Plasma con $B=0$ $\quad D \sim \dfrac{T}{m\nu}$

Plasma con $B\neq 0$ $\quad D \sim r_L^2\,\nu$

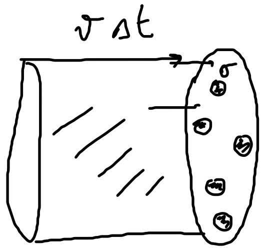
<u>Plasmi debolmente ionizzati</u>

Collisioni dominanti con i neutri

Neutri

$$e+n \qquad i+n$$

$$\sigma_{ne} \approx \sigma_{ni}$$




$$\frac{\#\text{ collisioni}}{\text{tempo}} = \frac{\text{Area coperta dalle varie } \sigma}{\text{Area totale}}\,\frac{1}{\Delta t}$$

# bersagli incontrati da i o e $= n_n \cdot$ Volume del cilindro di lungh. $v\Delta t$

$= n_n \cdot S v \Delta t$

$$\nu = \frac{\text{Area della collisione}}{S} \cdot \frac{1}{\Delta t} = \frac{(\#\text{ bersagli})\,\sigma}{S} \frac{1}{\Delta t} = \frac{n_n \cancel{S} v \cancel{\Delta t}\, \sigma}{\cancel{S} \cancel{\Delta t}}$$

$$\nu_{e,i} = n_n v_{e,i}\, \sigma$$

$$\nu_{e,i} \sim n_n v_{th_{e,i}}\, \sigma$$

$T_e \simeq T_i$

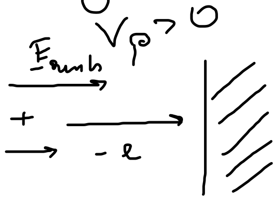
$$\frac{\nu_e}{\nu_i} \sim \frac{v_{th_e}}{v_{th_i}} \sim \sqrt{\frac{m_i}{m_e}} \gg 1$$

Se $B=0$ $\quad D \sim \dfrac{T}{m\nu}$

$$\frac{D_e}{D_i} \sim \frac{m_i \nu_i}{m_e \nu_e} \sim \frac{m_i}{m_e}\sqrt{\frac{m_e}{m_i}} \sim \sqrt{\frac{m_i}{m_e}}$$

Elettroni diffondono di più (ci provano) ⇒ si produce un $\underline{E}_{\text{ambipolare}}$ dalla sep. carica

$\underline{E}_{\text{amb.}}$ garantisce uguale diffusioni per ioni ed elettroni




$$r_L = \frac{m v_\perp}{qB} \sim \frac{m v_{th}}{qB} \sim \sqrt{m}$$

Se $B \neq 0$ $\quad D \sim r_L^2 \nu$

$$\frac{D_e}{D_i} \sim \frac{r_{Le}^2 \nu_{en}}{r_{Li}^2 \nu_{in}} \sim \frac{m_e}{m_i}\sqrt{\frac{m_i}{m_e}} \sim \sqrt{\frac{m_e}{m_i}}$$

Ioni tentano di diffondere più velocemente ⇒ si produce per sep. di carica un $\underline{E}_{\text{amb.}}$ che garantisce uguale diffusione per ioni ed elettroni

$u\nu^{-1} \ll L$ $\qquad \left\|\dfrac{\partial u}{\partial t}\right\| \sim u\nu$

$$\|(\underline{u}\cdot\underline{\nabla})\underline{u}\| \sim \frac{u^2}{L} \qquad \frac{\|(\underline{u}\cdot\underline{\nabla})\underline{u}\|}{\left\|\frac{\partial \underline{u}}{\partial t}\right\|} \sim \frac{u^{\cancel{2}}}{L}\,\frac{1}{\cancel{u}\nu} \sim \frac{u\nu^{-1}}{L} \ll \frac{\cancel{L}}{\cancel{L}}\,1$$

Stato stazionario: $\dfrac{\partial u}{\partial t} = 0$

$\underline{\nabla} p$ : T uniforme, n disunif. $\quad p = n k_B T$

$$0 \simeq q\underline{E}n - k_B T\,\underline{\nabla} n - m n \nu \underline{u}$$

$$\underline{u} \simeq \frac{q\underline{E}}{m\nu} - \frac{k_B T}{m\nu}\,\frac{\underline{\nabla} n}{n}$$

$\underline{E}_{amb}$ deve garantire che: $\quad \underline{\Gamma}_{el} = \underline{\Gamma}_{ioni} \qquad n_e \underline{u}_e = n_i \underline{u}_i$

$$\frac{e\underline{E}}{m_i\nu_{in}} - \frac{k_B T_i}{m_i\nu_{in}}\frac{\underline{\nabla} n}{n} = \frac{-e\underline{E}}{m_e\nu_{en}} - \frac{k_B T_e}{m_e\nu_{en}}\frac{\underline{\nabla} n}{n}$$

$$e\underline{E}\left(\cancel{\frac{1}{m_i\nu_{in}}} + \frac{1}{m_e\nu_{en}}\right) = -\frac{\underline{\nabla} n}{n}\left(\frac{T_e}{m_e\nu_{en}} \cancel{- \frac{T_i}{m_i\nu_{in}}}\right)$$

$$\frac{m_e\nu_{en}}{m_i\nu_{in}} \sim \sqrt{\frac{m_i}{m_e}}\,\frac{m_e}{m_i} \sim \sqrt{\frac{m_e}{m_i}}$$

$$\underline{E}_{amb} = -\frac{\underline{\nabla} n}{n}\frac{T_e}{e}$$

$$D_{amb} = \frac{T_e + T_i}{m_i\nu_{in}}$$

$$\underline{\Gamma}_{ioni} = n\,\underline{u}_i = \frac{\cancel{n}\cancel{e}}{m_i\nu_{in}}\left(-\frac{\underline{\nabla} n}{\cancel{n}}\frac{T_e}{\cancel{e}}\right) - \frac{T_i}{m_i\nu_{in}}\frac{\underline{\nabla} n}{\cancel{n}}\cdot\cancel{n} = -\frac{(T_e + T_i)}{m_i\nu_{in}}\underline{\nabla} n$$

$$D_{amb} = \frac{T_e + T_i}{m_i \nu_{in}}$$

$$D_e = \frac{T_e}{m_e \nu_{en}} \qquad D_i = \frac{T_i}{m_i \nu_{in}}$$

$$\frac{D_i}{D_{amb}} \simeq \frac{T_i}{m_i \cancel{\nu_{in}}} \frac{m_i \cancel{\nu_{in}}}{T_e + T_i} \sim \frac{1}{2} \qquad \frac{D_e}{D_{amb}} \sim \frac{T_e}{m_e \nu_{en}} \cdot \frac{m_i \nu_{in}}{T_e + T_i}$$

$$\sim \frac{1}{2} \frac{m_i}{m_e} \sqrt{\frac{m_e}{m_i}} \sim \sqrt{\frac{m_i}{m_e}}$$