Magnetismo

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

Correnti atomiche

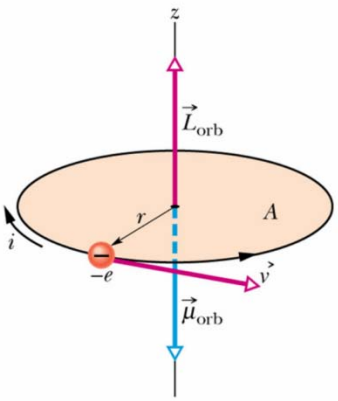
$$2\pi r = vT \qquad i = e/T = \frac{e}{2\pi r/v} = \frac{ev}{2\pi r}$$

$$\mathbf{m} = i\mathbf{S} \qquad m = i\pi r^2 = \frac{ev}{2\pi r}\pi r^2$$

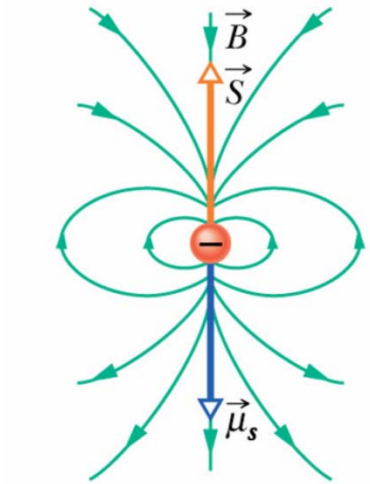
$$m = \frac{1}{2}evr$$

$$\mathbf{L} = \mathbf{r} \wedge \mathbf{p} \rightarrow L = m_e vr$$

$$\boxed{\mathbf{m} = -\frac{e}{2m_e}\mathbf{L}}$$



Spin $\qquad \mathbf{m} = -\frac{e}{m_e}\mathbf{S}$



Magnetizzazione

$\mathbf{m}_i$ = momento magnetico della molecola i-esima

$$\mathbf{M} = \frac{\sum \mathbf{m}_i}{\Delta V} \qquad \left[\frac{A}{m}\right]$$

Misura

$$U = -\mathbf{M} \cdot \mathbf{B}$$

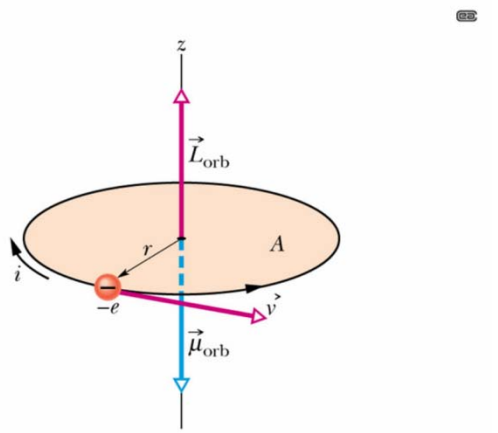
$$F_z = \frac{\partial U}{\partial z} = -\mathbf{M} \cdot \frac{\partial \mathbf{B}}{\partial z}$$

Magnetometro SQUID

Diamagnetismo

$$fem = -\frac{\partial \Phi(B)}{\partial t} = -\pi r^2 \frac{\partial B}{\partial t}$$

$$fem = -\int_{Circ} Edl = -2\pi rE$$

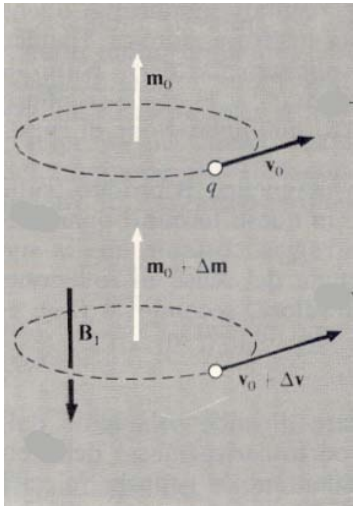


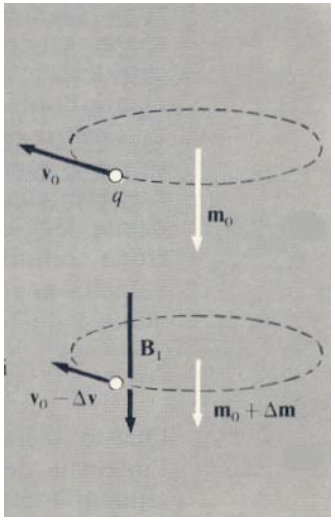
$$\pi r^2 \frac{\partial B}{\partial t} = 2\pi rE$$

