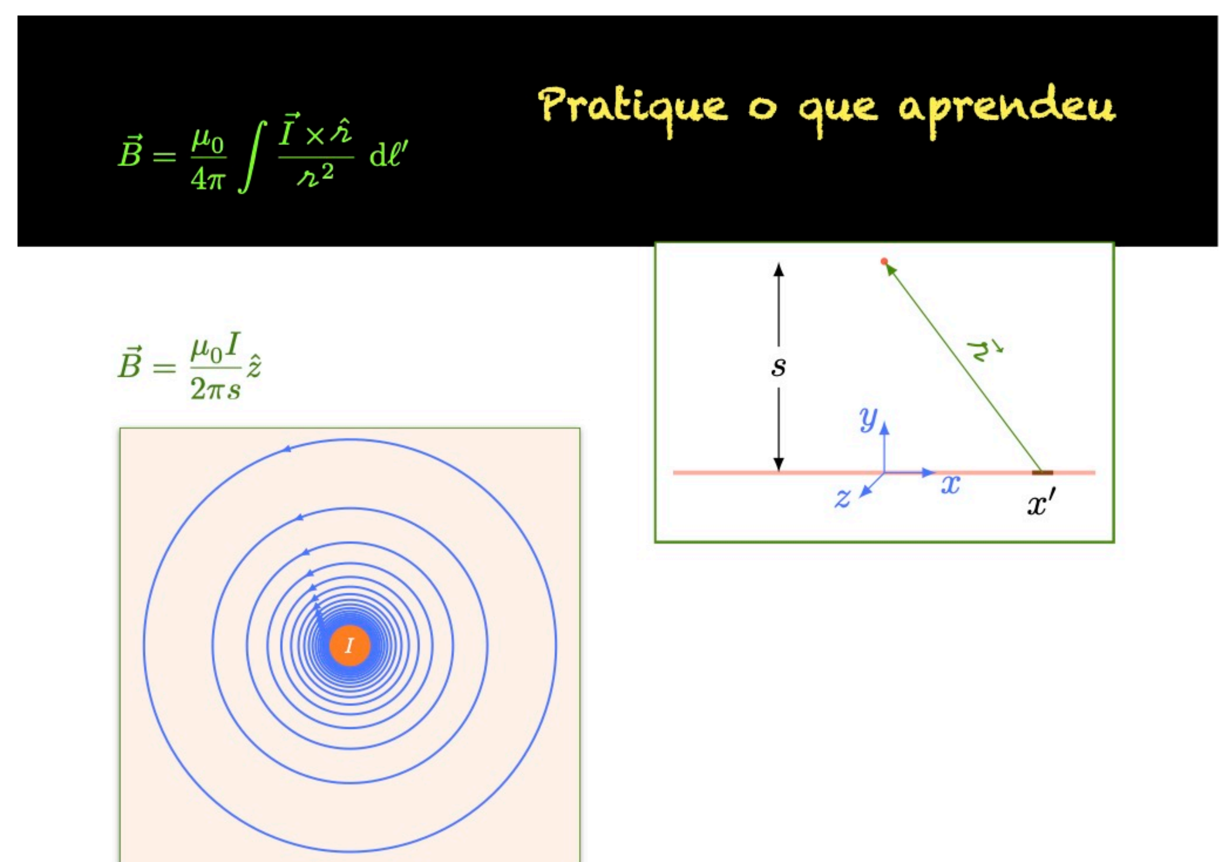


Pratique o que aprendeu

$$\oint \vec{B} \cdot \mathrm{d}\vec{\ell} = \mu_0 I_{\text{int}}$$

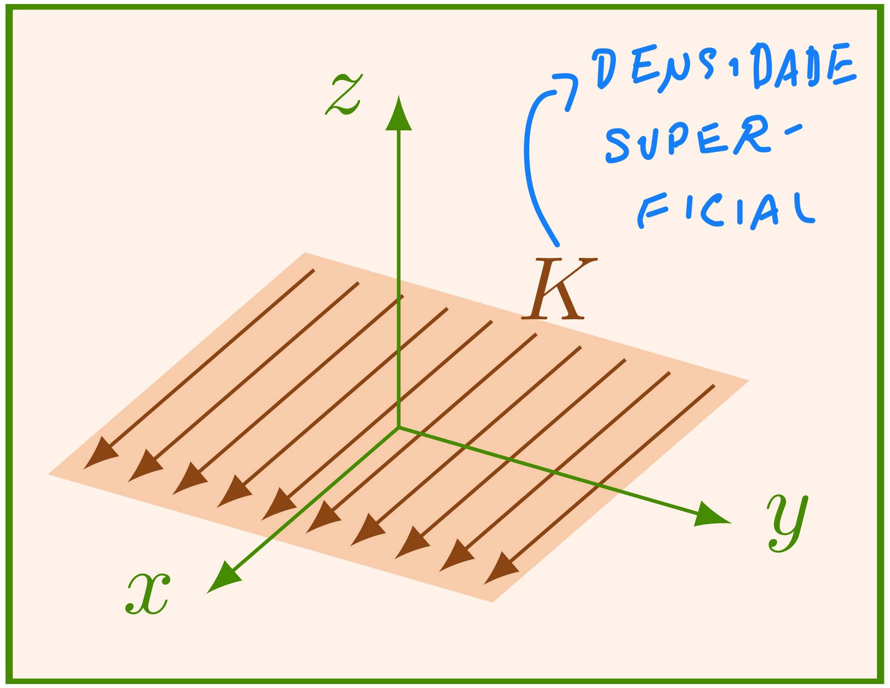
