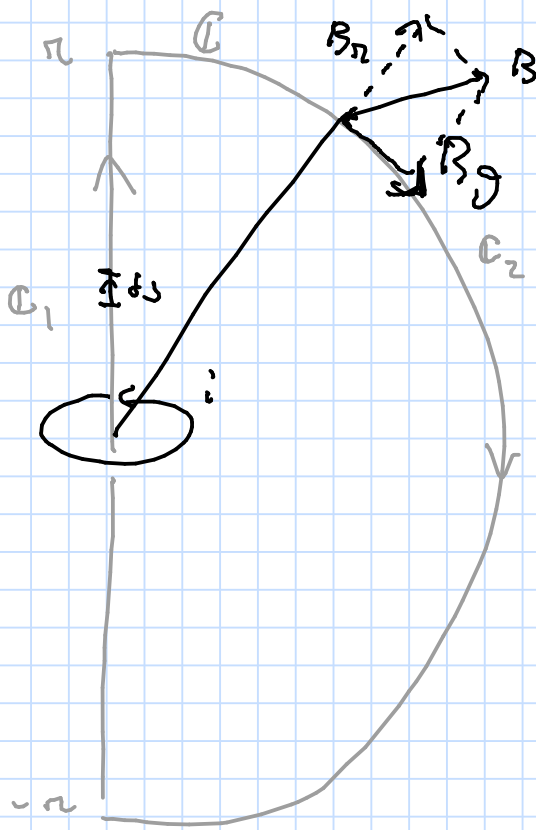




Verificare legge di Ampere,  
dato campo di spira  
(dipolo)

$$\oint_C \vec{B} \cdot d\vec{s} = \mu_0 i$$

$$\begin{aligned} I_1(z) &= \int_{-\pi}^{\pi} \vec{B}(z) \cdot d\vec{s} \\ &= \frac{\mu_0 i R^2}{z} \int_{-\pi}^{\pi} \frac{ds}{(s^2 + R^2)^{3/2}} \\ &= \frac{\mu_0 i R^2}{z} \left[ \frac{s}{R^2} \frac{1}{(s^2 + R^2)^{1/2}} \right]_{-\pi}^{\pi} \\ &= \mu_0 i \frac{R}{(R^2 + R^2)^{1/2}} \end{aligned}$$

$$I_1(z) \xrightarrow{z \rightarrow \infty} \mu_0 i$$

$$I_2(z) = \int_{C_2} \vec{B} \cdot d\vec{s} = \int_{C_2} B_{\theta} ds = \int_{\theta=0}^{\theta=\pi} B_{\theta} R d\theta$$

in lontananza da dipolo

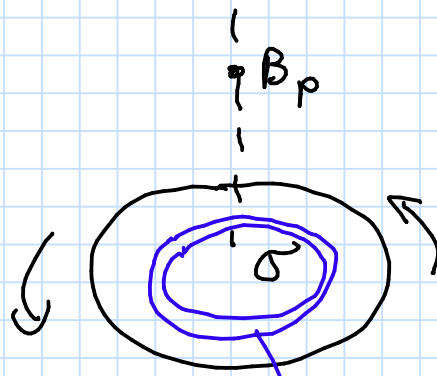
$$B_{\theta} = \cos \theta \frac{1}{R^3} \sin \theta$$

$$= \cos \theta \int_{\theta=0}^{\theta=\pi} \left[ \frac{1}{R^2} \right] \sin \theta d\theta \xrightarrow{R \rightarrow \infty} 0$$

