FYS 3610

Exercise Week 38 due 28. September 2016

Questions as they might appear in the mid-term and/or oral exam

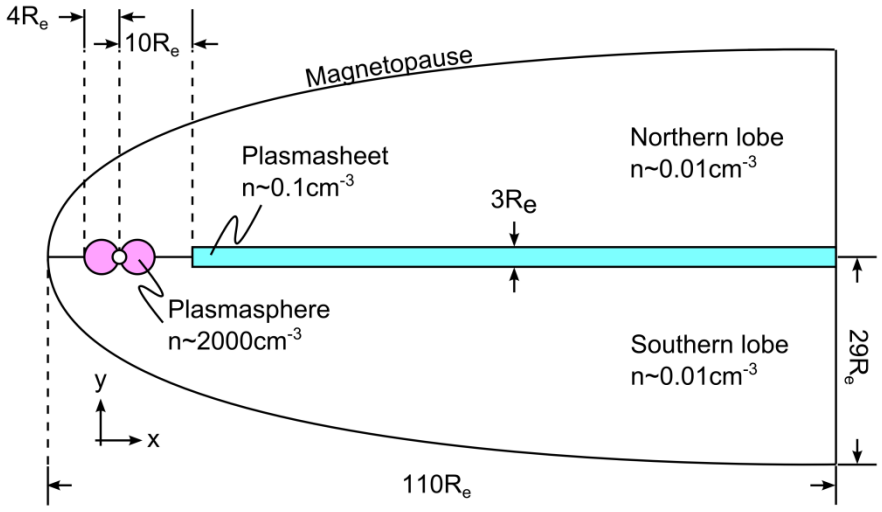
How does the solar wind interact with the terrestrial magnetic field on the dayside? What are the names of the main regions/boundary layers formed? What characterizes each region? What are the typical stand-off distances of these boundaries?

Explain the Chapman-Ferraro current.

What is the magnetic topology on the nightside? What are typical dimensions of these regions?

Exercises

According to Wikipedia, African elephants can reach a mass of 7 tons. Given the following magnetospheric dimensions (as seen from the side with the Sun to the left)



calculate the total mass of the magnetosphere in units of "elephants". Exclude the mass of Earth itself and the upper layers of the atmosphere, i.e., only include the regions

shown above (the lobes, the plasmasheet, and the plasmasphere). Assume the plasma composition is 85% protons, 10% helium, and 5% atomic oxygen throughout all regions. Also assume that the plasmasphere (magenta is the picture above) is a torus which is rotationally symmetric around the vertical y axis. Furthermore, the magnetopause shall have the shape of a polynomial of order 2, i.e. it can be described as $y(x) = a + bx + cx^2$, that is rotationally symmetric around the x axis.

Hints:

To find the total mass, it is easiest to assume that the origin of the coordinate system is at the subsolar point, i.e., at the tip of the magnetopause.

Find a, b, and c, i.e., the coefficients that describe the shape of the magnetopause.

Given a function $f(x)$, the volume enclosed by $f(x)$ between $x_0 < x < x_1$ as $f(x)$ rotates around the x-axis is given by $V = \pi \int_{x_0}^{x_1} f(x)^2 dx$.

The volume of a torus is $2\pi^2 R r^2$, where R is the distance from the center of the torus to the center of the tube and r is the radius of the tube.

The energy density of a magnetic field in vacuum is $E_B = B^2/2\mu_0$. Determine the total energy content of the geocentric dipole field of the Earth outside the Earth's surface. How does that relate to the total energy consumed by humans in 2008 of about 500 exajoules ($10^{18} J$)?