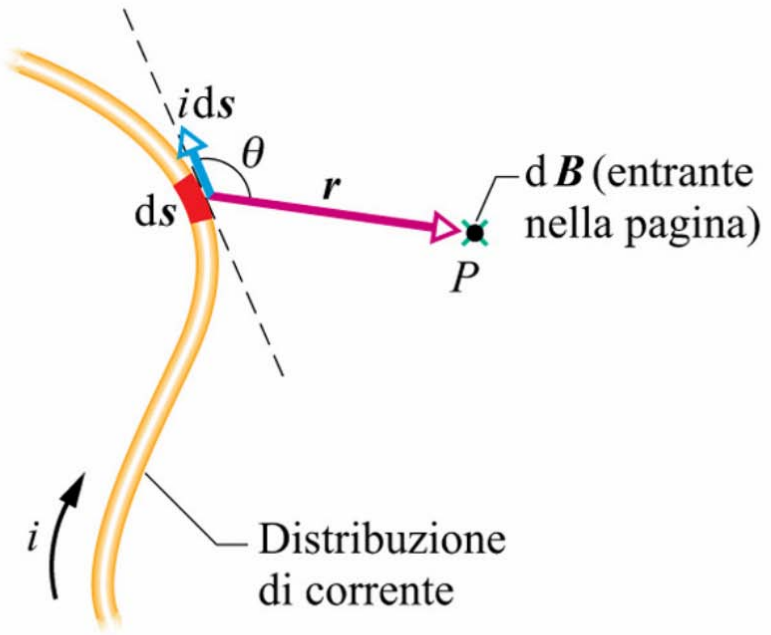
Magnetismo

- Il campo magnetico
- Campo magnetico e correnti
- Induzione elettromagnetica (auto e mutua)
- Campi magnetici nella materia

Legge di Biot e Savart



$$d\vec{E} = \frac{1}{4\pi\varepsilon_0}\frac{dq}{r^2}\hat{r}$$

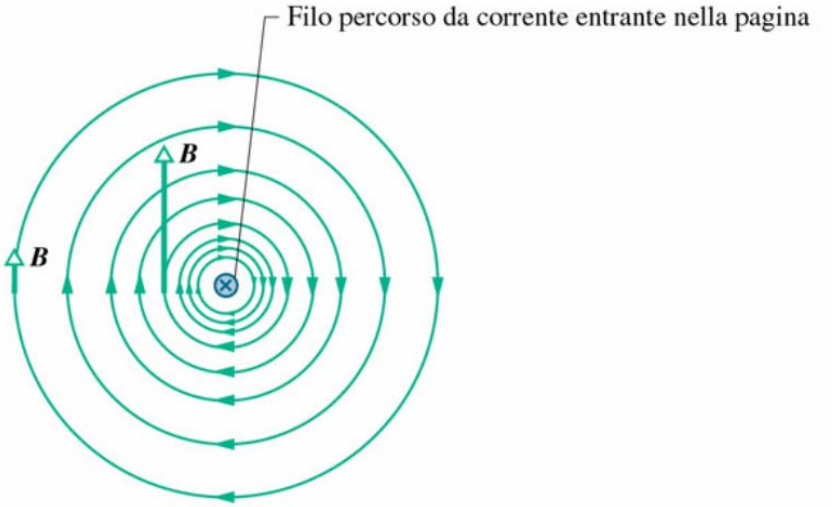
$$d\vec{B} = \frac{\mu_0}{4\pi}\frac{Id\vec{l}\wedge\hat{r}}{r^2}$$

