Homework questions for Ch. 4 Vol. IV

Q1:

Let's define r_0 as the point along a magnetic field line of the Astrospheric Magnetic Field (AMF) at which the field line is open to space by the stellar wind (this is the point at which the wind speed equals the local Alfvén speed). In general, the location of this point, as well as the stellar rotation rate, Ω, can be related to the magnetic field strength at this point, $B_0(r = r_0)$ by some power loaws:

$$\Omega = \alpha B_0^m$$
$$r_0 = \beta B_0^n,$$

where α and β are numerical constants. Using these scaling laws:

1. Modify eq. 4.1 with the above relations.
2. Create tentative plots of B_r and B_θ as a function of r for m=1 or 2, and n=1 (make different plots for each combination of m and n).
3. Discuss how the different solutions affect the shape of the AMF, and how these changes may impact particle transport, CME evolution and propagation, and planets in the Astrosphere.

Q2:

Close-in plants are most likely tidilly-locked. This means that the orbital motion is synchronised with the rotation so that the same side of the planet faces the star all the time. As a result, one side of the planet is always in light and the other is always dark. It has been suggested that with a continuous aurora on the night side, photosynthesis life can exist on the auroral light.

Discuss what information we may need to estimate the amount of available light for such life to exist. Hint: consider what generates the aurora, what input parameter we need to estimate the amount of light (intensity), and what determines the kind of light we may have (i.e., wavelength).