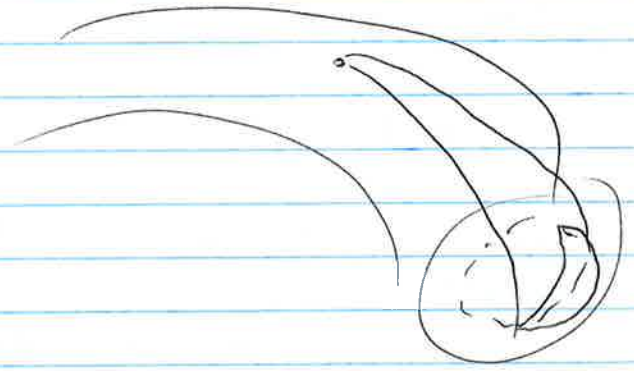
2010 Neoclassical

a.



b. $P_\phi = mRv_\phi + eRA_\phi = mRv_\phi - e\psi(r)$

$P_\phi(\text{turn}) = -e\psi(r)$

$P_\phi(\text{mid}) = m(R_0 + r + \Delta)v_\phi - e\psi(r+\Delta)$ ($R_0 + r$)

$\psi(r+\Delta) \approx \psi(r) + \Delta\,\hat{r}\cdot\nabla\psi = \psi(r) + \Delta R B_p$

$\rightarrow 0 = m(R_0 + r + \Delta)v_\phi - e\Delta(R_0 + r)B_p$

$$\Delta \sim \frac{mv_\phi}{eB_p} \sim \frac{mv_{th}}{eB_p}\epsilon^{1/2} \sim \frac{mv_{th}}{e}\frac{q}{B_T}\epsilon^{1/2}$$

$$\sim \frac{mv_{th}}{eB_0}\frac{q}{\epsilon^{1/2}}, \quad \frac{mv^2}{r} \sim \frac{qvB}{c} \rightarrow r \sim \frac{mvc}{qB}$$

$$\sim \rho q\,\epsilon^{-1/2}$$

c. $D_{ra} \sim f_{trapp}\,\Delta^2\,\nu_{eff} \sim \epsilon^{1/2}\left(\frac{\rho q}{\epsilon^{1/2}}\right)^2 \frac{\nu_{ei}}{\epsilon} \sim \rho_e^2 \nu_{ei} q^2 \epsilon^{-3/2}$

d. $D_{PS} \sim \frac{(\Delta x)^2}{\Delta t} \sim v_{D,r}^2\,\Delta t_{||}$

$$v_{D,r} \sim \frac{1}{\Omega}\hat{n}\times\left(\mu\nabla B + \hat{n}\cdot\nabla\hat{n}\right) \sim \frac{\mu}{\Omega}(\hat{n}\times\nabla B)_r \sim \frac{\mu}{\Omega}\frac{B_\theta}{R}$$

$$D_{||} \sim \frac{\Delta x_{||}^2}{\Delta t_{||}} \sim \frac{(R_0 q)^2}{\Delta t_{||}} \sim \frac{v_{th}^2}{\nu_{ei}} \rightarrow \Delta t_{||} \sim \left(\frac{R_0 q}{v_{th}}\right)^2 \nu_{ei}$$

$$D_{PS} \sim \left(\frac{v_{th}\rho}{R}\right)^2\left(\frac{R_0 q}{v_{th}}\right)^2 \nu_{ei} \sim \rho_e^2 \nu_{ei} q^2$$

e. $\nu^* = \frac{\nu_{eff}}{\omega_B} \sim \frac{\nu_{ei}}{\epsilon}\left(\frac{R_0 q}{\epsilon^{1/2} v_{th}}\right) \sim \frac{\nu_{ei} R_0 q}{v_{th}}\epsilon^{-3/2}$

$\nu^* < 1$ banana (all orbits complete before scatter)

$\nu^* > \epsilon^{-3/2}$ PS (no orbits complete before scatter)

f. $\lim D_{mm} = \rho_e^2 \nu_{ei} q^2 \epsilon^{-3/2}$

$\nu^* \to 1$

$\nu^* \sim \nu_{ei} \frac{R_0 q}{v_{th}} \epsilon^{-3/2} \to 1$

$\nu_{ei} \to \frac{v_{th}}{R_0 q \epsilon^{-3/2}}$, $D_{mm} \to \rho^2 q^2 \epsilon^{-3/2} \left(\frac{v_{th}}{R_0 q \epsilon^{3/2}} \right)$

$\to \rho^2 q \frac{v_{th}}{R_0}$ $D_{Plat.}$

$\lim \nu^* \to \epsilon^{-3/2}$

$\nu_{ei} \to \frac{v_{th}}{R_0 q}$

① $D_{PS} \to \rho^2 \nu_{ei} q^2 \to \rho^2 q^2 \left(\frac{v_{th}}{R_0 q} \right) \to \rho^2 q \frac{v_{th}}{R_0}$ D_{Plat}