$$B = \frac{\mu_0 I}{2\pi s}$$





Pratique o que aprendeu

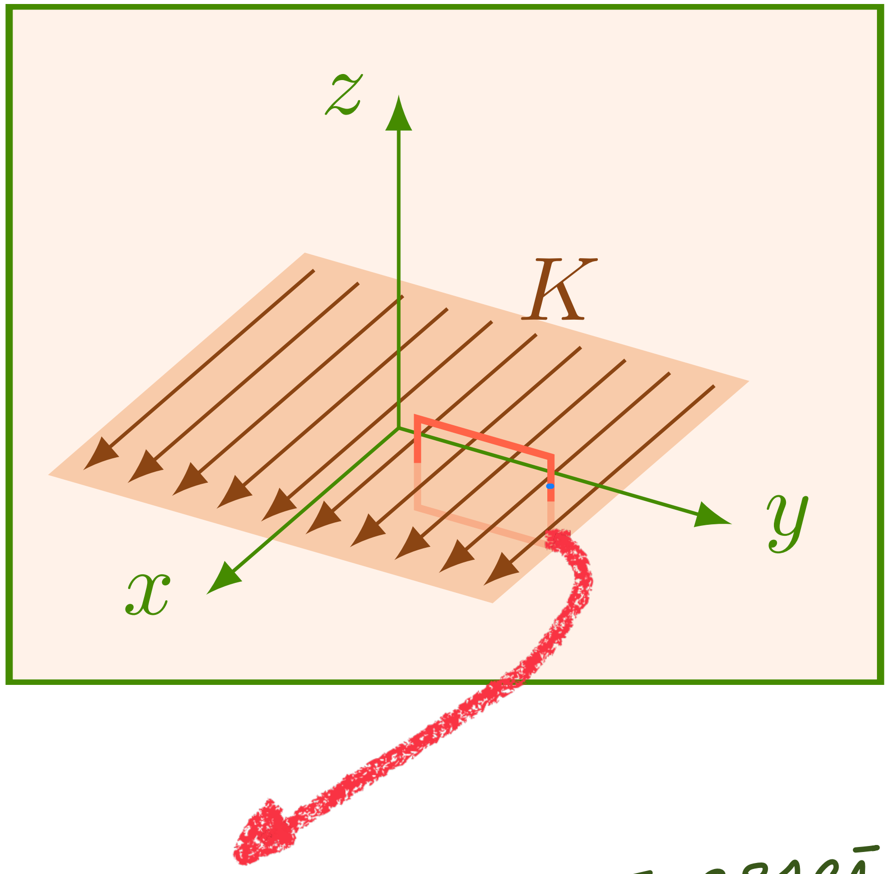
$$\oint \vec{B} \cdot \mathrm{d}\vec{\ell} = \mu_0 I_{\text{int}}$$