$\lim_{R \rightarrow \infty}$

$$I_1 + I_2 = \oint_C \vec{B} \cdot d\vec{s} = \mu_0 i$$

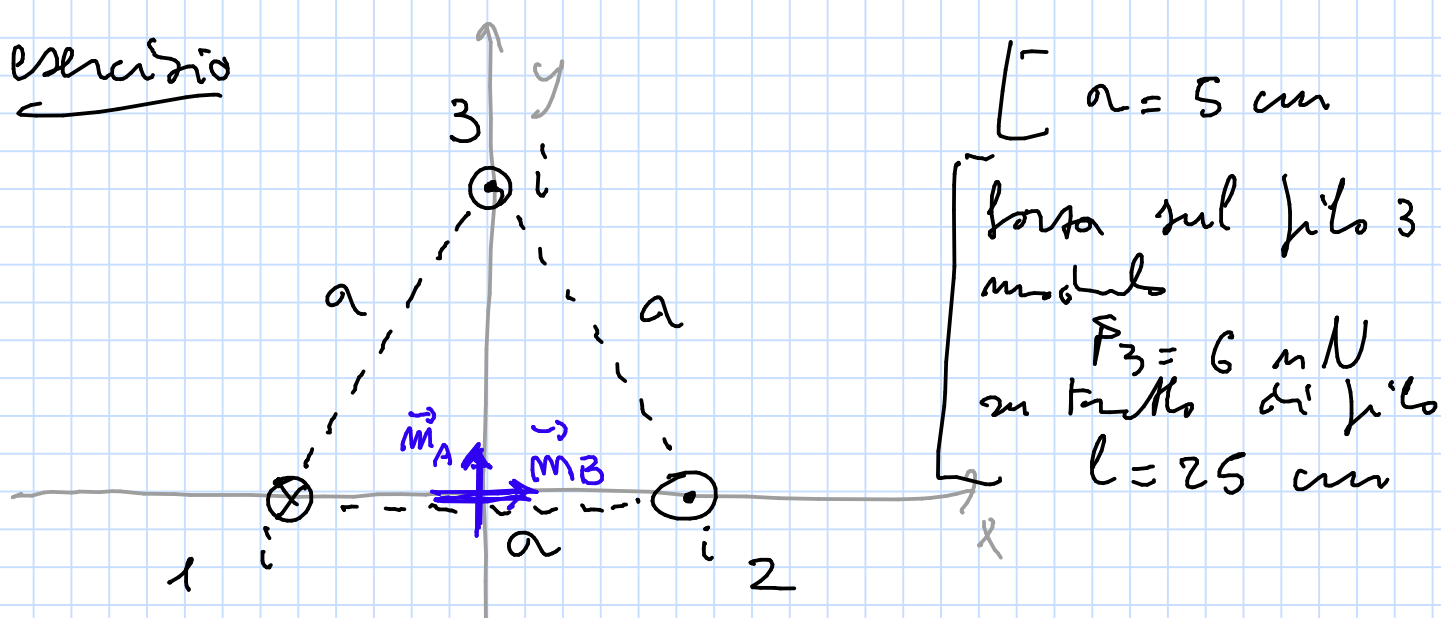
Rowland



vedere libro

$d\pi \Rightarrow di \Rightarrow$  spirale percorsa  
da corrente

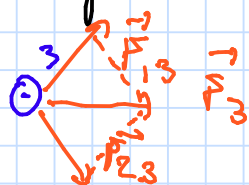
# esercizio



1) i ?

2) direzione di  $\vec{F}_3$

3) dato dip. m.  $|\vec{m}| = m = 10^{-8} \text{ Am}^2$   
 lavoro esterno per ruotarlo da  $\vec{m}_A \rightarrow \vec{m}_B$



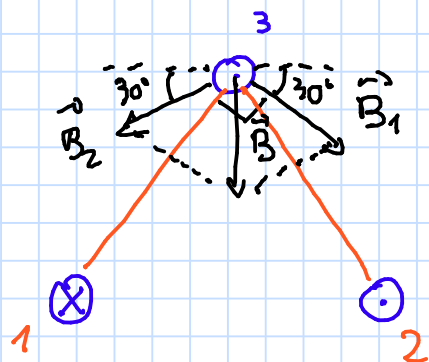
2)

1

2

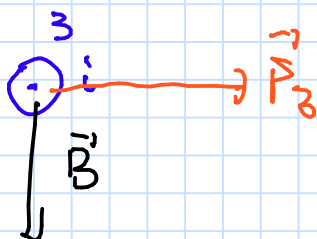
1) calcoliamo  $\vec{B} = \vec{B}_1 + \vec{B}_2$  dove c'è filo 3

$$B_1 = \frac{\mu_0 i}{2\pi a} = B_2 \quad \text{in modulo}$$



somma vettori

$$\vec{B} = \frac{\mu_0 i}{2\pi a} (-\hat{y})$$



$$\begin{aligned}
 F_3 &= i l B \\
 &= \frac{\mu_0 l i^2}{2\pi a}
 \end{aligned}$$

