Exercises for november 6.

The magnetic canopy

Imagine a single isolated flux tube in the solar photosphere. Assume the solar photosphere to have a pressure of $1.2 \cdot 10^4$ Pa and a temperature of 5700 K. The molecular wight $\mu = 0.8$ and the graviational acceleration $g = 2.74$ km/s. Assume that the atmosphere is static and isothermal. The magnetic field inside the flux tube is vertical and uniform and completely empty of gas and has a field strength in the photosphere of 0.15 T.

How far up in the atmosphere must we travel before the flux tube has expanded by a factor 10?

Assume know that another flux tube is located at a distance of 25 Mm, How far up in the atmosphere must we go before the two flux tubes meet?

The rapid expansion of the flux tubes with height is named the magnetic canopy (baldakin). It is because of the magnetic canopy that most of the upper chromosphere and the whole corona is filled with magnetic field originating in different flux tubes in the photosphere.

Two component model of stellar atmospheres

Assume that the there are aliens living on a planet that revolves around a star far away. They observe the Sun and try to investigate it's magnetic activity. They observe the combination $fB = 0.045$ T.

First assume that the two component model of the atmosphere holds - meaning that the solar atmosphere is either magnetic or nonmagnetic. Assume further that the solar magnetic part of the atmosphere is only above sun spots, and that all sun spots are the size of the earth (assume the earth has a radius of 6000 km).

If the magnetic field strength inside the sun spots are observed to be 0.2 T, how large a fraction of the solar disk would need to be covered by sunspots? How many sun spots does that corresponds to (assume the solar radius to be $R_\odot = 6.8 \cdot 10^8$ m)?

If the magnetic part of the solar atmosphere was not made from a single size of structures but from several different sizes of structures, then it is necessary to integrate over the different structures.

Assume now that the sizes of magnetic structures have a functional form which follows a power law : $N_B = N_0 \exp\left(-\frac{R-R_0}{1100}\right)$ and that the magnetic field strength inside each of the structures also follows a power law $B_R = B_0 \exp\left(\frac{R-R_0}{7000.}\right)$ with $B_0 = 0.1$ T and $R_0 = 1000$ km.

Now find N_0 when $fB = 0.45$ as the aliens observe.

How many sun spots ($R > 10000$ km) are there?