1. Magnetic gradient drift:

Evaluate the time average for the gradient drift velocity

$$\mathbf{v}_\nabla = \frac{1}{B_0} \left\langle \mathbf{v}_g x \frac{dB_0}{dx} \right\rangle$$

by using the general motion of a single particle with charge q and mass m in a magnetic field along the z direction with a gradient in the the x direction (without any electric field in the Lorentz equation). Show that the resulting drift is in the y direction and can be written as

$$\mathbf{v}_\nabla = \frac{mv_\perp^2}{2qB^3} \mathbf{B} \times \nabla B$$

2. Radius of curvature:

A magnetic field is given by $B_z = \epsilon B_0$, $B_x = B_0 z/L$.

(a) Compute the radius of curvature as a function of ϵ and L.

(b) Assume $B_0 = 2 \cdot 10^{-8}$ T, $\epsilon = 0.1$ and $L = 10^7$ m in the previous problem for a typical magnetotail configuration. Compute the the curvature drift velocity for thermal electrons and ions with a temperature of $T = 10^7$ K.

3. Mirror motion:

Assume that all particles with a pitchangle smaller than α_0 are lost from a Maxwell distribution. Compute the fraction of particles which is lost from the whole distribution. Does this change in case of a non-Maxwellian but isotropic distribution?

Please turn in the solutions to the homework on Monday, 10/09/06