

FYS 3610

EXERCISES WEEK 42

EXERCISE 1

Assume an Earth-fixed Cartesian coordinate system (x,y,z) where x is pointing magnetic northward, y magnetic eastward, and z downwards towards the Earth's center. In this coordinate system the magnetic field is given by

$$\vec{B} = B(\cos I \hat{x} + \sin I \hat{z}) \quad \text{Eq. 1.3}$$

and the electric field is given by

$$\vec{E} = E_x \hat{x} + E_y \hat{y} + \vec{E}_z \hat{z} \quad \text{Eq. 1.4}$$

For this coordinate system it is assumed that the magnetic dipole axis is antiparallel to the Earth's rotation axis and that the magnetic field is symmetric around this axis. In this coordinate system the height-integrated current can be expressed on tensor form as:

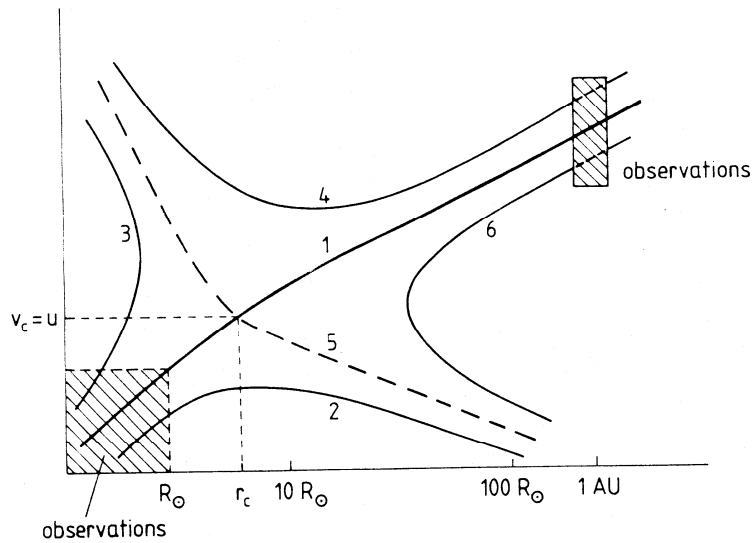
$$\begin{bmatrix} J_x \\ J_y \\ J_z \end{bmatrix} = \begin{bmatrix} \Sigma_p \sin^2 I + \Sigma_{\parallel} \cos^2 I & -\Sigma_H \sin I & (\Sigma_{\parallel} - \Sigma_p) \sin I \cos I \\ \Sigma_H \sin I & \Sigma_p & -\Sigma_H \cos I \\ (\Sigma_{\parallel} - \Sigma_p) \sin I \cos I & \Sigma_H \cos I & \Sigma_p \cos^2 I + \Sigma_{\parallel} \sin^2 I \end{bmatrix} \begin{bmatrix} E_x \\ E_y \\ E_z \end{bmatrix} \quad \text{Eq.1.5}$$

EXERCISE 2

The solar wind equation for an expansion spherically and symmetrically gives the following relationship between v and r (see also lecture notes):

$$\left(2 - \frac{GM_s}{c_s^2} \frac{1}{r} \right) \frac{dr}{r} = \left(\frac{v^2}{c_s^2} - 1 \right) \frac{dv}{v}$$

6 different solution of this equation is illustrated in the figure below. In the lecture we explained solution 1. Discuss the other 5 solutions.



EXERCISE 3

The NASA satellite ACE is used for monitoring the solar wind. It is located around $230 R_{\odot}$ upstream. Visit the following homepage <http://sec.noaa.gov/ace/> and get yourself familiar with it. Concentrate on the Real Time Data and Dynamics plots, and plot data from MAG and SWEPAM (6 hours time scale I find very useful). List up the different parameters that are plotted in the MAG and SWEPAM plots. What is the typical range for each parameter? Estimate a typical time delay from plasma is being probed by the satellite until the same plasma impinge on the magnetopause.

EXERCISE 4

Investigate the home page for SuperDARN radars: <http://superdarn.jhuapl.edu>. In particular look at Real-Time data, Convection maps. Notice that the solar wind Theta angle in the XZ plane is given in the upper right. It would be good if you could take a frequent look at convection maps under varying solar wind conditions to hopefully reveal a systematic pattern. Then you get an experimental approach to ionospheric convection before we lecture it. (Unfortunately this home page does not always work).

MID-TERM EXAM 2009

Problems and answers on the web. Ask Hiroatsu Sato to go through if you have any difficulties with some of the questions.