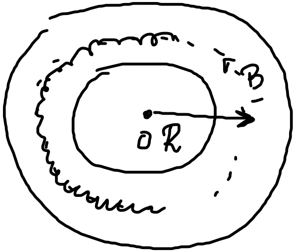
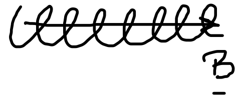
$$\underline{F} = -\mu \underline{\nabla} |\underline{B}|$$

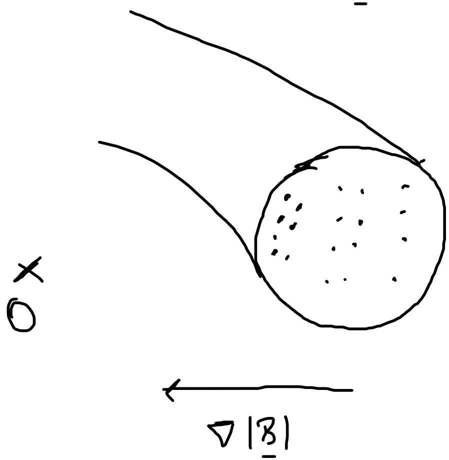
$$\mu = \frac{m v_\perp^2}{2B}$$

$$\underline{v}_D = \frac{\underline{F}_\perp \times \underline{B}}{q B^2}$$





$$B \propto \frac{1}{R}$$



$$\underline{v}_D = -\mu \frac{\underline{\nabla}|\underline{B}| \times \underline{B}}{q B^2}$$

Elettroni

Ioni

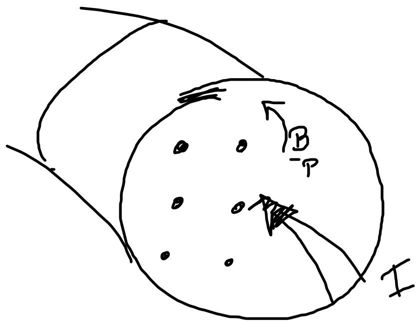
$\underline{E}$

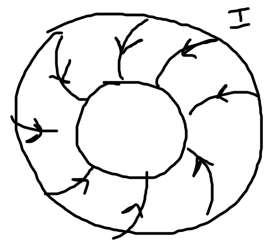
$$\underline{v}_{\underline{E} \times \underline{B}} = \frac{\underline{E} \times \underline{B}}{B^2}$$

$\underline{v}_{\underline{E} \times \underline{B}}$

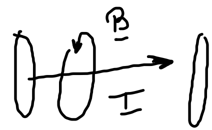
Trucco: fare avvolgere la linea di $\underline{B}$ su se stessa durante un giro toroidale

$\Rightarrow$ aggiungere una componente poloidale al $\underline{B}$





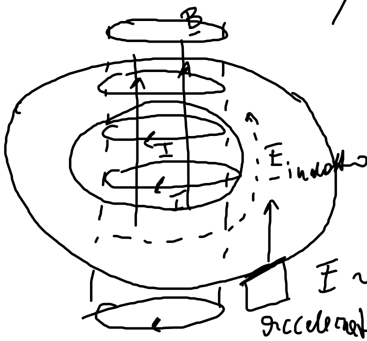
Tokamak $\rightarrow$ fare scorrere una corrente toroidale



Stellarator

macchina intrinsecamente stazionaria, ma complessa

Corrente toroidale ⇒ campo elettrico toroidale indotto



$$f.e.m. = -\frac{d\Phi(\underline{B})}{dt}$$ legge Faraday-N-L

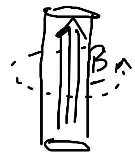
$$\underline{\nabla} \times \underline{E} = -\frac{\partial \underline{B}}{\partial t}$$

$E \sim 100$ eV - keV

acceleratorismo

$\underline{E}$ indotto

(f.e.m. = = =)

