FYS 3610

EXERCISES WEEK 46

EXERCISE 1

Figure 1 illustrates crossing through the auroral cusp by the FAST satellite.

a) Describe the typical energy of incoming electrons and ions (pitch angle zero is down along the magnetic field line).
b) What are the most likely source for these particles.
c) Note the energy dispersion of ions which is taken as a characteristic of cusp precipitation. Can you provide an explanation for the energy dispersed ions (decreasing with latitude)?
d) dBz in panel b) of the FAST plot is magnetic field variation perpendicular to the orbital plane. Introduce position and direction of Birkeland current sheets from the positive and negative slopes. Where are the Birkeland currents located with respect to the auroral form. Comment your answer.

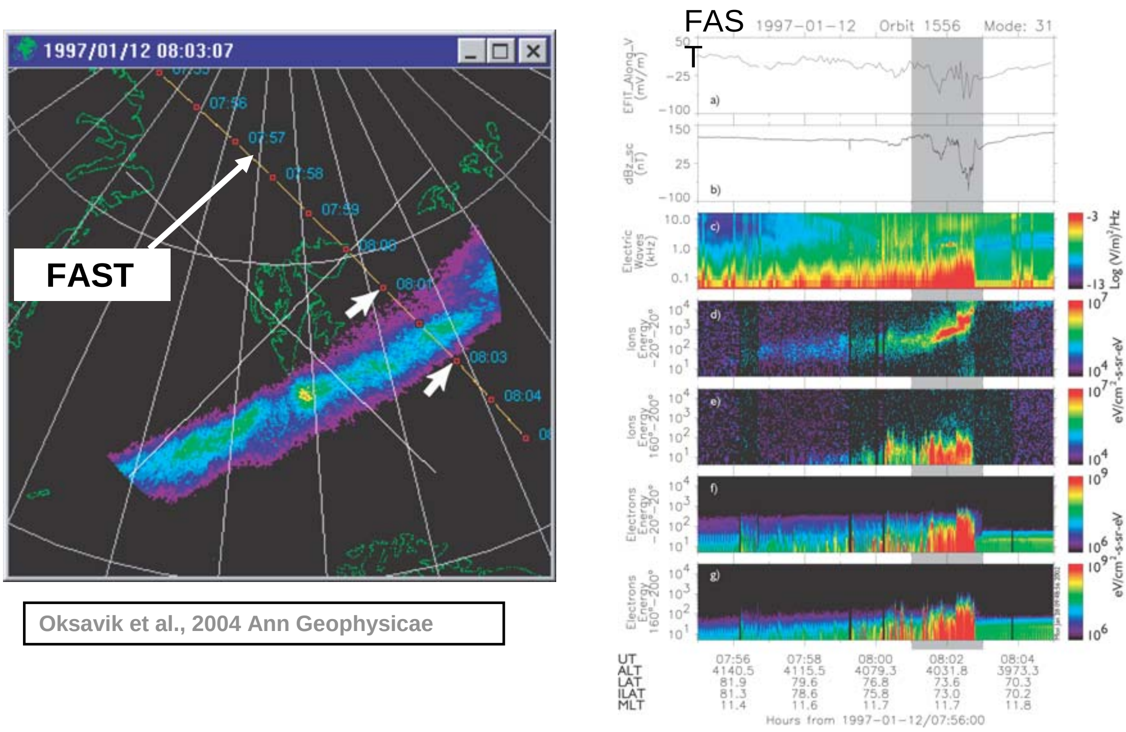

Figure 1 630.0 nm All-sky image from Ny-Ålesund. The straight yellow line indicates the FAST passage over through it, from which data are presented on the right.