$$\pi r^2 q \int \frac{\partial B}{\partial t} dt = 2\pi r \int qEdt$$

$$rq(B - B_0) = 2\int Fdt = 2m(v - v_0)$$

$$v - v_0 = \Delta v = \frac{rqB}{2m} \qquad \Delta\omega = \frac{qB}{2m}$$





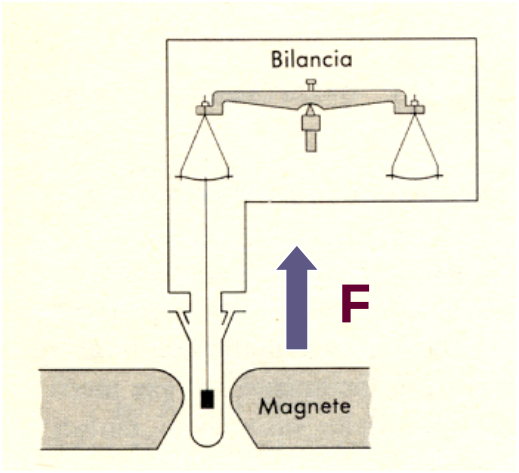
frequenza di Larmor

Diamagnetismo

M ~ **B** e direzione opposta

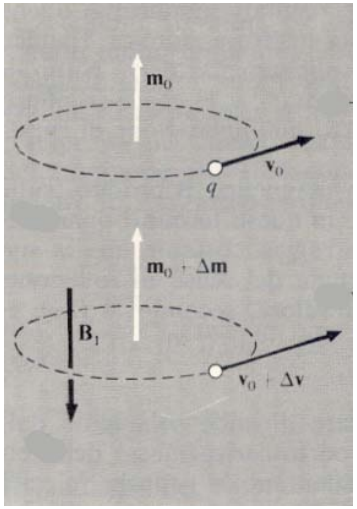
$$\mathbf{m}_1 = -\frac{e\mathbf{L}_1}{2m_e} \qquad \mathbf{m}_2 = -\frac{e\mathbf{L}_2}{2m_e}$$

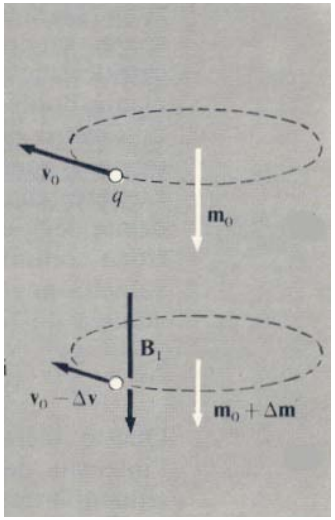
$$\mathbf{L}_1 = -\mathbf{L}_2 \qquad \rightarrow \mathbf{m}_1 + \mathbf{m}_2 = 0$$