$$K = \frac{dI}{dy}$$

Pratique o que aprendeu

$$\oint \vec{B} \cdot \vec{\mathrm{d}\ell} = \mu_0 I_{\mathrm{int}}$$

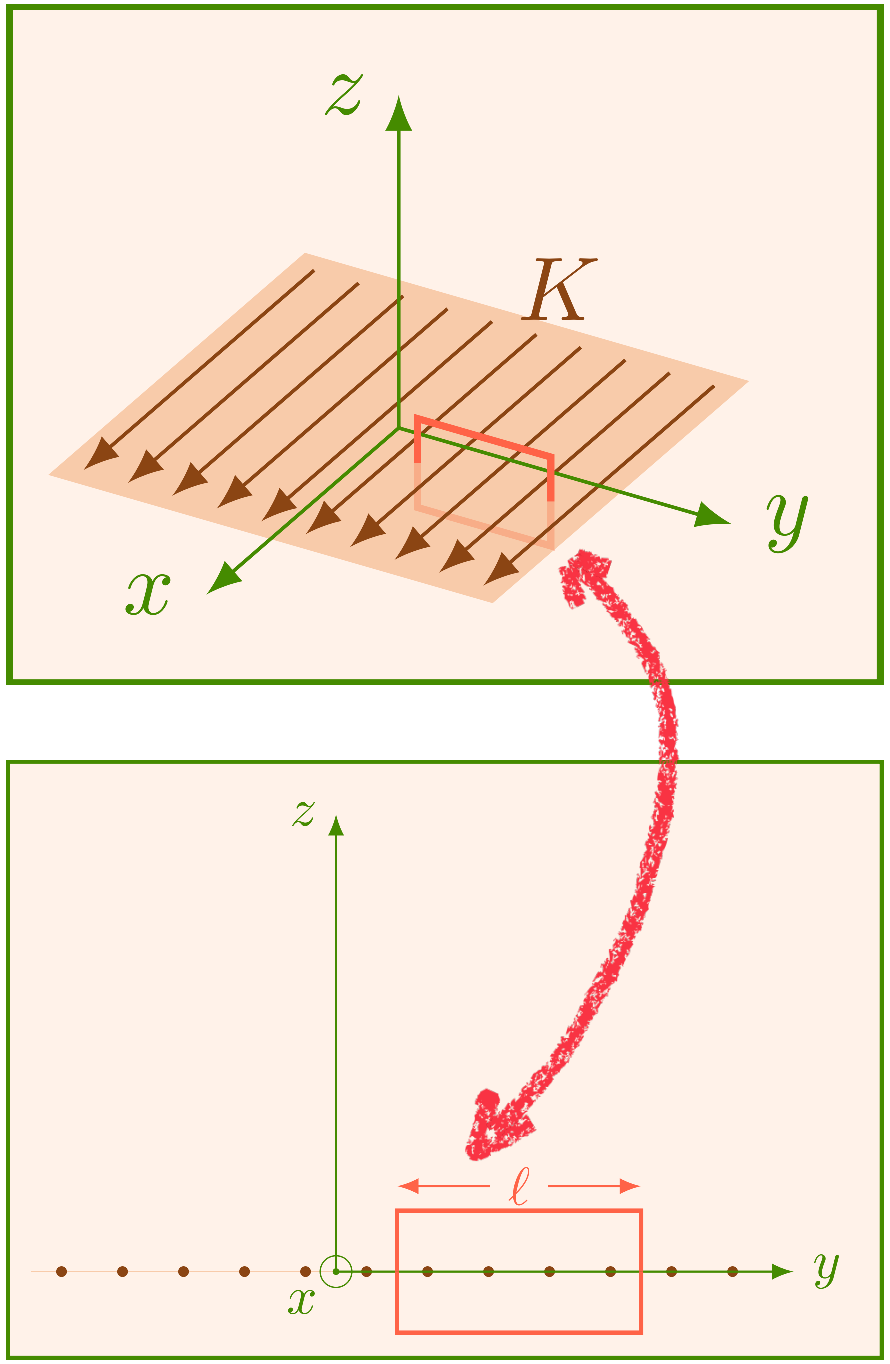


CIRCUITO DE INTEGRAÇÃO

Pratique o que aprendeu

$$\oint \vec{B} \cdot \vec{\mathrm{d}}\ell = \mu_0 I_{\mathrm{int}}$$

$$B2\ell = \mu_0 K\ell$$

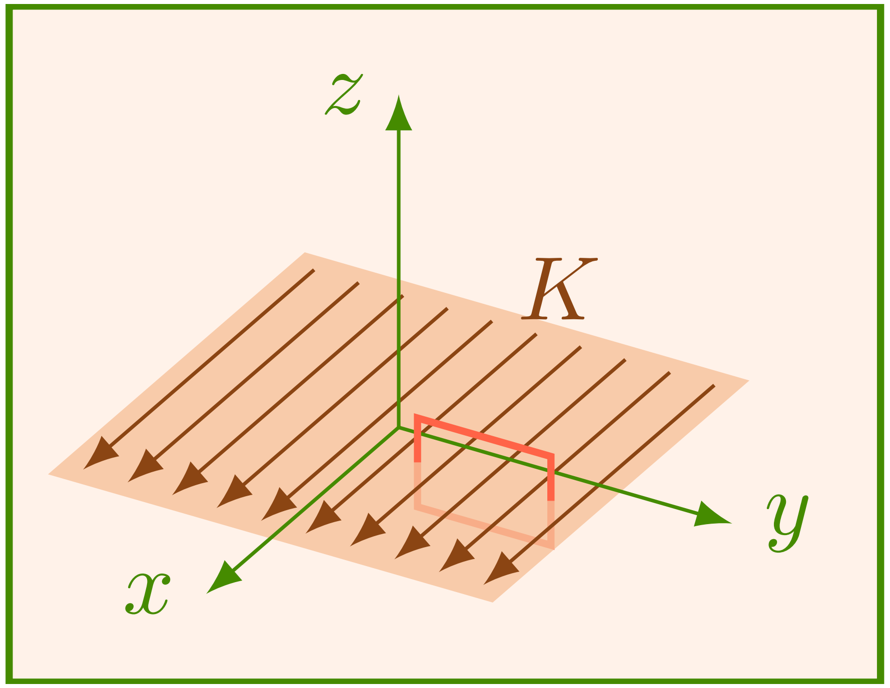


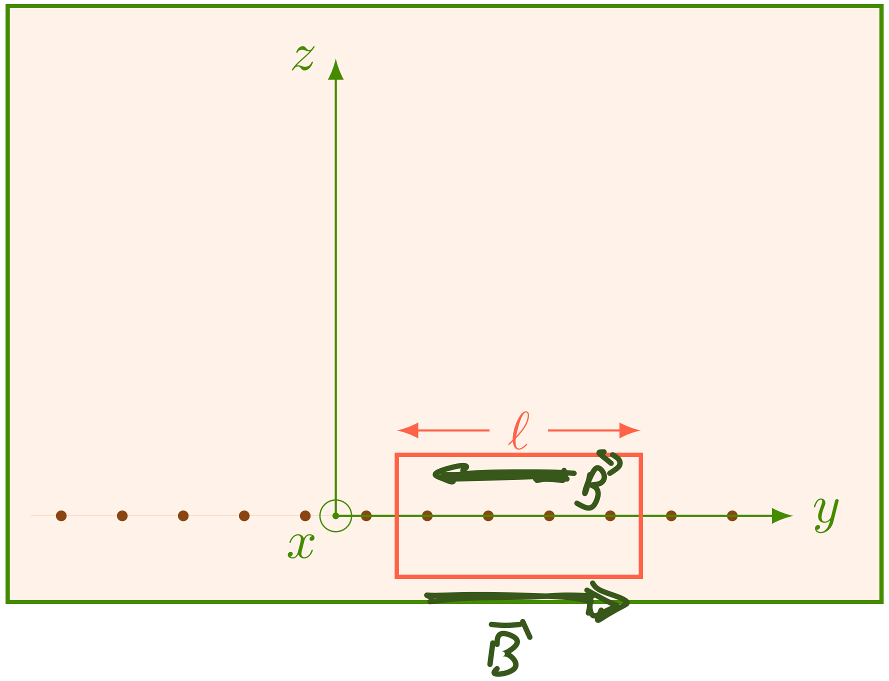
Pratique o que aprendeu

$$\oint \vec{B} \cdot \vec{\mathrm{d}\ell} = \mu_0 I_{\mathrm{int}}$$

$$B 2\ell = \mu_0 K \ell$$

$$B = \mu_0 \frac{K}{2}$$



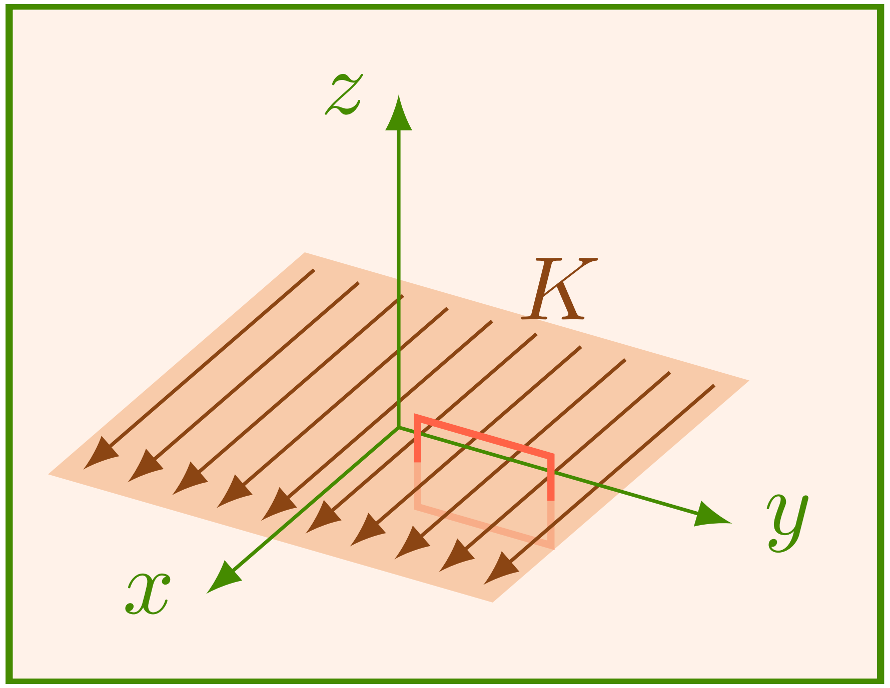


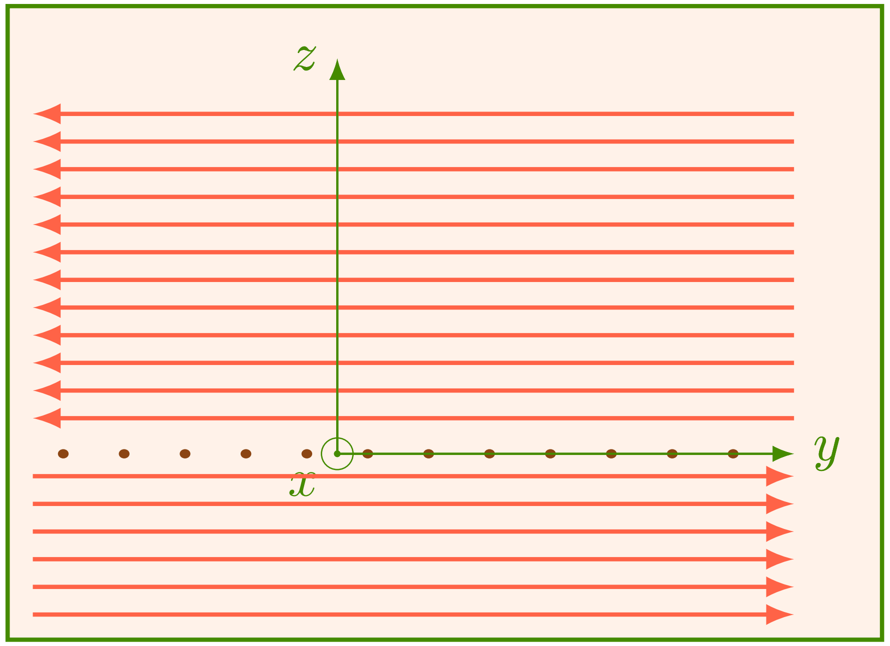
Pratique o que aprendeu

