FYS 3610 Week 42

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

Describe the different layers of the Sun.

What equations do you need to derive the gas dynamic model of the solar wind and what are the assumptions made?

How is the β of a plasma defined?

Sketch the interplanetary magnetic field (IMF) in the ecliptic plane.

Sketch the electric fields, plasma convection and principal currents in the polar ionosphere.

How does the particle motion of electrons and ions change with altitude in the ionosphere?

What is the Pedersen conductivity? What is the Hall conductivity?

Exercise 1:

The equation of motion for ions in the generally is given by

$$m_i n \frac{D\vec{v}_i}{Dt} = nq_i(\vec{E} + \vec{v}_i \times \vec{B}) - \nabla p_i + m_i n\vec{g} + nm_i\gamma_i(\vec{v}_n - \vec{v}_i).$$

Above $\vec{v}_i$ is the ion velocity and $\vec{v}_n$ is the neutral velocity. In the ionosphere and on time scale larger than a few seconds, one can neglect the acceleration term, the pressure gradient term and gravity. Show that

$$\vec{v}_i - \vec{v}_n = \frac{\omega_i \gamma_i}{\omega_i^2 + \gamma_i^2} \frac{\vec{E}'_\perp}{B} + \frac{\omega_i^2}{\omega_i^2 + \gamma_i^2} \frac{\vec{E}'_\perp \times \vec{B}}{B^2} + \frac{\omega_i}{\gamma_i} \frac{\vec{E}_\parallel}{B}$$

Where the electric field $\vec{E}$ is split up into one part perpendicular to $\vec{B}$ and one part parallel to $\vec{B}$: $\vec{E} = \vec{E}_\parallel + \vec{E}_\perp$.

$\vec{E}'_\perp = \vec{E}_\perp + \vec{v}_n \times \vec{B}$ is the perpendicular electric field in the neutral frame. ω_i is the ion gyrofrequency, γ_i is the ion-neutral collision frequency.

Hint:

Step 1) Calculate the dot product of the simplified equation to find the parallel component.

Step 2) Cross the simplified equation of motion with $\vec{B}$, of motion with $\vec{B}$ to find the perpendicular component.

Step 3) Rearrange!

Exercise 2 (optional)

Show that for ideal MHD, the magnetic flux passing through a closed curve that moves with the plasma flow velocity remains constant