$$\mu_0 = 4\pi\cdot 10^{-7}\ \mathrm{T\ m\ A^{-1}}$$

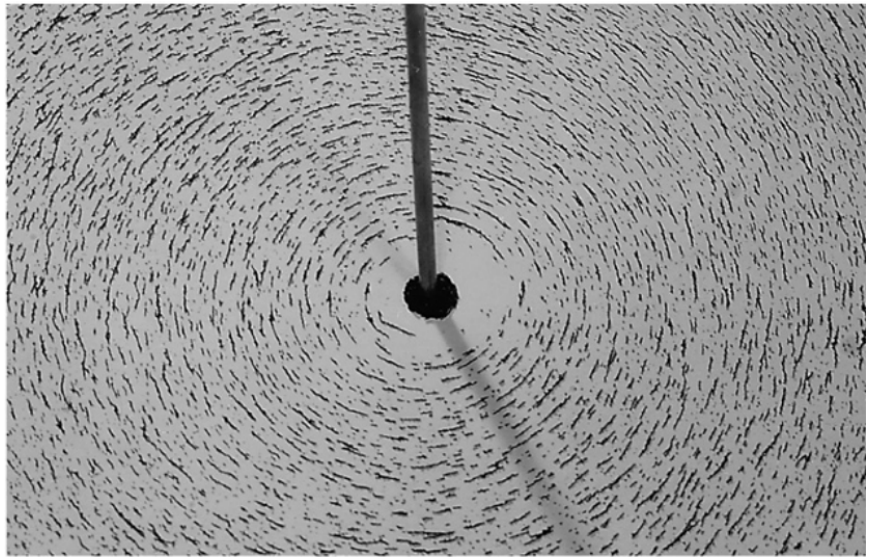
μ_0 = permeabilità magnetica

$$\vec{B} = \int \frac{\mu_0}{4\pi}\frac{I\vec{dl}\wedge\hat{r}}{r^2}$$

Filo rettilineo

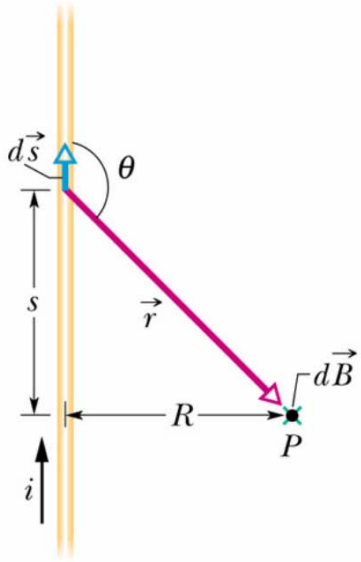


$$B = \frac{\mu_0 I}{2\pi R}$$



Filo rettilineo

$$d\vec{B} = \frac{\mu_0}{4\pi}\frac{Id\vec{l}\wedge\hat{r}}{r^2}$$



$$dB = \frac{\mu_0}{4\pi}\frac{Ids\sin\theta}{s^2+R^2} =$$

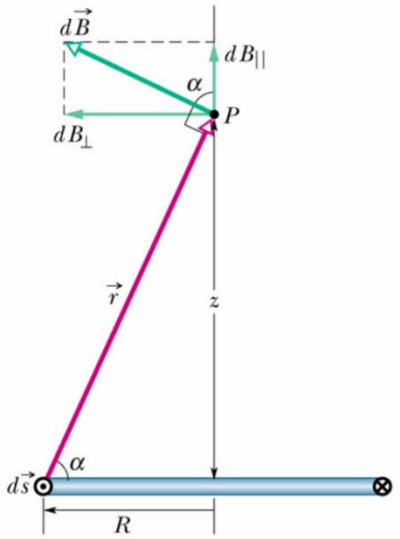
$$\sin\theta = \frac{R}{\left(s^2+R^2\right)^{1/2}}$$

$$= \frac{\mu_0}{4\pi}\frac{IRds}{\left(s^2+R^2\right)^{3/2}}$$

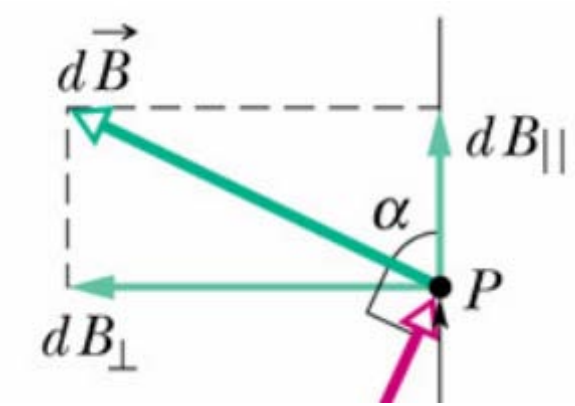
$$B = \frac{\mu_0}{4\pi}\int_{-\infty}^{+\infty}\frac{IR}{\left(s^2+R^2\right)^{3/2}}ds \quad = \frac{\mu_0 IR}{4\pi}\frac{2}{R^2}$$