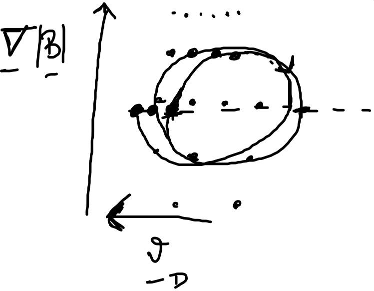


costante nel tempo ⇒ $\Phi(\underline{B}) \propto t$

⇒ $B \propto t$ solenoide

Dispositivo impulsato

⇒ $I_{sol} \propto t$



$r_L = \frac{mv_\perp}{qB} \propto \frac{1}{B}$ $\left(- \underline{\nabla} |\underline{B}| \times \underline{B} \right)$ vs sinistra

$\mathcal{L}(q_j, \dot{q}_j, t)$ $j = 1 \ldots N$ q_j : coordinate libere

$\dot{q}_j$: velocità generalizzate

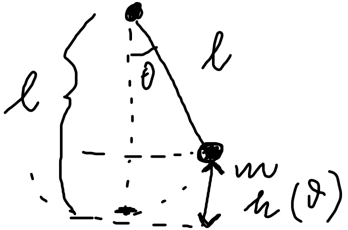
$$\frac{d}{dt}\frac{\partial \mathcal{L}}{\partial \dot{q}_j} - \frac{\partial \mathcal{L}}{\partial q_j} = 0$$

$p_j \stackrel{def}{=} \frac{\partial \mathcal{L}}{\partial \dot{q}_j}$ momento canonico

Se $\mathcal{L}$ <u>non</u> dipende da una particolare q_k

$\Rightarrow \frac{\partial \mathcal{L}}{\partial q_k} = 0 \Rightarrow p_k$ è costante esatta

Pendolo semplice



$q = \theta$

$\mathcal{L} = K - U$

en. cinetica

en. potenziale

$K = \frac{1}{2} m v^2 = \frac{1}{2} m \ell^2 \dot{\vartheta}^2$

$v = \ell \dot{\vartheta}$

$U = mgh(\vartheta)$

$h(\vartheta) = \ell - \ell\cos\vartheta = \ell(1-\cos\vartheta)$

$= mg\ell(1-\cos\vartheta)$

$\mathcal{L} = \frac{1}{2} m\ell^2\dot{\vartheta}^2 - mg\ell(1-\cos\vartheta)$

$\frac{d}{dt}\frac{\partial \mathcal{L}}{\partial \dot{\theta}} - \frac{\partial \mathcal{L}}{\partial \theta} = 0$

$\frac{\partial \mathcal{L}}{\partial \theta} = -mg\ell\sin\vartheta$

$\frac{\partial \mathcal{L}}{\partial \dot{\theta}} = m\ell^2\dot{\vartheta}$

$\cancel{m}\ell^{\cancel{2}}\ddot{\vartheta} + \cancel{m}g\cancel{\ell}\sin\vartheta = 0$

$\ddot{\vartheta} = -\frac{g}{\ell} \sin\vartheta$ $\qquad \vartheta \ll 1 \qquad \ddot{\vartheta} = -\frac{g}{\ell}\vartheta \qquad \vartheta(t) = \vartheta_0 \cos(\omega t)$

$$\vartheta(t) = \mathrm{Re}\left[\vartheta_0 e^{i\omega t}\right] \qquad \omega = \sqrt{g/\ell}$$

$$= \mathrm{Re}\left[\underline{\vartheta_0}\, e^{i\int_0^t \omega\, dt'}\right]$$

$\ell = \ell(t)$ e $\ell \simeq$ cost su un periodo $\qquad \ddot{\vartheta} = -\frac{g}{\underline{\ell(t)}}\vartheta$

$$\omega(t) = \sqrt{g/\ell(t)}$$

$$\sqrt{\frac{g}{\ell(t')}}$$

Mi aspetto $\quad \vartheta(t) = \mathrm{Re}\left[\underline{\vartheta_0(t)}\, e^{i\int_0^t \omega(t')\, dt'}\right]$