Dopo l'applicazione di un campo B

$$\mathbf{m}_1 + \mathbf{m}_2 \neq 0$$



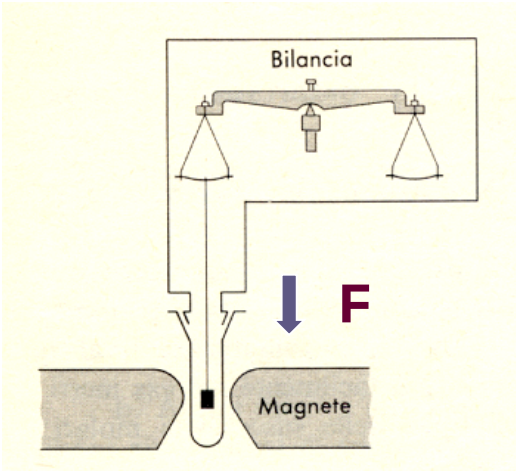


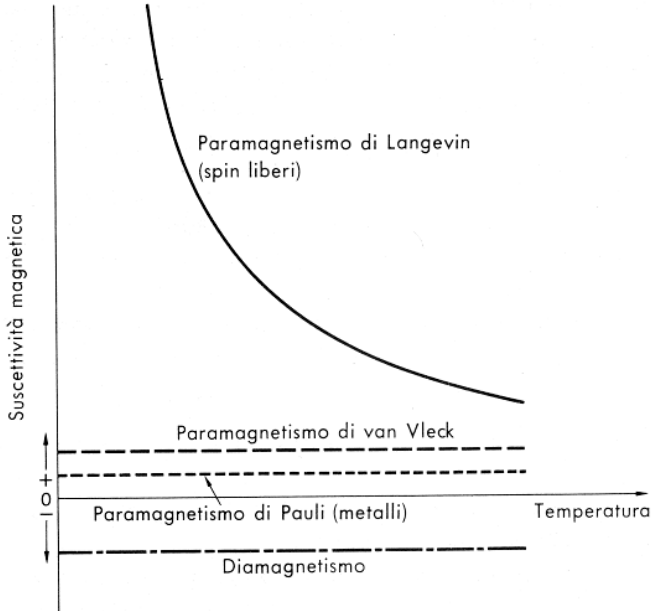
Paramagnetismo

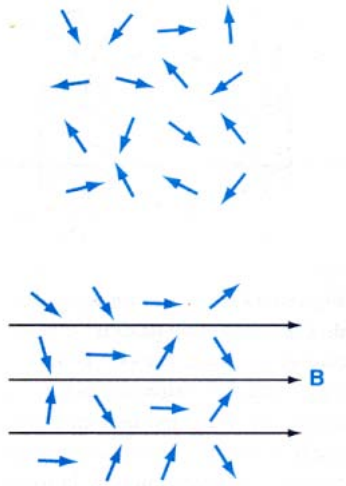
$$U = -\mathbf{m} \cdot \mathbf{B}$$

$$\mathbf{M} = \frac{C\mathbf{B}}{\mu_0 T}$$

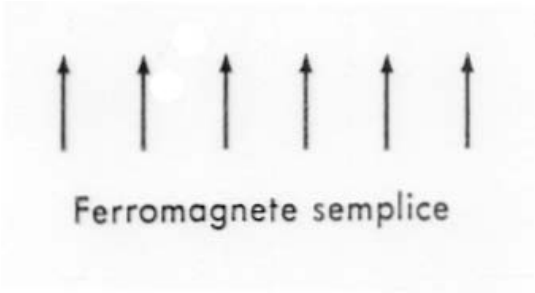
Legge di Curie

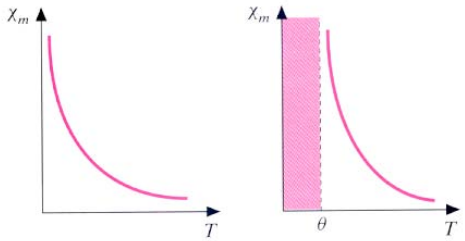


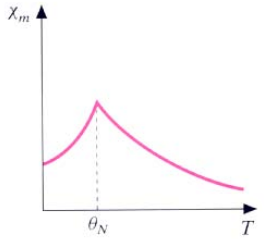


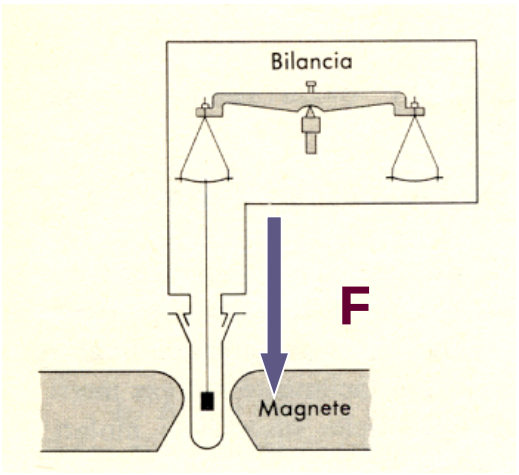


