ESS 415/515 Problem set 6
Due Friday Feb 14

Read Parks Chapter 5.

1. Parks Chapter 5 prob 2, page 208.

2. An isothermal plasma with temperature T is confined between the planes x = ± a in a magnetic field $\mathbf{B} = B\mathbf{z_{hat}}$. The density distribution is given by $n = n_o(1 - (\sin(\pi x/2a))^2)$.

a. **Derive** an expression for the magnetization current density $\mathbf{j}_M$ as a function of x.

b. **Draw** a diagram showing the density profile and the direction of $\mathbf{j_M}$ on both sides of the midplane if **B** is out of the paper.

c. **Evaluate** $\mathbf{j_M}$ at x=a/2 if $Bo = 0.4\times10^{-4}$nT, kBT_e = 3eV and a=100 km (e.g. in the ionosphere).

3. **Determine** the electron partial pressure tensor $\overleftrightarrow{P}_e$ components for an isotropic plasma with $\mathbf{B} = B\mathbf{z_{hat}}$ with electron temperatures of $T_{e\|}$ = 1 keV, $T_{e\perp}$ = 10 keV and density ne = 104 cm–3. **Show** specifically that the off diagonal elements are zero.

4. A cylindrically symmetric plasma column in a uniform B field has
$n(r) = noexp(-r2/ro^2)$ and $n_i = n_e = n_o\exp(e\phi/KTe)$

(a) **Show** that the $V_B \equiv \dfrac{\vec{E}\times\vec{B}}{B^2}$ drift and the electron Diamagnetic drift V_{De} are equal and opposite, where $V_{De} \equiv -\dfrac{\nabla\tilde{P}\times\vec{B}}{qnB^2}$

(b) **Show** that the plasma rotates as a solid body.

(c) In the frame which rotates with velocity VE, some plasma waves (drift waves) propagate with a phase velocity $v\phi = 0.5V_{De}$. What is v_ϕ in the lab frame? On a diagram of the r - θ plane, **draw** arrows indicating the relative magnitudes and directions of V_B, V_{De}, and V_ϕ in the lab frame.