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

Spira percorsa da corrente



$$d\vec{B} = \frac{\mu_0}{4\pi}\frac{Id\vec{l}\wedge\hat{r}}{r^2}$$



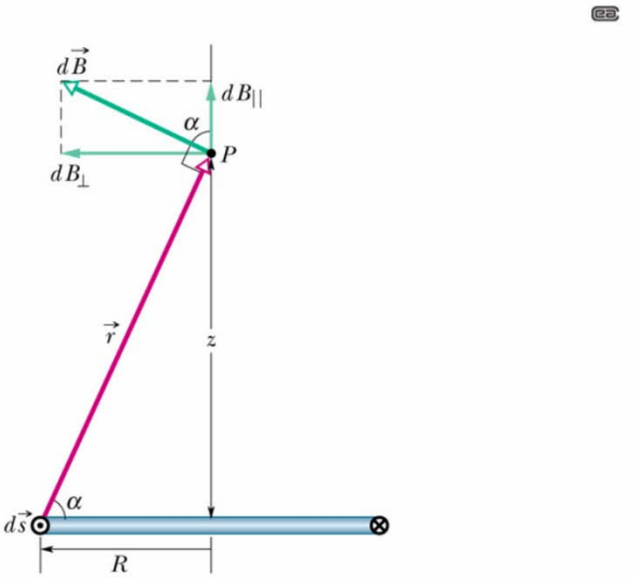
$$B_z = \int dB_z = \int \frac{\mu_0 Ids\cos\alpha}{4\pi\left(z^2+R^2\right)}$$