$$i = \sqrt{\frac{2\pi a F_3}{\mu_0 l}} = 77.5 \text{ mA}$$

3)  $\vec{m}_A \rightarrow \vec{m}_B$

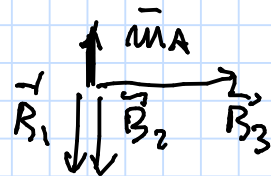
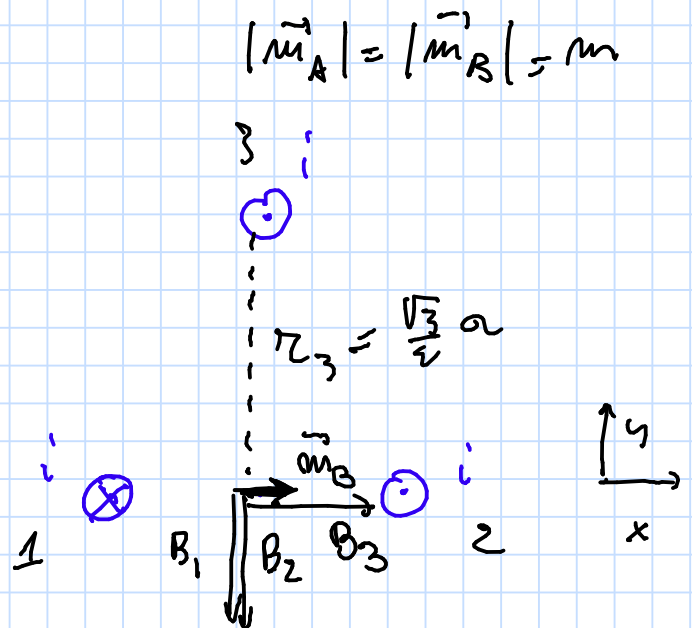
$$W_{A \rightarrow B} = U_B - U_A$$

$$\begin{aligned} U_B &= -\vec{m}_B \cdot \vec{B} = \\ &= -\vec{m}_B (\vec{B}_1 + \vec{B}_2 + \vec{B}_3) \\ &= -m B_3 \\ &= -\frac{\mu_0 i}{2\pi (\frac{\sqrt{3}}{2} a)} \cdot m \end{aligned}$$

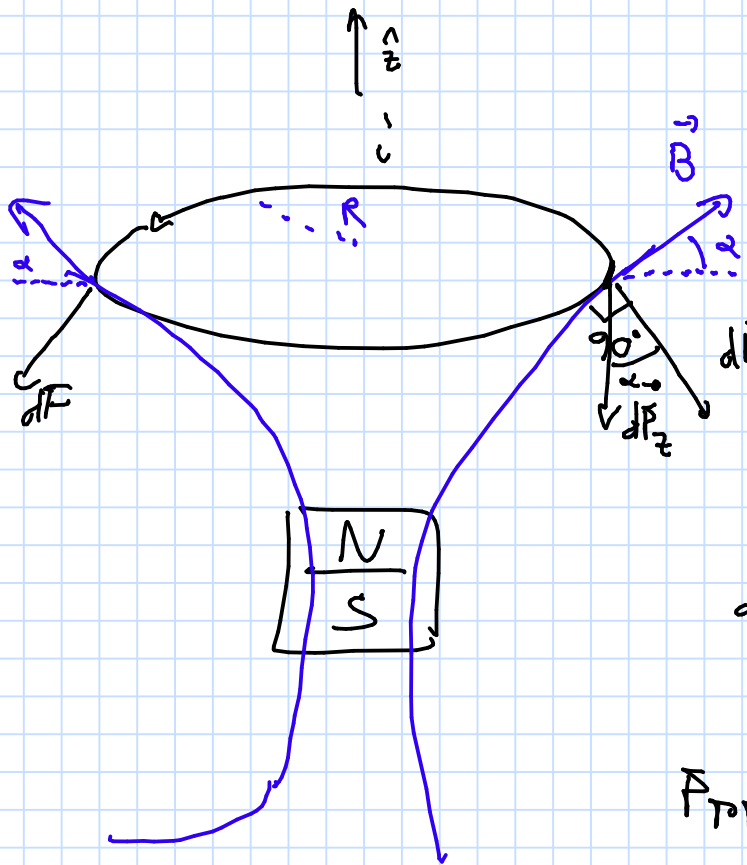
$$\begin{aligned} U_A &= -\vec{m}_A \cdot \vec{B} \\ &= -m_A (B_1 + B_2) (-1) \\ &= m 2 B_1 \\ &= 2 \frac{\mu_0 i}{2\pi (\frac{a}{2})} m = 2 \frac{\mu_0 i}{\pi a} m \end{aligned}$$

