2017 I: QS Transport

a.) $P_\varsigma = mRv_\varsigma + \frac{e}{c}\psi(r,t)$

$$\frac{d}{dt}\langle P_\varsigma\rangle = \frac{d}{dt}\langle \cancel{mRv_\varsigma}^{\,0}\rangle + \frac{e}{c}\frac{d}{dt}\langle\psi(r,t)\rangle$$

$$\Rightarrow \frac{\partial}{\partial t}\psi + \frac{\partial x}{\partial t}\frac{\partial}{\partial x}\psi = 0$$

$$\Rightarrow \boxed{\frac{\partial\psi}{\partial t} = -\vec{v}\cdot\nabla\psi}$$

b.) $\nabla\times E = -\frac{1}{c}\frac{\partial B}{\partial t} \Rightarrow \int E\cdot d\ell = -\frac{1}{c}\frac{d\psi}{dt}$

$\frac{d\psi}{dr} = 2\pi R B_p$

$$2\pi E_\varsigma R = -\frac{1}{c}v_r\nabla_r\psi$$

$$E_\varsigma \cancel{R} \sim -\frac{1}{c}v_r B_p \cancel{R}$$

$$\Rightarrow \boxed{v_c \sim -\frac{cE_\parallel}{B_p}}$$

c.) $\vec{B} = \nabla\times\vec{A}$ $\quad \psi\sim RA_\varsigma \quad \int\vec{B}\cdot d\vec{s} = A_\varsigma$

$$P_\varsigma = mRv_\varsigma + \frac{e}{c}R\int\vec{B}\cdot d\vec{s}$$

d.) $P_\varsigma = m(r+R_0+\Lambda)v_\varsigma + \frac{e}{c}\left[\psi(r) + \Lambda\frac{\partial\psi}{\partial r}\right]$ $\quad \to B_pR = B_p(r+R_0)$

$$= m(r+R_0+\Lambda)v_\varsigma + \frac{e}{c}\left[\psi(r) + \Lambda B_p(r+R_0)\right]$$

e.) $\Rightarrow \Lambda = \frac{m(r+R_0+\Lambda)}{r+R_0}v_{th}\,\varepsilon^{1/2}\,\frac{c}{eB_p}$

$q = \varepsilon\frac{B_T}{B_p} \quad \rho\sim v_{th}/\Omega \sim v_{th}\frac{mc}{eB_T} \quad \Rightarrow \boxed{\Lambda\sim\rho q\,\varepsilon^{-1/2}}$