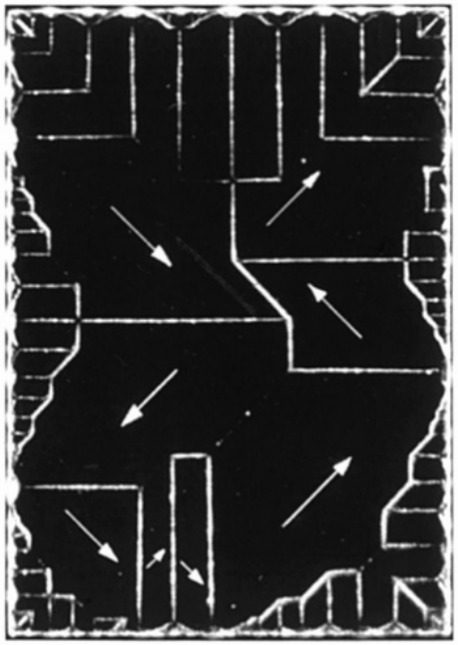
Ferromagnetismo

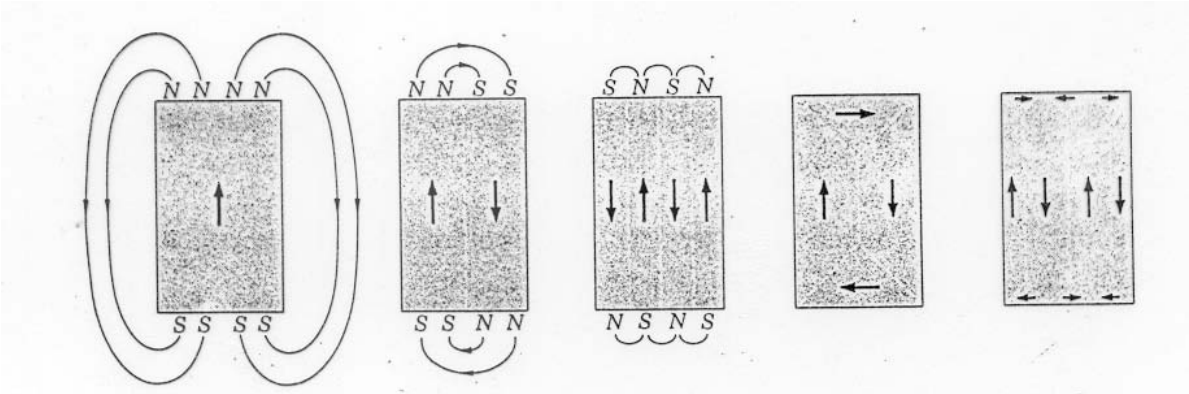




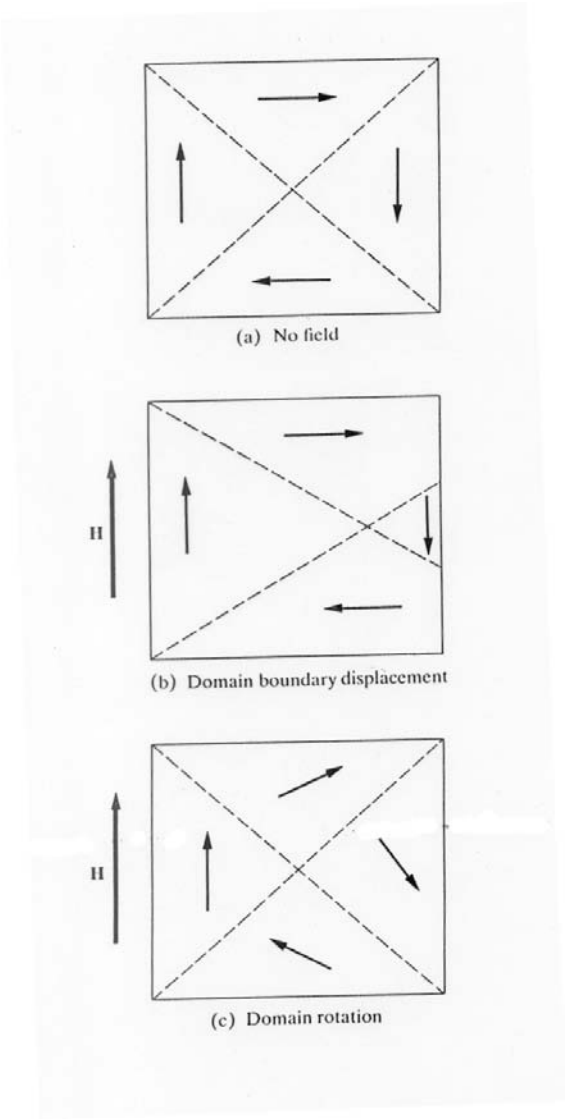


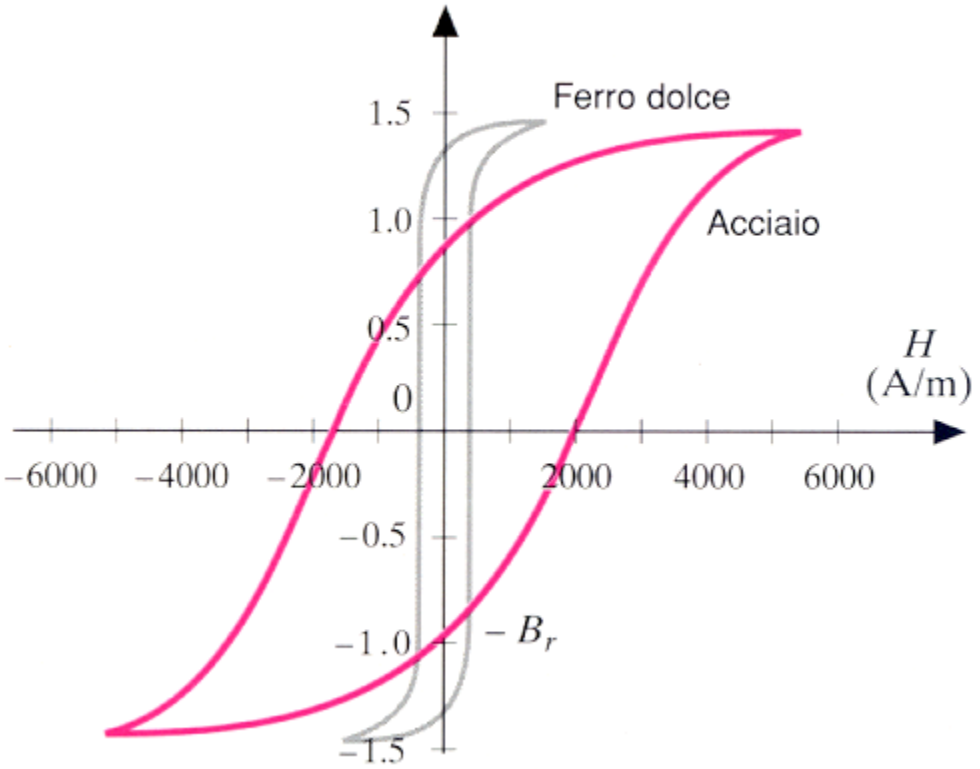






Ciclo di isteresi





Campo magnetico

$$\mathbf{H} = \mathbf{B}/\mu_0 - \mathbf{M} \qquad \mathbf{B} = \mu_0\left(\mathbf{H} + \mathbf{M}\right)$$

Soleniode $B = \mu_0 n i \qquad H = ni \qquad [\mathrm{A}/m]$

Paramagnetismo o diamagnetismo $\rightarrow \mathbf{B} = \mu\mathbf{H}$

