FYS 3610

Exercise Week 42 due 25. October 2013

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

Explain the Dungey-cycle.

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

How is the westward electrojet formed?

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

Exercises

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

$$m_i n \frac{d\vec{v}_i}{dt} = q\left(\vec{E} + \vec{v}_i \times \vec{B}\right) - \nabla p_i + m_i n \vec{g} + n m_i \gamma_i (\vec{v}_i - \vec{v}_n).$$

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: Cross the simplified equation of motion with $\vec{B}$, calculate the dot product of the simplified equation of motion with $\vec{B}$, and rearrange.