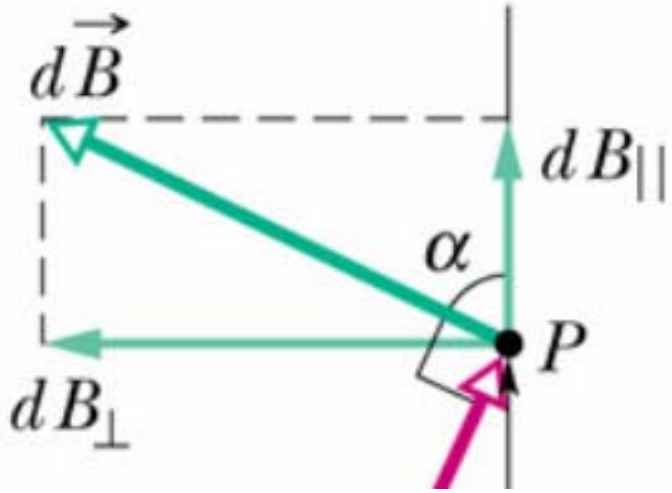
$$dB = \frac{\mu_0 Ids}{4\pi r^2}$$

$$\int ds = 2\pi R \qquad \cos\alpha = \frac{R}{\left(z^2+R^2\right)^{1/2}}$$

$$B_z = \frac{\mu_0 I 2\pi R^2}{4\pi\left(z^2+R^2\right)^{3/2}}$$

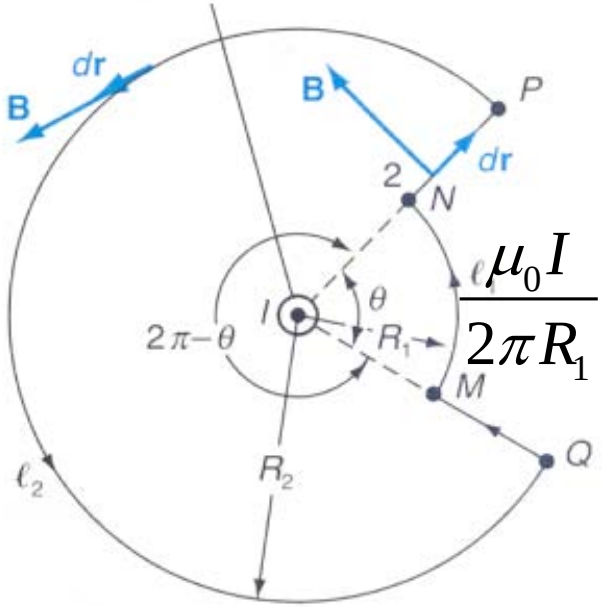
Spira percorsa da corrente

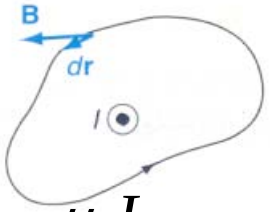




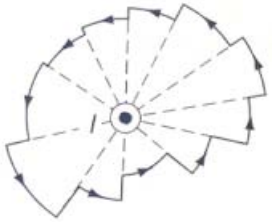
$$B_z = \frac{\mu_0 I 2\pi R^2}{4\pi\left(z^2+R^2\right)^{3/2}} = \frac{\mu_0}{2\pi}\frac{\mathbf{m}}{\left(z^2+R^2\right)^{3/2}}$$

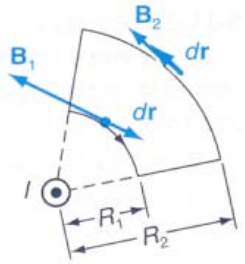
Legge di Ampere

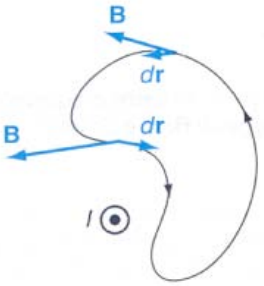




$$\frac{\mu_0 I}{2\pi R_1}\theta R_1 + 0 - \frac{\mu_0 I}{2\pi R_2}\theta R_2 + 0 = 0$$



