ASSIGNMENT 2, TFY4240 ELECTROMAGNETIC THEORY MIDTERM PROJECT, FALL 2015

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You are out walking at night with your mother during your christmas holiday. Suddenly, you are awed by the appearance of a beautiful display of aurora borealis above your heads. Your mother asks you what the aurora is—after all, you should know, being a physicist. You wave your hands and tell her about charged particles. When she asks you how these charged particles actually move around, you are embarrassed: you have no idea! However, you quickly come up with a plan:

(1) Model the Earth as a sphere with a magnetic dipole embedded at its centre (remember that the direction of the magnetic dipole is tilted with regard to the ecliptic). Plot the magnetic field in at least 2 of the 3 planes through the origin: the xy and xz planes. Choose the x axis from the Sun toward the Earth and the z axis perpendicular to the ecliptic.
(2) Model the solar wind as charged particles (e.g. protons) coming in with (initially) constant velocity along the x axis. Experiment with different velocities to get a feeling for the effect of the magnetic field on the particles. Use the simple Euler's method[1] to solve the equation of motion in 3 dimensions.
(3) Find a test condition to estimate the accuracy of your numerical solution.[2]
(4) To save your results for later analysis, write the final particle trajectories for different initial conditions to one or several text files.[3]
(5) Load some of those files[4] and make some beautiful curve plots showing a projection of the particles' trajectory into your choice of the xy, xz, and yz planes (or any other convenient plane). (It is also possible to make 3D plots, but this is not a requirement. Often, such plots are very difficult to read on paper.)

[1]Euler's method is described in some detail here: `http://en.wikipedia.org/wiki/Euler_method`

[2]Hint: magnetic fields do no work! See Griffiths, Eq. 5.11.

[3]Hint: `http://tinyurl.com/284gwez`

[4]Hint: `http://tinyurl.com/2dq9spn`