μ permeabilita' magnetica

$$\left(\mu - \mu_0\right)\mathbf{H} = \mu_0\mathbf{M}$$

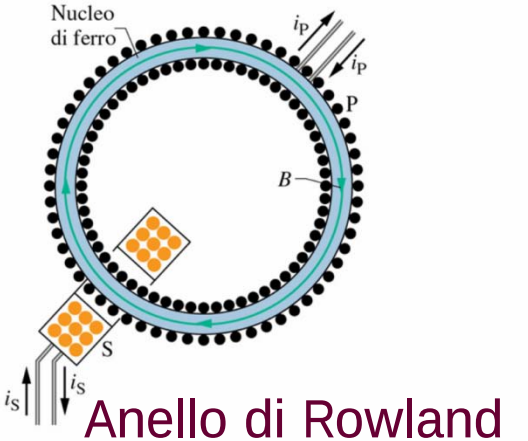
$\mu < \mu_0$ materiali diamagnetici

$\mu > \mu_0$ materiali paramagnetici

Misura del ciclo di isteresi

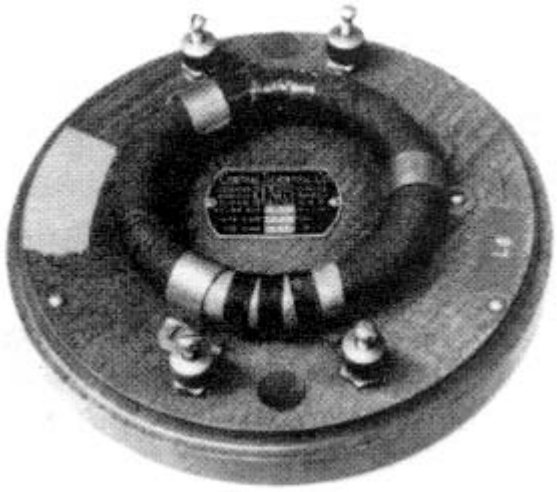
$$H = n_p i \qquad E = N_s S \frac{dB}{dt} = R_s i_s$$

$$Q_s = \int i_s dt = N_s S \int \frac{dB}{dt} dt = N_s S \Delta B$$



Anello di Rowland

Galvanometro balistico



Campo terrestre