Problem set 3. Due Feb 10 in class

February 10, 2011

- For particles at the edge of the Earth magnetosphere, located at 10 Earth radii, estimate drift velocity due to (i) gravitational attraction of the Earth; (ii) inhomogeneity of magnetic field. Assume that the particle is electron of e1nergy 1 keV, magnetic field on the Earth surface is 1 Gauss, magnetic field of the Earth is dipole, $B \propto 1/r^3$. Assume that gravity acceleration equals that on the surface of the Earth.

$$v_{grav} = (F/e)/Bc = \frac{mgc}{eB}$$
$$v_{grav} = 5 \times 10^{-2} cm/s \text{ for eletrons} \quad (1)$$

$$v_{\nabla B} = \frac{mc}{eB}\frac{v^2}{2}\nabla \ln B = \frac{mv^2}{2}\frac{c}{eB}\frac{1}{3R} = 5 \times 10^3 cm/s \quad (2)$$

- A particle at the edge of the Earth magnetosphere, located at 10 Earth radii, has a pitch angle of 45 degrees. Find a distance at which it will be reflected.

$$\frac{\sin^2 \alpha_0}{B_0} = \frac{1}{B}$$
$$B = B_0 (r/R_0)^{-3}$$
$$r = R_0 \sin \alpha_0^{2/3} = 5 \times 2^{2/3} R_E \quad (3)$$

- For a particle at the edge of the Earth magnetosphere, located at 10 Earth radii, find the frequency of the cyclotron emission (corresponding to a transition by one Landau level).

$$\omega = \omega_B = \frac{eB}{m_e c} = \frac{eB_E}{m_e c}\left(R/R_E\right)^3 = 1.8 \times 10^4 \text{rad}/s \quad (4)$$