EXERCISE 2

THE SUN

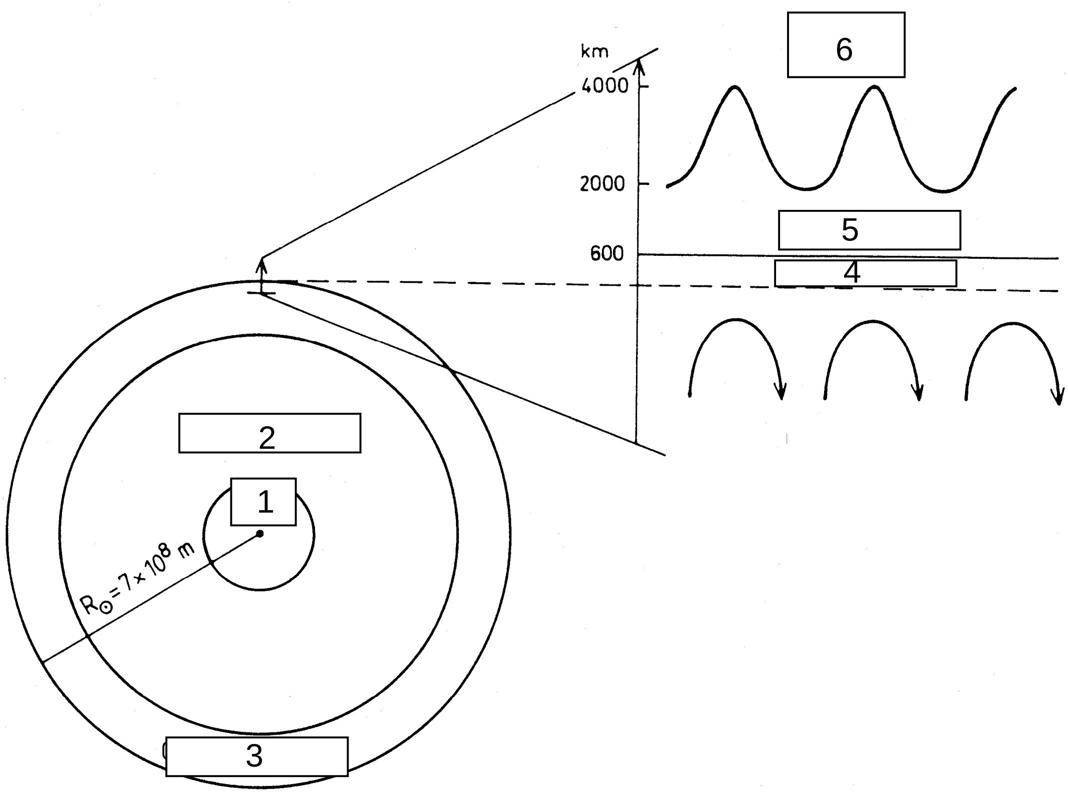

Figure 2

a) Name different regions 1- 6 in Figure 2.

b) Give a brief characteristics of sunspots (where do they occur, magnetic field, temperature,11-year cycle).

c) The solar radius is 6.960 x 10^5 km; the Sun weights 1.989 x 10^{30} kg. What is the escape velocity?

d) The Sun emits 3.9 x 10^{26} Js^{-1}. If all the energy emitted comes from fusion in the core, how much mass is burned off per second of the Sun? How long will it take to burn off 1% of the mass?

e) The total radiated power from the Sun is:

$$Q_S = 4\pi R_S^2 E_S = 3.9 \text{ x } 10^{26}\,\text{W}$$

Show that the radiated energy per unit area at 1 AU (1.496 x 10^8 km) is

1380 Wm^{-2}.

Exercise 3:

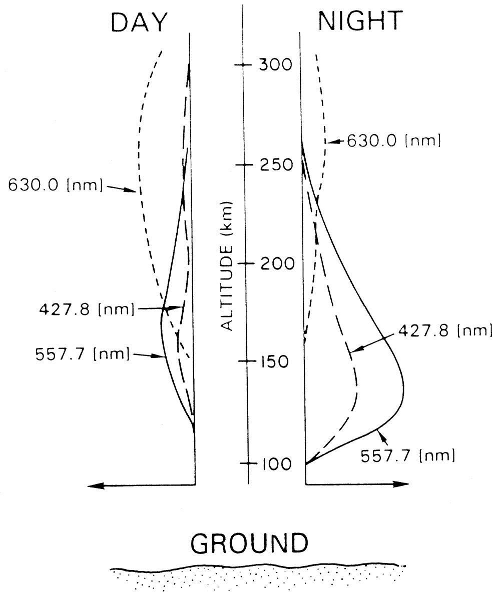

Figure 3.1 Differences between dayside and nightside auroras versus altitude.

a) From Figure 3.1 we notice that 557.7 nm (O^1S) and 630.0 nm (O^1D) emission intensities peak at different altitudes. Explain this observational feature by accounting for the actual excitation cross-sections (σ) given in Table 3.1.

Excited state	σ_{max} (m^2)	E_{max}(eV)
O^1S	0.25×10^{-21}	10
O^1D	0.28×10^{-20}	5.6

Table 3.1. Maximum cross-section and corresponding energy at this maximum for the ^1S and ^1D states of atomic oxygen.

b) Why is the 630.0 nm emission completely absent from the E-region.

c) Why is the dayside aurora more red-dominated than the nightside aurora.

d) Figure 3.2 shows typical altitude profiles of Hall and Pedersen conductivites. Argue why it is reasonable to assume a functional relationship between the ratio $I_{630.0nm}$ / $I_{427.8nm}$ of the auroral intensities and the conductance ratio Σ_P/Σ_H.

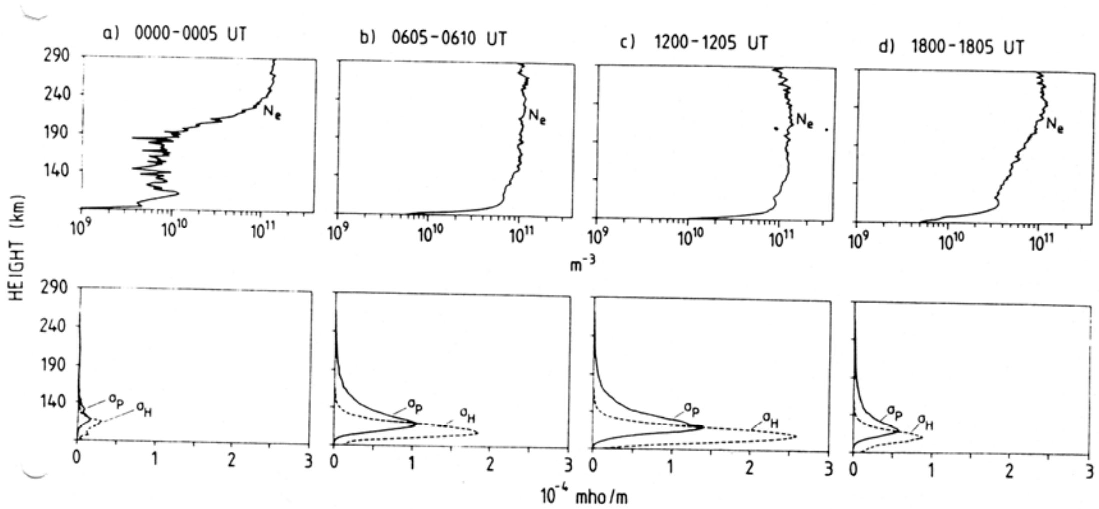

Figure 3.2 Ionospheric $\sigma_H(z)$ and $\sigma_P(z)$ conductivity profiles.