FYS 3610 Week 43

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

Sketch the solar wind-magnetosphere interaction for IMF Bz>0 and IMF Bz <0

Explain the Dungey-cycle.

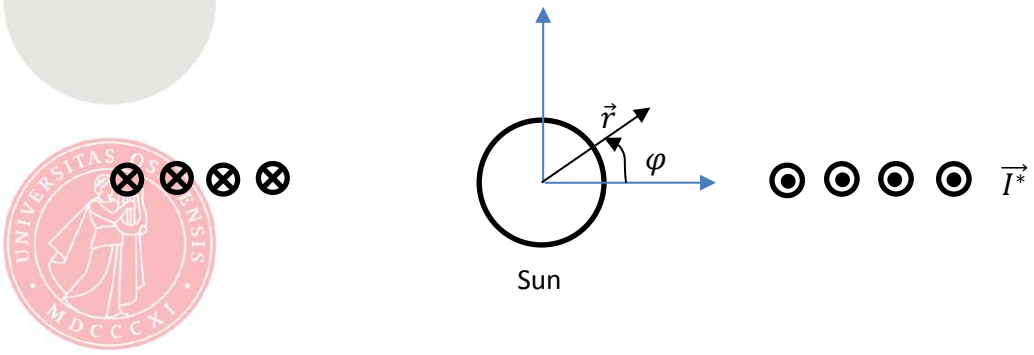
Sketch the typical twin-cell convection pattern in the polar ionosphere and outline how it is formed. Also sketch the horizontal electric fields and locations of field-aligned currents.

Sketch the magnetospheric-ionospheric current circuits.

Exercise 1:

The following sketch illustrates the meridional section of the Sun and heliospheric current sheet with surface current density $\vec{I^*}$ using a spherical coordinate system centered on the Sun $(\vec{r}, \lambda, \varphi)$ (λ going inside the paper).

a) Draw the B_r components of the magnetic field around the heliospheric current sheet.



b) The surface current density is given by $\overrightarrow{I^*} = -\frac{2}{\mu_0}\,\vec{B} \times \hat{n}$ with $\hat{n}$ being the normal unit vector.

Using $B_r(r) = B(r_0)\left(\frac{r_0}{r}\right)^2$ and $B_\lambda(r) = -B(r_0)\,\frac{\Omega_S r_0}{u_{sw}}\left(\frac{r_0}{r}\right)$, where Ω_S and u_{sw} are the angular frequency of the Sun and the velocity of the solar wind, respectively, find an expression for the components of surface current density. Is the current going towards or away from the Sun?

c) Assume that the current heliospheric current sheet is inclined with respect to heliographic equator (the plane where the Earth is located), show that this might provide a plausible explanation for the sector structures of the IMF?

Exercise 2

The ionospheric footpoint regions of the tail lobes are approximately circular regions called the polar caps. Ignoring open magnetic field lines extending into interplanetary space and assuming that the magnetic flux of the polar cap ϕ_{PC} is equal to the magnetic flux at the beginning of the magnetotail ϕ_{mt}, one can estimate the magnetic latitude of the polar cap φ_{pc}.

a) Show that the magnetic flux inside the northern polar cap can be expressed by

$\phi_{pc} = 2\,\pi\,R_E^2\,B_{00}\cos^2\varphi_{pc}$, where B_{00} is the dipole magnetic field strength on the ground at magnetic equator.

Hint: (Use spherical coordinates and the radial component of the dipole magnetic field of the Earth.)

b) Use magnetic flux conservation and calculate the magnetic latitude of the northern polar cap using a magnetic field strength in the magnetotail $B_{mt} \approx 25\ nT$ and a radius of the magnetotail $R_{mt} \approx 18\ R_E$.

Hint: assume the tail lobe to be a half circle.