18 Gradient and curvature drift

(a) A single proton has a parallel and perpendicular energy of 10 keV. Compute $(\mathbf{B} \times \nabla B)/B^3$ and determine the instantaneous curvature and gradient drift velocity for the Earth's dipole field in the magnetic equator at a radial distance of 5 R_E

(b) Consider an isotropic Maxwell plasma distribution for protons with a temperature $T = 10^8$ K in the equatorial plane. Evaluate the instantaneous bulk (average) velocity of the distribution at a radial distance of 5 $R_{\rm E}$ based on the gradient and curvature drift.

19. Loss cone distribution

Consider an initial Maxwell distribution function $f(v) = n\left(\frac{m}{2\pi k_B T}\right)^{3/2} \exp\left(-\frac{mv^2}{2k_B T}\right)$ with desity n and temperature T in the equatorial plane.

a) For a given loss cone with angle α determine the fraction of particles lost from the isotropic distribution function. Determine the number density $\widetilde{n}$ for the new distribution function $\widetilde{f}$ (distribution without particles in the loss cone; hint: Represent the distribution in velocity space in spherical velocity coordinates.).

b) Compute the parallel and perpendicular energy for the distribution function with the loss cone as a function of temperature T, density n, and angle α.

c) What is the angle α for the loss cone if the energy ratio is $W_\parallel/W_\perp = 1/4$?

20 Particle drifts

(a) What perpendicular particle energy is required to compensate the co-rotational drift in the Earth's magnetosphere through the gradient B drift at the magnetic equator? Sketch or plot the required perpendicular velocity as a function of r. What is this energy for particles at L =4, 6, and 8?

(b) Express the perpendicular energy through the magnetic moment. Assume that the particle is on a field lines with $L = 8$ and is mirrored just above the ionosphere. What are the latitude of the mirror point and what is the parallel energy of the particle? What is wrong with this problem?

Please turn in the solutions to the homework on Friday, 3/07/2014