$$\oint \vec{B}\cdot \mathrm{d}\vec{\ell} = \mu_0 I_{\text{int}}$$

$$B2\ell = \mu_0 K\ell$$

$$B = \mu_0 \frac{K}{2}$$





Potencial vetor

$$\vec{\boldsymbol{\nabla}} \times \vec{B} = \mu_0 \vec{J}$$

$$\vec{\boldsymbol{\nabla}} \cdot \vec{B} = 0$$

$$\cancel{\vec{B} = \vec{\boldsymbol{\nabla}} V_B}$$

Pq $\vec{\nabla} \times \vec{B} \neq 0$

Potencial vetor

$$\vec{\nabla} \times \vec{B} = \mu_0 \vec{J}$$

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

~~$\vec{B} = \vec{\nabla} V_B$~~

$$\vec{B} = \vec{\nabla} \times \vec{A}$$

PORQUE

$\vec{\nabla} \cdot \vec{\nabla} \times \vec{A} = 0$

QUALQUER VETOR $\vec{A}$

Potencial vetor

$$\vec{B} = \vec{\nabla} \times \vec{A}$$

Potencial vetor

$$\vec{B} = \vec{\nabla} \times \vec{A}$$

$$\vec{\nabla} \times \vec{B} = \mu_0 \vec{J}$$

$$\vec{\nabla} \times \vec{B} = \vec{\nabla} \times (\vec{\nabla} \times \vec{A})$$

Potencial vetor

$$\vec{B} = \vec{\nabla} \times \vec{A}$$

$$\vec{\nabla} \times \vec{B} = \mu_0 \vec{J}$$

$$\vec{\nabla} \times \vec{B} = \vec{\nabla} \times (\vec{\nabla} \times \vec{A})$$

$$\vec{\nabla} \times \vec{B} = \vec{\nabla}(\vec{\nabla} \cdot \vec{A}) - \nabla^2 \vec{A}$$

Potencial vetor

$$\vec{B} = \vec{\nabla} \times \vec{A}$$

$$\vec{\nabla} \times \vec{B} = \mu_0 \vec{J}$$

$$\vec{\nabla} \times \vec{B} = \vec{\nabla} \times (\vec{\nabla} \times \vec{A})$$

$$\vec{\nabla} \times \vec{B} = \vec{\nabla}(\vec{\nabla} \cdot \vec{A}) - \nabla^2 \vec{A}$$

$$\vec{\nabla} \cdot \vec{A} = 0 \Rightarrow$$

$\vec{B} = \vec{\nabla} \times \vec{A}$ SOMENTE DEFINE O ROTACIONAL
DIVERGENTE TAMBÉM PRECISA SER ESPECIFICADO
ESCOLHA $\vec{\nabla} \cdot \vec{A} = 0$ É CONVENIENTE

Potencial vetor

$$\vec{B} = \vec{\nabla} \times \vec{A}$$

$$\vec{\nabla} \times \vec{B} = \mu_0 \vec{J}$$

$$\vec{\nabla} \times \vec{B} = \vec{\nabla} \times (\vec{\nabla} \times \vec{A})$$

$$\vec{\nabla} \times \vec{B} = \vec{\nabla}(\vec{\nabla} \cdot \vec{A}) - \nabla^2 \vec{A}$$

$$\vec{\nabla} \cdot \vec{A} = 0 \quad \Longrightarrow \quad \nabla^2 \vec{A} = -\mu_0 \vec{J}$$