$\underline{B} = \overrightarrow{\text{const}}$

moto $\begin{cases} \text{rett. unif. lungo } \underline{B} \\ \text{circ. unif. } \perp \underline{B} \end{cases}$

$r_L = \dfrac{m v_\perp}{qB}$

$\omega_L = \dfrac{qB}{m}$

$K = \text{const}$ (se $\underline{B}$ non dip. da t)

$\underline{F} = \underline{\text{const}} + \underline{B} \Rightarrow \underline{v} = \underline{v}_L + \underline{v}_D$ $\quad \underline{v}_D = \overrightarrow{\text{const}}$

$$m \frac{d\underline{v}}{dt} = q(\underline{v} \times \underline{B}) + \underline{F}$$

In dir. //: $m \dfrac{dv_{\parallel}}{dt} = F_{\parallel}$

moto rett. unif. accelerato

$a = F_{\parallel}/m$

In dir. $\perp$

$$m \frac{d}{dt}(\underline{v}_L + \cancel{\underline{v}_D}) = q\left[(\underline{v}_L + \underline{v}_D) \times \underline{B}\right] + \underline{F}_\perp$$

$\langle \quad \rangle$

$\times\, \underline{B}$

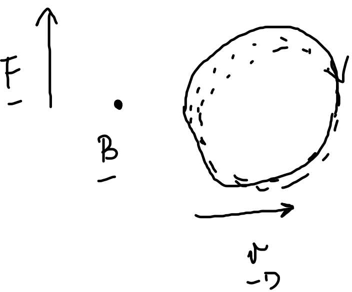
$$\underline{0} = q(\underbrace{\underline{v}_D}_{C} \times \underbrace{\underline{B}}_{B}) + \underline{F}_\perp \qquad \times \underbrace{\underline{B}}_{A}$$

$$\underline{A} \times (\underline{B} \times \underline{C}) = (\underline{C} \times \underline{B}) \times \underline{A} =$$

$$= (\underline{A}\cdot\underline{C})\underline{B} - (\underline{A}\cdot\underline{B})\underline{C}$$

$$\underline{0} = \cancel{q(\underline{v}_D \cdot \underline{B})}\underline{B} - qB^2 \underline{v}_D + \underline{F}_\perp \times \underline{B}$$

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



$\underline{F}$ non dip. da q: gravità

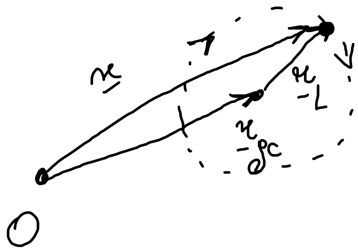
$\underline{v}_D$ verso opp. ioni/elettroni

$\Rightarrow \underline{j} \neq \underline{0}$

$\underline{F} = q\underline{E} \Rightarrow \underline{v}_D$ nella stessa dir. e verso per ioni ed el.

$\underline{B}$ ed $\underline{E}$ disuniformi

disuniformità "lieve"



gc: giro-centro

L scala della disunif.

$$\left(\frac{d|\underline{E}|}{dx} \Big/ |\underline{E}| \right)^{-1} \nearrow$$

Se $L \gg r_L$

$T \gg T_L$

$$m \frac{d\underline{v}}{dt} = q \left[\underline{E}(\underline{r}) + \underline{v} \times \underline{B}(\underline{r}) \right]$$

$$\underline{r} = \underline{r}_{gc} + \underline{r}_L$$

$$\underline{E}(\underline{r}) \simeq \underline{E}(\underline{r}_{gc}) + (\underline{r}_L \cdot \underline{\nabla}) \underline{E}(\underline{r}_{gc})$$

Esp. Taylor attorno a $\underline{r} = \underline{r}_{gc}$

$$\underline{E}(\underline{r}) \simeq \underline{E}(\underline{r}_g) + \left[\underbrace{(\underline{r} - \underline{r}_{gc})}_{\underline{r}_L} \cdot \underline{\nabla} \right] \underline{E}(\underline{r})$$

$$\underline{x} = \underline{x}_{gc} + \underline{r}_L \Rightarrow \underline{v} = \underline{v}_{gc} + \underline{v}_L$$

$$m\left[\frac{d\underline{v}_{gc}}{dt} + \frac{d\underline{v}_L}{dt}\right] = q\left[\underline{E}(\underline{x}_{gc}) + (\underline{r}_L \cdot \underline{\nabla})\underline{E}(\underline{x}_{gc})\right] \qquad (1)$$

$$+ q\,(\underline{v}_L + \underline{v}_{gc}) \times \left[\underline{B}(\underline{x}_{gc}) + (\underline{r}_L \cdot \underline{\nabla})\underline{B}(\underline{x}_{gc})\right]$$

Girazione: $$m\frac{d\underline{v}_L}{dt} = q\left[\underline{v}_L \times \underline{B}(\underline{x}_{gc})\right] \qquad (2)$$

(1) − (2):

$$\langle\ \rangle = 0$$

$$m\frac{d\underline{v}_{gc}}{dt} = q\left[\underline{E}(\underline{x}_{gc}) + (\underline{r}_L \cdot \underline{\nabla})\underline{E}(\underline{x}_{gc})\right] + q\,\underline{v}_L \times (\underline{r}_L \cdot \underline{\nabla})\underline{B}(\underline{x}_{gc})$$

$$+ q\,\underline{v}_{gc} \times \underline{B}(\underline{x}_{gc}) + q\,\underline{v}_{gc} \times (\underline{r}_L \cdot \underline{\nabla})\underline{B}(\underline{x}_{gc})$$

$$\langle\ \rangle = 0$$

$\langle\ \rangle$ su T_L

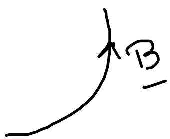
$$m \frac{d\underline{v}_{gc}}{dt} = q \Big[\underset{\parallel,\ \perp}{\underline{E}(\underline{x}_{gc})} + \underset{\parallel,\ \perp}{\langle \underline{v}_L \times (\underline{r}_L \cdot \underline{\nabla}) \underline{B}(\underline{x}_{gc}) \rangle} + \underbrace{\underline{v}_{gc} \times \underline{B}(\underline{x}_{gc})}_{\perp\, \hat{\underline{b}}} \Big]$$

