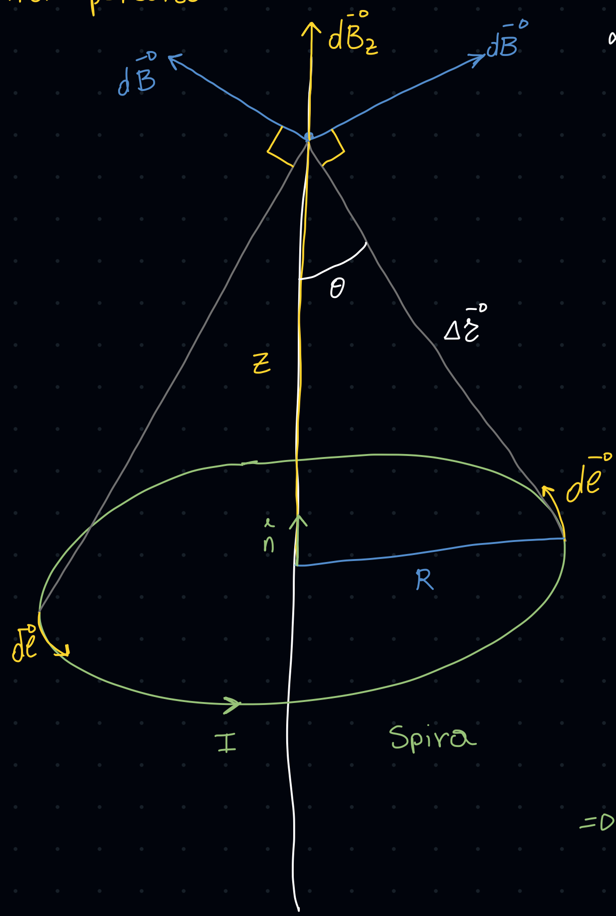
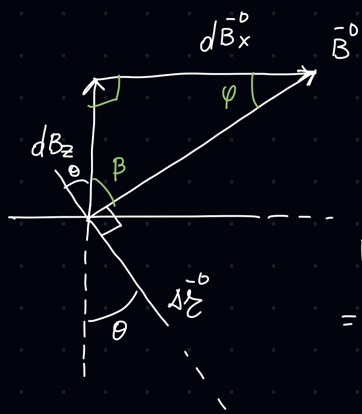
Spira percorsa da corrente



Le componenti x e y di z si annullano a due a due $\rightarrow$ $\vec{B} = \vec{B}_z$

Da Laplace $d\vec{B} = \frac{\mu_0 I}{4\pi} \cdot \frac{d\vec{l} \wedge \Delta\vec{r}}{\Delta r^3}$



$180 - \varphi - \beta$

$\beta = 180 - 90 - \theta$

$\Rightarrow \varphi = 180 - \cancel{90 - 180 + 90} + \theta = \theta$

$\Rightarrow B_z = B \sin\theta$

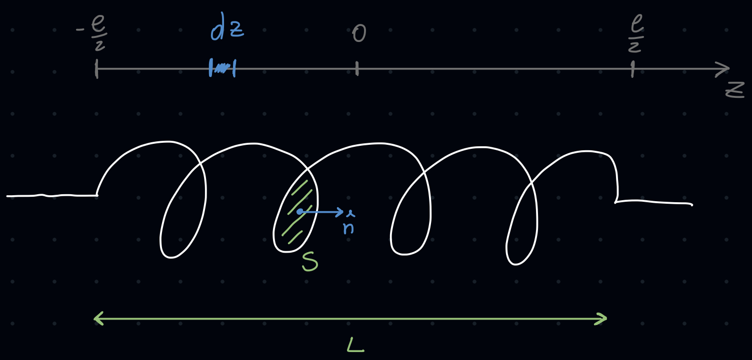
$$\Rightarrow d\vec{B}_z = \frac{\mu_0 I}{4\pi} \oint \frac{dl \wedge \Delta\vec{r}}{\Delta r^3} \cdot \sin\theta = K \oint \frac{dl \cdot \cancel{\Delta r} \cdot \cancel{\sin(90)}^{\,1}}{\Delta r^{\cancel{3}\,2}} \cdot \sin(\theta) = K \cdot \frac{\sin\theta}{\Delta r^2} \oint dl$$

$$= \frac{\mu_0 I}{\cancel{4\pi}_{\,2}} \cdot \frac{\sin\theta}{\Delta r^2} \cdot \cancel{2\pi} R = \frac{\mu_0 I}{2} \cdot \frac{R\sin\theta}{\Delta r^2}$$

$\Delta r \cdot \sin\theta = R \rightarrow \sin\theta = \frac{R}{\Delta r}$, $\Delta r^2 = R^2 + z^2$

$$\Rightarrow \frac{\mu_0 I}{2} \frac{R^2}{(R^2 + z^2)^{\frac{3}{2}}}$$

Campo $\vec{B}$ di un Solenoide



$N =$ Numero di spire , $n =$ spire per unità di lunghezza

$\rightarrow \; n = \frac{N}{L}$

$\Rightarrow \; n\,dz =$ Spire nella porzione dz

costante

$$\Rightarrow \; B_{TOT} = \int_{-\frac{l}{2}}^{\frac{l}{2}} B_{spira} \cdot n\,dz = \frac{\mu_0 I}{2} \int \frac{R^2}{(R^2+z^2)^{\frac{3}{2}}} \cdot n\,dz$$

Non costante

$$\Rightarrow \; \int \frac{1}{(R^2+z^2)^{\frac{3}{2}}}\,dz = \frac{1}{R^2}\,\frac{z}{\sqrt{R^2+z^2}} + c$$

$$\Rightarrow \; \vec{B}_{TOT} = \hat{n}\,\frac{\mu_0 I R^2}{2}\,n \left[\frac{1}{R^2} \cdot \frac{z}{\sqrt{R^2+z^2}}\right]_{-\frac{l}{2}}^{\frac{l}{2}} = \hat{n}\,\frac{\mu_0 I}{2}\,n \left[\frac{1}{R^2} \cdot \frac{l}{\cancel{2}\sqrt{R^2+(\frac{l}{2})^2}} + \frac{1}{R^2}\,\frac{l}{\cancel{2}\sqrt{R^2+(\frac{l}{2})^2}}\right]$$

$$= \hat{n}\,\mu_0 I \cancel{R}^2 \cdot \frac{N}{\cancel{2}l} \cdot \cancel{2} \left[\frac{l}{\cancel{R^2}\,\cancel{2}\sqrt{R^2+\frac{l^2}{4}}}\right]$$

$$\rightarrow \; \sqrt{\frac{4R^2+l^2}{4}} = \frac{\sqrt{4R^2+l^2}}{\cancel{\sqrt{4}}} \quad 2$$

$$= \hat{n}\,\mu_0 I R^2 \cdot \frac{N}{\cancel{l}} \cdot \frac{\cancel{l}}{\sqrt{4R^2+l^2}}$$

Approx $\quad l \gg R \Rightarrow \sqrt{4R^2+l^2} = l$

$$\rightarrow \; \vec{B} = \hat{n}\,\mu_0 I \left(N \cdot \frac{1}{l}\right) \; n \quad \rightarrow \; \vec{B} = \hat{n}\,\mu_0 I\,n$$