Chapter3_2

2021年4月21日　9:30

① Perpendicular to $\mathbb{B}$

$$mn\Big[\underbrace{\frac{\partial \mathbf{v}}{\partial t}}_{①}+\underbrace{(\mathbf{u}\cdot\nabla)\mathbf{v}}_{②}\Big]=qn(\mathbb{E}+\underbrace{\mathbf{v}\times\mathbb{B}}_{③})-\nabla p$$

$$\frac{①}{③}\simeq\frac{mn\,i\omega v_\perp}{qn\,v_\perp B}\approx\frac{\omega}{\omega_c}$$

② → neglect

⇩ then.... concerned with only $v_\perp$

$$0=qn(\mathbb{E}+v_\perp\times\mathbb{B})-\nabla p \quad \Big)\times\mathbb{B}$$

$$0=qn(\mathbb{E}\times\mathbb{B}+\underline{(v_\perp\times\mathbb{B})\times\mathbb{B}})-\nabla p\times\mathbb{B}$$

$$(v_\perp\times\mathbb{B})\times\mathbb{B}=\mathbb{B}\cdot(v_\perp\cdot\mathbb{B})-v\cdot\mathbb{B}^2$$

$$0=qn(\mathbb{E}\times\mathbb{B}+\underbrace{\mathbb{B}(v_\perp\cdot\mathbb{B})}_{=0}-v_\perp\mathbb{B}^2)-\nabla p\times\mathbb{B}$$

0 ($\because$ $v_\perp$ perpendicular to $\mathbb{B}$)

⇩ then...

$$v_\perp=\frac{1}{qnB^2}\Big[qn(\mathbb{E}\times\mathbb{B})-\nabla p\times\mathbb{B}\Big]$$

$$=\underbrace{\frac{\mathbb{E}\times\mathbb{B}}{B^2}}_{\equiv v_E}-\underbrace{\frac{\nabla p\times\mathbb{B}}{qnB^2}}_{\equiv v_D}$$

$\mathbb{E}\times\mathbb{B}$ drift　　Diamagnetic drift

② Parallel to $\mathbb{B}$

z-component.

$$mn\Big[\frac{\partial v_z}{\partial t}+\underline{v_z\frac{\partial v_z}{\partial z}}\Big]=qn(E_z+\underbrace{(\vec{v_z}\times\mathbb{B})}_{0})-\frac{\partial p}{\partial z}$$

assumption: v_z = uniform. $\rightarrow \frac{\partial v_z}{\partial z}=0$

⇩ then.

$$\frac{\partial v_z}{\partial t}=\frac{qn}{mn}E_z-\frac{\gamma kT}{mn}\frac{\partial n}{\partial z}\quad(p\equiv nkT)\quad\cdots\cdots(*)$$

when we think of electron, $m\rightarrow 0$, $q\rightarrow -e$, then,

$$eE_z=e\frac{\partial\phi}{\partial z}=\frac{\gamma kTe}{n}\frac{\partial n}{\partial z}\quad\Big)\text{ integrate.}$$

$$e\phi=kTe\log n+\text{const.}$$

or,

$$n=n_0\exp\left(\frac{e\phi}{kTe}\right)\quad(\text{Boltzmann relation})$$

★ what this means that;

electrons is very mobile and would be easily accelerated if there are a net force on them!!