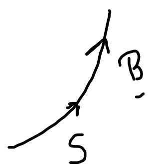
$$\underline{v}_{gc} = \underline{v}_{\perp gc} + v_{\parallel gc}\, \hat{\underline{b}}$$

$\hat{\underline{b}}$: versore associato a $\underline{B}$

$$\frac{d}{dt}\underline{v}_{gc} = \frac{d}{dt}\Big[\underline{v}_{\perp gc} + v_{\parallel gc}\, \hat{\underline{b}}\Big] = \underbrace{\frac{d}{dt}\underline{v}_{\perp gc}}_{\perp\, \hat{\underline{b}}} + \underbrace{\frac{dv_{\parallel gc}}{dt}\hat{\underline{b}}}_{\parallel\, \hat{\underline{b}}} + \underbrace{v_{\parallel gc}\frac{d\hat{\underline{b}}}{dt}}_{\perp\, \hat{\underline{b}}}$$

$$\underbrace{\frac{\partial \hat{\underline{b}}}{\partial s}}_{(\hat{\underline{b}} \cdot \underline{\nabla})\hat{\underline{b}} \cdot v_{\parallel}}$$





$$\hat{\underline{b}} = \hat{\underline{b}}(s)$$

$$s = s(t)$$

$$\frac{d\hat{\underline{b}}}{dt} = \frac{\partial \hat{\underline{b}}}{\partial s}\overbrace{\frac{\partial s}{\partial t}}^{v_{\parallel}} =$$

$\textcircled{=}$

$$m \frac{d\underline{v}_{=gc}}{dt} = q\left[\underline{E}_{=}(\underline{x}_{gc}) + \langle \underline{v}_{\perp} \times (\underline{r}_{\perp}\cdot\underline{\nabla})\,\underline{B}(\underline{x}_{gc}) \rangle_{=} \right]$$

$\textcircled{\perp}$

$$m \frac{d\underline{v}_{\perp gc}}{dt} = q\Big[\underline{E}_{\perp} + \langle \underline{v}_{\perp} \times (\underline{r}_{\perp}\cdot\underline{\nabla})\,\underline{B}(\underline{x}_{gc}) \rangle_{\perp} + \underline{v}_{gc} \times \underline{B}(\underline{x}_{gc})$$
$$- m v_{=gc}^{2}\,(\hat{\underline{b}}\cdot\underline{\nabla})\hat{\underline{b}} \Big]$$

$$\underline{F}_{\perp} = q\,\underline{E}_{\perp} + q\langle \underline{v}_{\perp} \times (\underline{r}_{\perp}\cdot\underline{\nabla})\,\underline{B}(\underline{x}_{gc}) \rangle - m v_{=gc}^{2}\,(\hat{\underline{b}}\cdot\underline{\nabla})\hat{\underline{b}}$$

$$m \frac{d\underline{v}_{\perp gc}}{dt} = q\left(\underline{v}_{gc} \times \underline{B}(\underline{x}_{gc})\right) + \underline{F}_{\perp}$$

So $\underline{F}_{\perp} \approx \overrightarrow{\text{const}}$ $\qquad \underline{v}_{\perp gc} = \dfrac{\underline{F}_{\perp} \times \underline{B}}{qB^{2}}$

$$\underline{v}_{gc} = \underline{v}_{gc}^{(0)} + \underline{v}_{gc}^{(1)}$$

$$m \frac{d}{dt}\left(\underline{v}_{gc}^{(0)} + \underline{v}_{gc}^{(1)}\right) = \cancel{\underline{F}_\perp} + q\left[\left(\cancel{\underline{v}_{gc}^{(0)}} + \underline{v}_{gc}^{(1)}\right) \times \underline{B}\right]$$

$$\frac{d\underline{v}_{gc}^{(1)}}{dt} \simeq 0 \qquad \underline{F}_\perp + q\,\underline{v}_{gc}^{(0)} \times \underline{B} = \underline{0}$$

$$\times \underline{B}$$

$$m \frac{d}{dt}\underline{v}_{gc}^{(0)} = q\,\underline{v}_{gc}^{(1)} \times \underline{B} \qquad \times \underline{B}$$

$$(\underline{C} \times \underline{B}) \times \underline{A} = (\underline{A} \cdot \underline{C})\underline{B} - (\underline{A} \cdot \underline{B})\underline{C}$$

$$= q\left[\underbrace{(\underline{v}_{gc}^{(1)} \cdot \underline{B})}\underline{B} - B^2 \underline{v}_{gc}^{(1)}\right] \qquad \underline{v}_{gc}^{(1)} = -\frac{m}{qB^2}\frac{d\underline{v}_{gc}^{(0)}}{dt} \times \underline{B}$$

Se $\underline{F}_\perp$ dip. tempo

$$\underline{v}_{gc}^{(0)} = \frac{\underline{F}_\perp \times \underline{B}}{B^2} \implies \underline{v}_{gc}^{(1)} = \frac{m}{qB^2}\frac{d\underline{F}_\perp}{dt}$$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