$$\begin{aligned} W_{A \rightarrow B} = U_B - U_A &= -\frac{\mu_0 i m}{\pi a} \left( \frac{1}{\sqrt{3}} + 2 \right) = -4.79 \cdot 10^{-12} \text{ J} \\ &= -4.79 \text{ pJ} \end{aligned}$$

negativo il apparato esterno ha ricevuto lavoro dal sistema



attrazione (repulsione)  
tra spira e  
magnete



$$d\vec{F} = i d\vec{s} \times \vec{B}$$

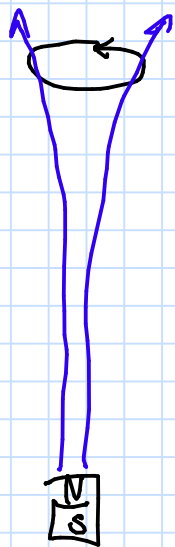
comp. verticale

$$dF_z = |d\vec{F}| \cos \alpha (-\hat{z})$$

$$\vec{F}_{\text{tot}} = \int d\vec{F}_z = i B \cos \alpha \int_0^{2\pi R} ds$$

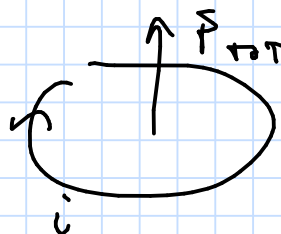
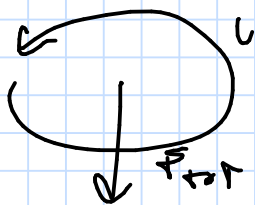
$$= i B \cos \alpha 2\pi R$$

in lontananza



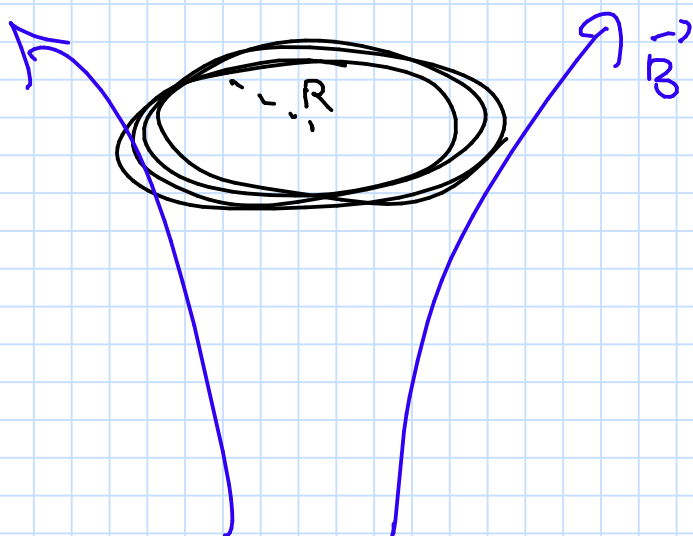
$$\alpha \rightarrow \frac{\pi}{2}$$

$$\cos \alpha \rightarrow 0$$

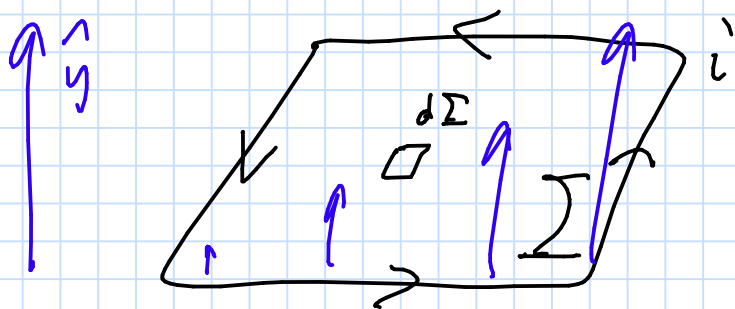


repulsione

bobina:  $N$  spire



$$\begin{aligned}\Phi_{\text{tot}} &= N \Phi_{\text{spira}} \\ &= N i B \sin \alpha \pi R^2\end{aligned}$$



$$\mathbf{B}(\mathbf{r}) = \alpha \times \hat{\mathbf{y}}$$

energia  $U$  ?

$$\begin{aligned}U &= - \int d\vec{m} \cdot \vec{B} \\ &= \int dS i \cdot (\vec{B} \cdot \hat{\mathbf{n}})\end{aligned}$$

$m$

$$dU = - d\vec{m} \cdot \vec{B}$$