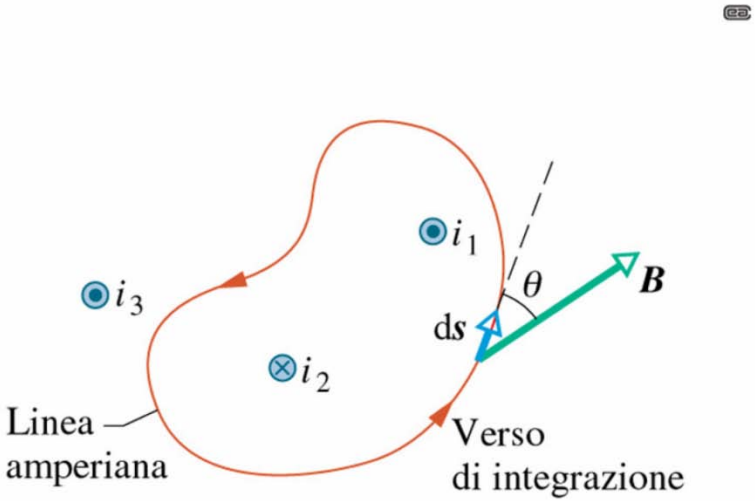


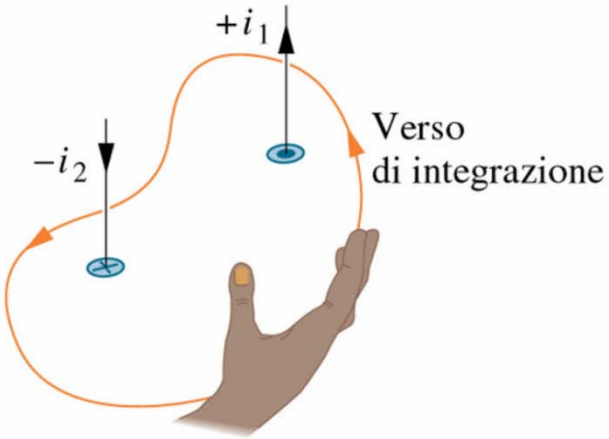


$$\oint \mathbf{B}\cdot d\mathbf{r} = \int_M^N \mathbf{B}\cdot d\mathbf{r} + \int_N^P \mathbf{B}\cdot d\mathbf{r} + \int_P^Q \mathbf{B}\cdot d\mathbf{r} + \int_Q^M \mathbf{B}\cdot d\mathbf{r} =$$

$$\frac{\mu_0 I}{2\pi R_1}\theta R_1 + 0 + \frac{\mu_0 I}{2\pi R_2}(2\pi - \theta)R_2 + 0 = \mu_0 I$$

Legge di Ampere



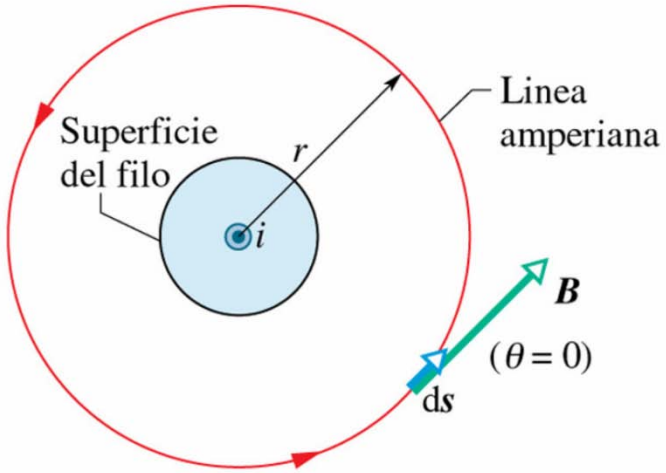


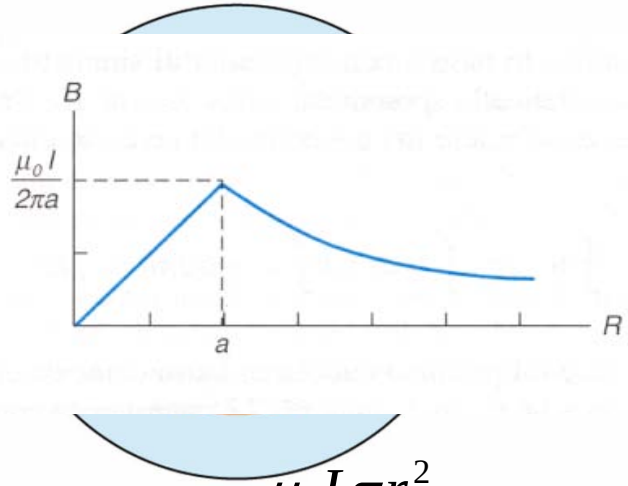
$$\oint \mathbf{B} \cdot d\mathbf{r} = \mu_0 \sum_i i_i$$

$$\oint \mathbf{E} \cdot d\mathbf{r} = 0$$

$$\oint \mathbf{B}\cdot d\mathbf{r} = \mu_0 \sum_i i_i$$

Filo Rettilineo





$$\oint \mathbf{B}\cdot d\mathbf{s} = B2\pi r$$

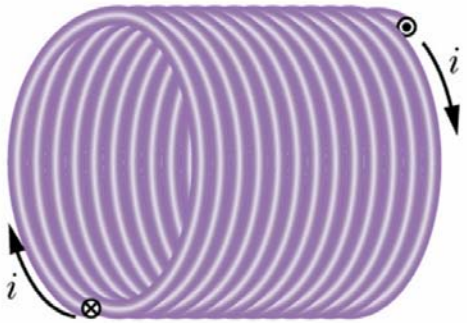
$$\sum i_i = j\pi r^2 = \frac{I}{\pi R^2}\pi r^2$$

