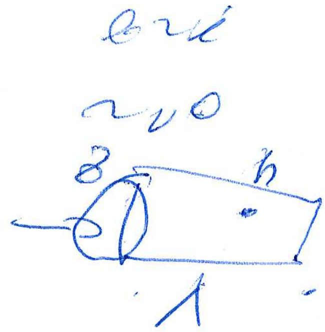
Opakování – Review (1)

~~málo~~ slabě ionizovaný – weakly ionized, without B_0

srážkový průřez s neutrály σ
cross section for collision with neutrals



mean free path $\lambda_m = \frac{1}{n_n \sigma}$
(střední volná dráha)

$$\tau = \frac{\lambda_m}{v} = \frac{1}{n_n \sigma v}$$ time between collisions

$$\nu = \left\langle \frac{1}{\tau} \right\rangle = n_n \langle \sigma v \rangle$$ coll. frequency

pohyblivost (mobility) $\mu = \frac{q}{m\nu}$ $\qquad D = \frac{k_B T}{m\nu}$ diffusion coefficient

tok $\vec{\Gamma}_j = \pm \mu_j n_j \vec{E} - D_j \nabla n_j$ flux

~~D~~al ambipolar $(Z = 1)$

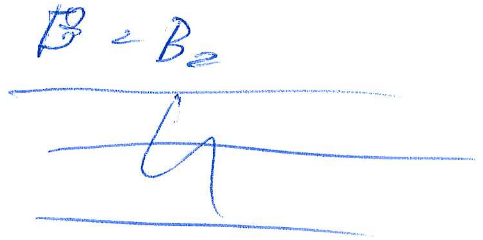
$$\vec{\Gamma}_e - \vec{\Gamma}_i = 0 \Rightarrow \vec{E} = \frac{D_i - D_e}{\mu_i + \mu_e} \frac{\nabla n}{n}$$

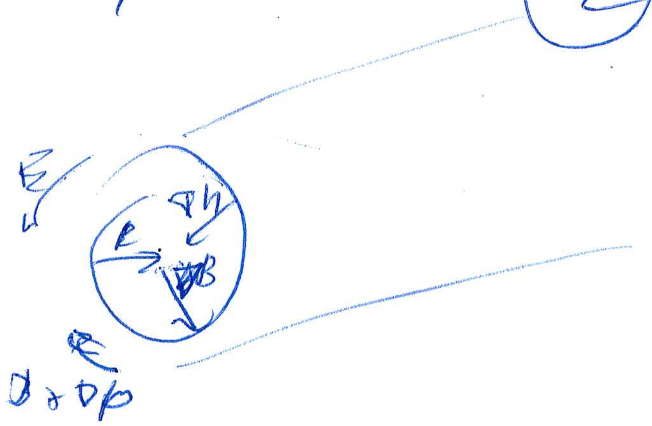
$$D_a = \frac{\mu_i D_e + \mu_e D_i}{\mu_i + \mu_e}$$

$$\frac{\partial n}{\partial t} = \text{div}\,(D_a \nabla n)$$

for D_a const $\rightarrow D_a \Delta n$

transverse to B_z weakly ion (2)





$$m n_\alpha \frac{dv_\alpha}{dt} = q n_\alpha(\vec E_\alpha + \vec v_\alpha \times B_\alpha) - \nabla p_\alpha - mn\nu \vec v$$

slow $\cong 0$

Isothermal T = const = $T_e = T_i$

$$mn\nu v_x = qnE_x - k_B T \frac{\partial n}{\partial x} + qnv_y B$$

$$mn\nu v_y = qnE_y - k_B T \frac{\partial n}{\partial y} - qnv_x B$$

$$\Rightarrow \quad v_x = \pm\mu E_x - \frac{D}{n}\frac{\partial n}{\partial x} \pm \frac{\omega_c}{\nu} v_y$$

$$v_y = \pm\mu E_y - \frac{D}{n}\frac{\partial n}{\partial x} \mp \frac{\omega_c}{\nu} v_x$$

v_x = ? do druhé ($\tau = \nu^{-1}$

$$v_y = \pm\underbrace{\frac{\mu E_y}{(1+\omega_c^2\tau^2)}}_{\mu_\perp} - \underbrace{\frac{D}{(1+\omega_c^2\tau^2)}}_{D_\perp}\frac{1}{n}\frac{\partial n}{\partial y} - \frac{\omega_c^2\tau^2}{1+\omega_c^2\tau^2}\frac{E_x}{B} \pm \frac{\omega_c^2\tau^2}{1+\omega_c^2\tau^2}\frac{k_B T}{qB}\frac{1}{n}\frac{\partial n}{\partial y}$$

similarly for v_x – podobně pro v_x

$\vec E \times \vec B$ and diamag. drifts along constant density – no diffusion

$$\vec{V}_\perp = \pm \mu_\perp \vec{E} - D_\perp \frac{\nabla n}{n} + \underbrace{\frac{\vec{V}_E + \vec{V}_D}{1 + \omega_e^2 \tau^2}}_{E \times B \ + \ \text{diamagnetic drift}}$$

flux along constant density

ambipolar

$$\operatorname{div} \vec{\Gamma}_e = \operatorname{div} \vec{\Gamma}_i$$

$$\nabla \Gamma_i = \nabla_\perp \left(\mu_{i\perp} n E_\perp - D_{i\perp} \nabla n \right) + \frac{\partial}{\partial z} \left(\mu_i n E_z - D_i \frac{\partial n}{\partial z} \right)$$

$$\nabla \Gamma_e = \nabla \left(-\mu_{e\perp} n E_\perp - D_{e\perp} \nabla n \right) + \frac{\partial}{\partial z} \left(-\mu_e n E_z - D_e \frac{\partial n}{\partial z} \right)$$

solution exists only

long plasma column, isolated ends $\frac{\partial}{\partial z} \simeq 0$

$$\left(\mu_{i\perp} n E_\perp - D_{i\perp} \nabla n \right) = \left(\mu_{e\perp} n E_\perp - D_{e\perp} \nabla n \right)$$

$$\Rightarrow E_\perp \Rightarrow D_a$$

$\vec{E}$ accel. els, decel. ions