CSI 769   Fall 2010
Solar and Heliospheric Physics

Homework Assignment 4

Assignment Date: Oct. 14, 2010
Due Date: Oct. 21, 2010

1. **Magnetic Reynolds Number,   Diffusivity and Diffusion Time Scale**
(1) Consider a sunspot in the photosphere, which has a temperature of 5700 K, density of 10^{21} m^3, characteristic size of 10^4 km, and characteristic velocity of 2 km/s. You are asked to calculate the magnetic diffusivity η, magnetic Reynolds number R_m, and diffusion time scale τ_d.
(2) Do the same calculation for coronal magnetic field, which has a temperature of 10^6 K, density of 10^{15} m^3, characteristic size of 10^4 km, and characteristic velocity of 10 km/s.

Note: the diffusivity formula is given in Eq. 1.13 in PF book.

2. **1-D Magnetic Diffusion Model**
Consider the dynamic evolution of the following 1-D magnetic diffusion model:

$$\frac{\partial B(x,t)}{\partial t} = \eta \frac{\partial^2 B(x,t)}{\partial x^2}$$

(1) Prove that the following function is the correct solution of the model. (You are asked to prove the solution, not derive the solution)

$$B(x,t) = \frac{2B_0}{\sqrt{\pi}} erf\left(\frac{x}{\sqrt{4\eta t}}\right)$$

(2) Derive the function of electric current density j(x, t) from the above B(x, t).
(3) Assuming in the corona η = 1 m^2s^{-1} and B_0=500 G, draw the distribution function B(x, t) versus x at t=0, t=10 s, and t=100 s, respectively.
(4) Assuming the same corona, draw the distribution function of j(x,t) versus x at t=0, t=10s, and t=100 s, respectively.