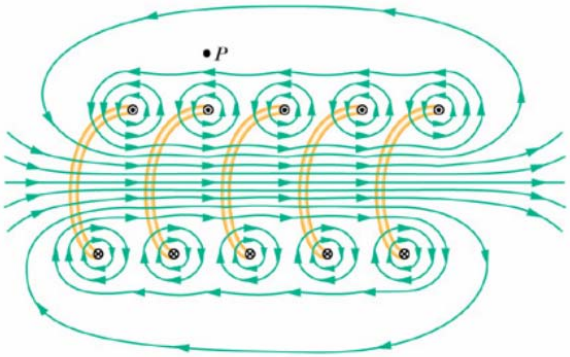
$$B2\pi r = \frac{\mu_0 I \pi r^2}{\pi R^2}$$

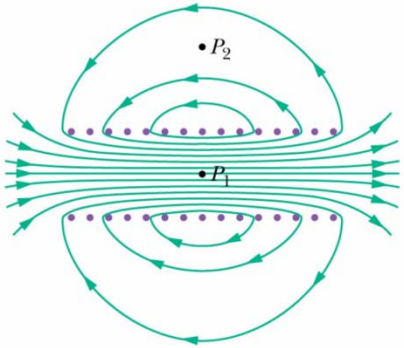
$$B = \frac{\mu_0 I r}{2\pi R^2} \quad (r \le R)$$

