ESS415/515 Midterm
Open Book, Open Note, Due at 12:20pm today 2/12/04

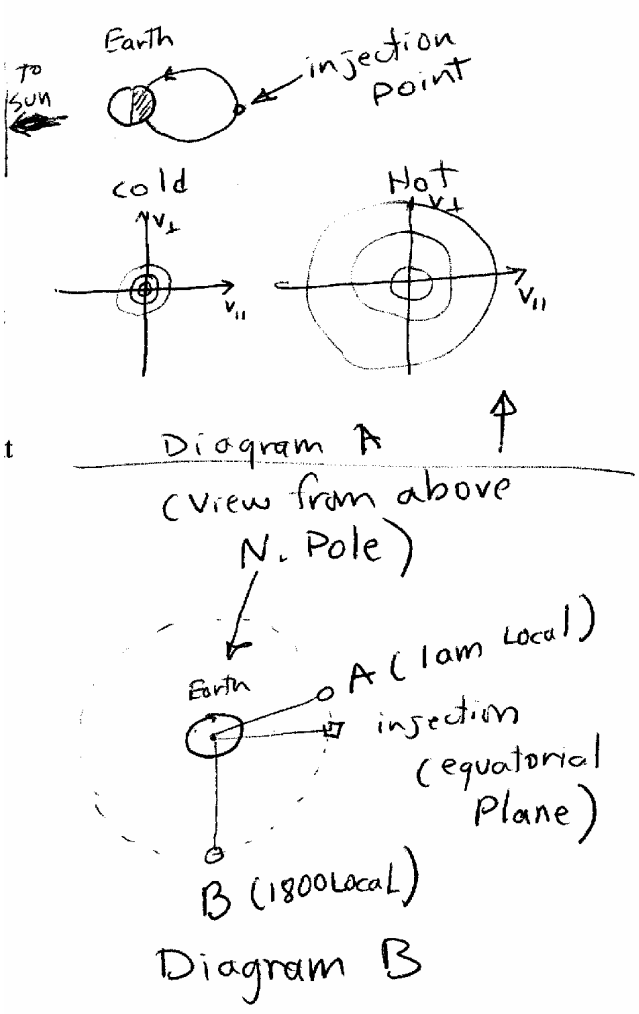
Question 1. Guiding Center Motion Effects on initial Maxwellian Distributions

Given: Two <u>isotropic</u> particle distributions, with low and high energy particle populations, are <u>continuously</u> injected on the magnetic equator at 3Re geocentric distance from the Earth at the longitude of midnight (see Diagram A).

The low energy distribution has a temperature equivalent energy of 1eV and the high energy distribution has a temperature equivalent energy of 10 keV. Assume there are no other significant sources of particles in the magnetosphere and ignore electrons except as a background which keeps the overall plasma quasi-neutral.

1. **Describe** the total ion distribution function at the equator, at 3Re, as a function of time at Point A, which is 15 degrees east of midnight (see Diagram B)
2. **Describe** the total ion distribution function at the equator, at 3Re, as a function of time, at Point B, which is 90 degrees West of midnight (see Diagram B).

HINT: Consider times from minutes to days, and all appropriate guiding center drifts which might be applicable in a static magnetosphere.



Question 2: Compare **Curvature and Gradient Drift** rates for a 100 keV electron at L=6 which mirrors just above the ionosphere. Plot the ratio of curvature drift over gradient drift: $\frac{W_{Curv}}{W_{\nabla B}}$ along the. field line

Problem 3. Adiabatic Invariants

a) **Give** expressions for each of the three adiabatic invariants of charged particle motion in a static magnetic dipole field.

b) Assume there is a uniform, time-varying electric field E across the whole magnetosphere in the dawn-to-dusk direction given by $E = E_o \cos(2\pi t / \tau)$ where τ = 600 seconds (or 10 minutes).

1) **How** will this E field affect each of the 3 adiabatic invariants of motion for typical magnetospheric particles?

2) For those particles resonant with this E-field at L=6, **What** is the maximum energy they could gain by radial diffusion caused by this E-field in the magnetosphere?