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

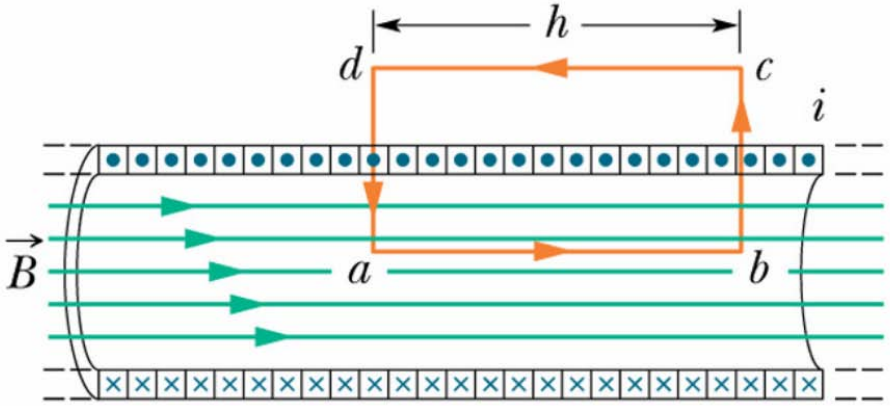
Solenoide







Solenoide

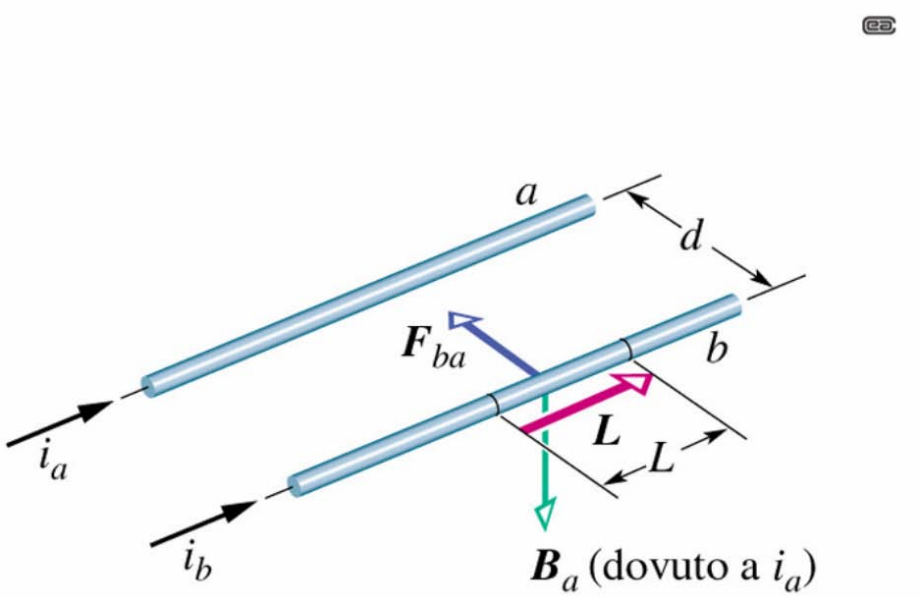


$$\oint \mathbf{B}\cdot\mathbf{dr} = Bh = \mu_0 NI$$

$$B = \mu_0 \frac{N}{h} I = \mu_0 nI$$

$$B = \mu_0 nI$$

Forza tra conduttori

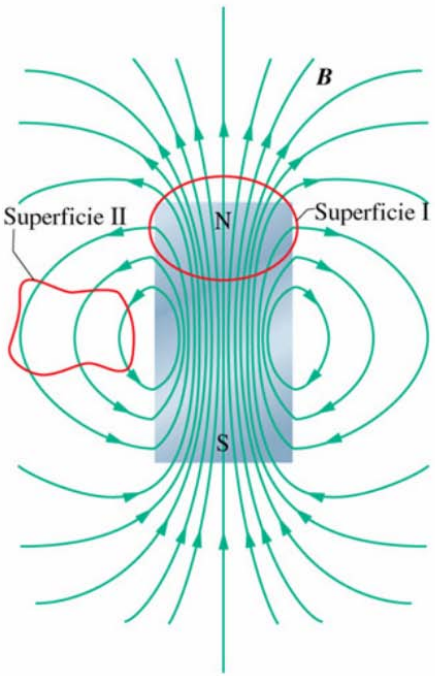


$$B_a = \frac{\mu_0 i_a}{2\pi d}$$

$$F_{ba} = i_b L B_a$$

$$F = \frac{\mu_0 i_a i_b}{2\pi d} L$$

Flusso Magnetico



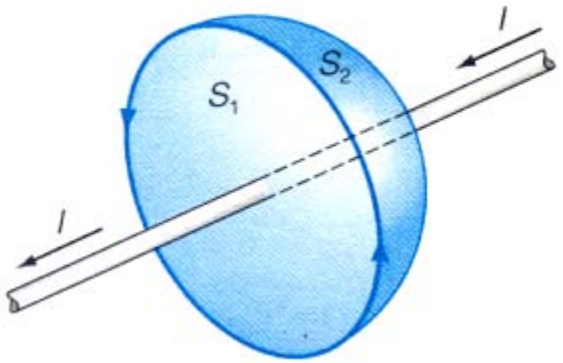
$$\Phi_B = \int \mathbf{B} \cdot d\mathbf{S} \quad [\mathrm{Wb}]$$

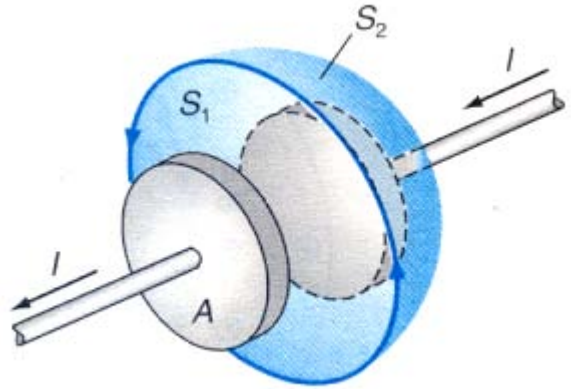
$$\oint \mathbf{B} \cdot d\mathbf{S} = 0$$

$$\oint \mathbf{E} \cdot d\mathbf{S} = \frac{\sum q}{\varepsilon_0}$$

Corrente di spostamento

$$I = \frac{dQ}{dt} \qquad I = \int_S \mathbf{j} \cdot d\mathbf{s} \qquad \oint_S \mathbf{j} \cdot d\mathbf{s} = 0$$

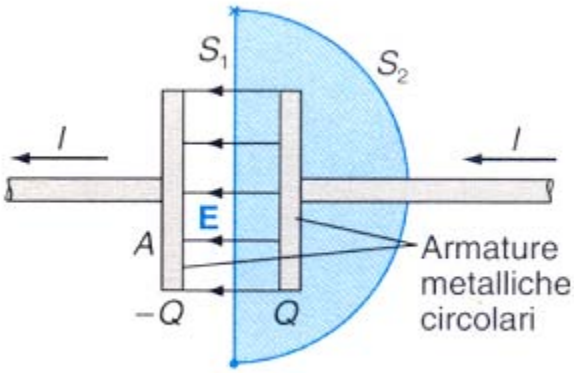




$$E = \frac{|\sigma|}{\varepsilon_0} = \frac{Q}{\varepsilon_0 A}$$

Corrente di spostamento

$$E = \frac{|\sigma|}{\varepsilon_0} = \frac{Q}{\varepsilon_0 A}$$

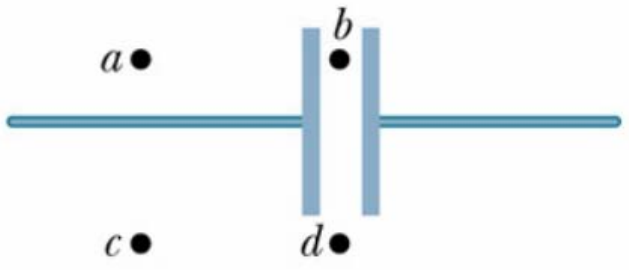


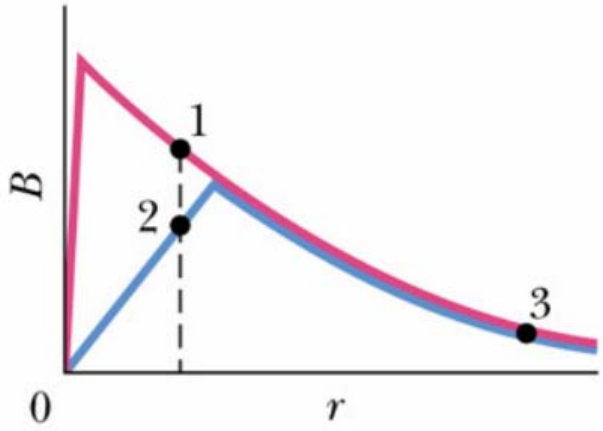
$$Q = \varepsilon_0 EA = \varepsilon_0 \Phi_E \qquad \Phi_E = \int \mathbf{E} \cdot d\mathbf{S}$$

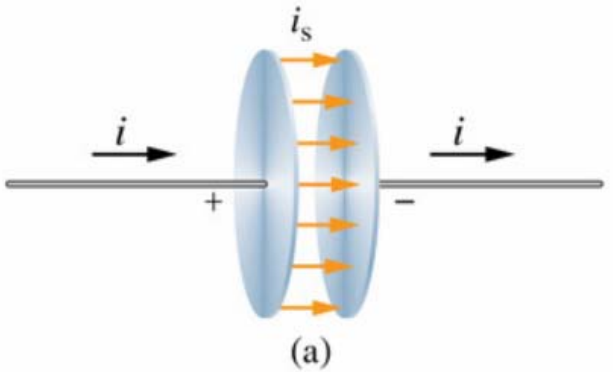
$$I = \frac{dQ}{dt} = \varepsilon_0 \frac{d\Phi_E}{dt} \qquad I_S = \varepsilon_0 \frac{d\Phi_E}{dt}$$ Corrente di spostamento

$$\oint \mathbf{B} \cdot d\mathbf{r} = \mu_0 \left(\sum i + \varepsilon_0 \frac{d\Phi_E}{dt} \right) \qquad \oint \mathbf{B} \cdot d\mathbf{r} = \mu_0 \left[\int \mathbf{j} \cdot d\mathbf{s} + \varepsilon_0 \frac{d}{dt} \int \mathbf{E} \cdot d\mathbf{s} \right]$$

Corrente di spostamento







(a)